COMBUSTION

DEVOTED TO THE ADVANCEMENT OF STEAM PLANT DESIGN AND OPERATION

Vol. 31 **No. 7**

January 1960

Feature Articles

Editorials

Departments

COMBUSTION publishes its annual index in the June issue and is indexed regularly by Engineering Index, Inc. and also in the Applied Science & Technology Index.

The magazine is now reproduced and distributed to libraries on microfilm by University Microfilms of Ann Arbor, Michigan.

Published monthly by COMBUSTION PUBLISHING COMPANY, INC., 200 Madison Ave., New York 16
A SUBSIDIARY OF COMBUSTION ENGINEERING, INC.
Joseph V. Santry, Pres.; Charles McDonough, Vice-Pres.; Otto Strauss, Treas.; Thomas A. Ennis, Secy.
COMBUSTION is sent gratis to engineers in the U. S. A. in charge of steam plants from 500 rated boiler horsepower up; and to consulting engineers in this field. To others the subscription rate, including postage, is $4 in the United States, $5.50 in Canada, and $8 in Latin America and other countries. Single copies: Domestic, 40 cents, Foreign, 60 cents plus postage. Publication Office, Easton, Pa. Issued the middle of the month of publication.
Acceptance under Section 34.64, P.L. & R., authorized by United States Post Office.

BPA

Printed in U. S. A.

(Drawn from the Monthly Technical Bulletin, International Combustion, Ltd., London, W. C. 1)

...els: Sources, Properties, Preparation

...al—Its Rank and Properties. J. P. ...uder. *Engng. Boil. Ho. Rev.* 1959, ...(July) 210–2.
The N.C.B. classification of British ...ls, types of coal, coking properties ...approximate output of each are ...ulated. The coal sizes and ranks ...st suitable for burning on Low ...m, chain-grate and underfeed ...kers are briefly indicated.

...luation of Low-Quality Coals as ...ler Fuel. H. Werkmeister. *Elektrotsch.* 1959, **58** (June 20) 417–23 (in German).
...n the basis of a questionnaire IPEDE has carried out an analy... of the evaluation of low-quality ...s which has resulted in an equa... of low-quality coals which has ...lted in an equation for the evalua... of a coal in which the utilization ...e of a coal is a direct function of its ...ific value; this is, however, mod... by economic factors variable co... ...ry to country. This new ...lat... ...function is compared with ...e valid in other countries.

Tensile Strength of Coal. R. ...nbaum and I. Brodie. *J. Inst.* 1959, 32 (July) 320–7.
...method particularly convenient ...easuring the tensile strength of ...s described and results obtained ...it are presented and discussed.

...tigations of Bituminous Coals ...e Chalk and Tertiary Formation. ...lasticity Properties and Coking ...cteristics of the Chalk-Tertiary ...—Influence of Petrographic ...osition of these Coals on Their ...ogical Behavior. H. Hoffmann ... Hoehne. *BrennstChemie* 1959, ...ly) 219–27 (in German).
...coals mentioned in the first ...were studied with regard to ...ity under carbonizing con... ...s. The relationship between ...raphic composition and rheo... behavior is presented in graphs ...bles.

Chemistry of Carbonization, ...d on Polymeric Bituminous Model Substances. III. Syn... of ...Model Substances. P. M. ...fs ... W. van Krevelen and ...Waterman. *BrennstChemie* 1959 40 (July) 215–9 (in German).
The methods used for the production of various model substances are described and the behavior of these substances during heating to 200–250 C discussed.

Heat: Cycles and Transmission

Radiant Interchange within an Enclosure. J. T. Bevans and R. V. Dunkle. *A.S.M.E. Preprint No.* 59-HT-4 1959, (Aug.) 19 pp.
A mathematical study in three parts: 1. Absorption and emission behavior of gases; 2. General interchange equations; 3. A method for solving multinode networks and a comparison of the band energy and gray radiation approximations. It is shown that the band energy method is more accurate though more time consuming. It is stressed that many ...assumptions had to be made because of lack of reliable data.

Heat Transfer to Water Flowing Parallel to Tube Gundles. J. Weisman. *Nuci. Sci. Engag* 1959, 6 (July) 78–9.
It is shown that square and triangular pitch lattices when plotted as function of ratio of water flow area to the total cross-sectional area of an infinite lattice yield essentially the same heat transfer coefficients at equivalent ratios. This means that lower fluid velocities can be used to obtain high heat transfer coefficients.

Steam Generation and Power Production

Experimental Determination of Specific Volumes of Steam at High Temperatures and Pressures. V. A. Kirillin and S. A. Oulibin. *Teploenergetika* 1959, (Aug.) 71–3 (in Russian).
New data for the temperature range 500–620 C and up to 700 kg/cm² are presented.

Steam Plant Enclosures May Be Justified. C. D. Birget and J. H. Kline. *Electr. Wrld.* 1959, **152** (Aug. 3) 46–8.

The calculations show that in the northern regions of the United States a fully enclosed power plant will be cheaper in overall costs than a semi- or fully-outdoor plant while in the southern regions the cost differences would be small.

The Calculation of Static Heads and Hydraulic Resistances Occurring in Vertical Risers during Movement of a Steam-Water Mixture. V. A. Lokshin and A. L. Shvartz. *Teploenergetika* 1959, (Aug.) 73–7 (in Russian).

Experimental data on useful heads of steam-water mixtures in risers are presented in graphs.

Operating Characteristics of Boilers in Relation to Steam Demand. E. G. Ritchie. *J. Inst, Fuel* 1959, **32** (July) 314–6.

Installation of thermal storage systems (by pressure drop, steam accumulators, hot process water storage, feedwater accumulator) in smaller industrial plants with widely fluctuating steam demand permits a uniform firing rate of the boiler with consequent efficient combustion and absence of smoke and grit emission.

Forward Planning for the Industrial Plant. C. E. Miller. *Coal Utilization* 1959, **13** (July) 25–8.

Because of changing fuel costs and availability it is recommended to install boilers able to efficiently burn solid liquid and gaseous fuels. Examples of boilers specially designed for rapid conversion are illustrated.

Thermal Liquids Match Process Heating Needs. R. C. Bellas. *Power* 1959, **103** (Aug.) 53–8.

The reasons for an advantages of using liquid heat transfer media for heating purposes in various industrial processes are set out, properties and operating limits of some of these media presented in tables and graphs and boiler plant specially designed for the purpose illustrated. One of the most important points is the prevention of overheating; the means adopted in various design are described.

Some Design Features of the Meramec Twin Furnace Reheat Steam Generator. M. F. Dallen and D. B. Stewart. *A.S.M.E. preprint* No. 59-SA-68 1959, (June) 13 pp.

This boiler is rated at 1850 klb/h at 2150 psi and 1010/1010 F, of semi-outdoor construction, twin furnaces with one convection pass containing the reheater, the other the final superheater. Reheat temperature control is by bias-firing of the furnaces, superheat temperature control by condenser type hea change with feedwater. Three each of 9700 lb h capacity ar nected to two exhausters ea provide for the bias firing. burners are surrounded by gas for firing natural gas alone or i ratio with coal. The dual circu principle is applied to reduc silica content of the steam.

Solid Fuel Firing

Combustion of Crushed, Dried T Lignite and Char in Steam-P Boilers. V. Z. Caracriti and H Mumper. COMBUSTION 1959, (July) 34–44.

A detailed account is given o design of the slagging furnace bc (800 klb h, 1550 psi, 1005/100 and the modifications found neces for the continuous firing of fuel. Also discussed are fur performance, ash deposition c acteristics, chemical composition the ash, fuel abrasion, firing of lig char and the effects of flue gas primary fuel-transport medium.

Liquid and Gaseous Fuel Firing

Comparison of Different Methods Fluid-atomising Oil Flames and Effect on Flame Emissivity and Rad tion of the Addition of Carbon Bl to Liquid Fuels. Performance T No. VIII of the Joint Committee the International Flame Resea Foundation on the Experimental and Gas Furnace at Ijmuiden. Comparison of Different Metho of Fluid Atomizing Oil Flames. The Effect on Flame Emissivity a Radiation of the Addition of C bon Black to Liquid Fuels. H. Hubbard. *J. Inst. Fuel* 195 **32** (July) 328–43.

In the first part differences in t use of a small nozzle at high pressu a convergent-divergent nozzle or t addition of preheat to the atomizin fluid were investigated; all have litt effect on the flame. The total radi tion of flame atomized by air or stea is the same but the former is mo evenly distributed over the leng and its temperature is higher. A dition of a 50/50 suspension of c bon black to gas oil and fuel increased flame emissivity roug in proportion to the increase C : H ratio. The difficulties in ke ing more than 6 per cent C by wei in suspension are discussed.

Water-Side Corrosion and Wa Treatment

The Removal of Organic Substan from Raw Water by Means of Spec Filter Aids. H. Hanning. M

...active carbon has proved in numerous experiments to be the best means of removing organic substances, even phenols and phenolic chlorides being completely removed. The economics of this method are discussed.

Co... ...e Demineralisation and Organ... ...ubstances. C. Janssen. *Mitt. V.G.B.* No. 60 1959, (June 172–8 (in German).

The reduction in capacity of strongly basic ion exchanger caused by the presence of organic substances in the raw water is discussed. Strongly acid ion exchangers on styrol basis are little affected but those on a carbon basis to a large extent. Treatment of the ion exchanger with sodium chloride and its addition to the regenerant is recommended as one means of restoring the initial capacity. Others are the pretreatment of the water with lime, by flocculation or an adsorption filter of special porous resins.

...silicizer Feedwater Process Aids ...ovill. C. K. Stickney, W. C. ...ns and J. W. Walter. *Pwr. ...gng.* 1959, 63 (Aug.) 93–4.

It has been found that strongly ...ic anion exchanges operating on ...hydroxyl cycle are capable of re... ...ing silica from soft water and a ...per process than hot-process soft... ...g or demineralization. At the ...ill plant the residual silica con... ...is ... than 1 ppm and has elim... ...ed CO_2 and CO_3 alkalinity. ...her advantages are that shells, ...es and pipelines do not need lin... that maintenance is low, and it can be added directly to exist... ...odium-zeolite softeners.

...ng Amines Control Corrosion in ...y Plant Condensate System. ... Galloway. *Corrosion* 1959, 15 ... 99–100, 103.

...les are presented showing the ...ion rate of iron in the condensate ...efore and after introducing oc... ...lamine at the rate of 5 ppm ...he feedwater. The protective ...rmed prevented attack by oxy... ...d carbon dioxide in the con... ...e lines but did not protect wet ...of the turbines. The filming ...as no adverse effect on copper ...er alloys.

...s, Ash and Dust

...lication of a Mechanical Col... ...n Combination with an Elec... Precipitator. A. B. Walker ...hyl. *Blast. Furn. Steel Plt.* (June) 622–4.

...ic ... are discussed on which

the decision must depend wh... the mechanical collector is to be installed upstream or downstream of the precipitator.

Possibilities of Fly Ash Separation by Mechanical Separators Taking into Account Experience with Slag... Furnaces. R. Nagel and R. ... *Mitt. V.G.B.* No. 60 1959, (J... 220–9 (in German).

The separation efficiency of cyclone separators and its relationship to costs, power consumption and pressure drop are discussed. High ... cyclones have been developed able to reduce the fly-ash content to below the limit set by law. Results of tests are presented. Deposit formation and complete clogging have been experienced, especially in boilers with slagging furnaces when the temperature of the flue gas fell below the dew point. Where cyclone separators and electrostatic precipitators are used it is suggested that better results are obtained if the former are installed downstream of the precipitators.

Recent Developments of Electrostatic Precipitator Plants. H. Brand... *Mitt. V.G.B.* No. 60, 1959, (J... 229–35 (in German).

The variables on which the separation efficiency of electrostatic precipitators depends are the electric charge the fly ash and gas obtain in the furnace (this may be positive or negative), the gas velocity and composition (moisture content, SO_2 content, SO_3/SO_2 ratio), shape of ash particles, their dielectric constant and composition, design of electrodes and distance between electrodes. In plants burning bituminous coals good experience has been obtained with sparking point electrodes made of flat, soft steel and precipitating electrodes in the shape of perforated boxes; rapping is preferred to vibrating; gas passages should have a width of 10 in.; gas velocity not above 2 m/s, preferably 1.5 to 1.8 m/s; high voltage supply either a.c. or equipped with transducers.

Heat Recovery Plant

Auxiliary Steam System to Blow Soot. Anon. *Electr. Wrld.* 1959, 152 (Aug. 17) 76.

At the Eddystone supercritical pressure plant three oil-fired boilers each rated at 39,500 lb/h at 500 psi have been installed to supply the soot-blowers.

Power Generation and Power Plant

Efficiency of Steam Generation. J. N. Williams. *Pwr. and Wrks. Engng.* 1959, 54 (July) 395–401.

...." method of determining ...ficiency, the Siegert ...ry heat loss, gas tem- ...CO_2 determinations are

...ics of Air Preheat on ...oilers. C. L. Brown. ...1959, 31 (July) 51–5.

...rovements in boiler ef- ...the installation of air pre- ...assessed on the basis of ...industrial plants with in- ...costs set against fuel sav- ...mulæ are presented for ...efficiency calculations.

...of a Steam Power Station. ...ly. *Engineering* 1959, 188 ...42–4.

...blem of economic and ef- ...tilation of a steam power ...set out and tests carried ...ation with 60 MW of plant ...escribed. The results are

...Converters. K. G. Hern... ...*leonics* 1959, 17 (July)

...in the design of therm- ...are described which promise ...efficiencies in the direct ...of the thermal energy of ...ctors into electricity at ...eratures.

...ell. H. A. Liebhafsky and ...las. *Mech. Engng.* 1959, 81

...of the different approaches ...ign of an efficient fuel cell ...cent progress by leading

...is Primary Fuel in New ...m Plant. H. B. De Bene- ... Farmer and E. F. Court- ...*Engng.* 1959, 63 (Aug.)

...d coke at a temperature of ...is directly delivered by ...boilerhouse bunkers and ...rized in attrition-type mills ...tungsten carbide. The ...elements are also faced with ...rial. The pulverized coke ...to the opposed burners tilted ...at an angle of 35° in the ...ted at 500 klb/h at 600 psi ...or 1300 psi and 950 F. ...he ash is collected as slag ...nace bottom; fly ash from ...the separators is mixed with ...and passed again through ...The abrading action of ...oke particles assists in keep- ...deposit formation. Up to ...nt of coke in a mixture of ...gas or oil has been fired suc-

...Steam Electric-Generat- ...C. H. Rulfs and J. K.

fuel cost over the life of the unit estimated at 22¢ per million B the load factor should average 75 p cent. The area required by the MW units 1 and 2 was 215 sq 1000 kW, for the 250 MW unit 3 164 sq ft/1000 kW and for the MW unit 4 it will be 134 sq ft/1 kW. The turbine is divided into hp and ip unit running at 3600 r and a lp unit running at 1800 r which has an axial flow design resul ing in a higher temperature of th condensate returned to the feedwat cycle. Three half-size boiler pump have been installed. The dual cir culation principle of the boiler is ex pected to reduce boiler blowdown by 80 per cent.

The "Schwarze Pumpe" Power Station. 1st Stage. K. Bruche. *Ener gietechnik* 1959, 9 (Aug.) 341–52 (in German).

In the East-German Republic a large combined undertaking is being developed on brown coal basis, including briquetting works, coke ovens, gas works and power stations. The power stations will have to provide energy for three briquetting factories with an output each of 2.1 × 10⁶ t/a, one pressure gasification plant for 3.5 × 10⁹ m³/a of gas, three coking plants each for 0.9 × 10⁶ t/a high temperature coke and 0.5 × 10⁹ m³/a coke oven gas, and also steam for process and space heating and a district heating network. The first stage of its power station "West" contains 230 t/h boilers, those of the 2nd and 3rd stages will contain units consisting of a 420 t/h boiler and a 50 MW extraction-back-pressure turbogenerator. There are 6 boilers each rated at 230 t/h at 125 atu and 535 C and a feedwater entry temperature of 235 C, three 50 MW extraction-back-pressure turbogenerators and four 25 MW condensing turbogenerators. Hot water for process heating is supplied at 110/180 C from calorifiers by exchange with steam from the 17.5 ata mains, hot water at 70/130 C for space heating by exchange with steam at 5 ata. The boilers are of the semi-outdoor type. The brown coal contains 57.5 per cent moisture, 7.5 per cent ash and 1 per cent S, pulverized in mills each of 32 t/h capacity and injected through corner burners. Bottom ash is removed hydraulically, fly ash from the hoppers of the electrostatic precipitator, flue gas ducts and chimney bottom pneumatically. The description also includes boiler control, turbogenerators, feedwater treatment and 30 kV switching station.

A. Müller. *Energie* 11–3 (in German).
Munich heat-power in the center of the emphasis was laid on the buildings and maproblems encountered employed are given.

Nuclear Power Sta- *Nucl. Energy Engr.* 456–7.
ilities of insulating the els at Berkeley nuclear owing to the large exiscussed and the methods described.

nah. Reactor Physics and P. M. Wood and Z. *ucl. Energy Engr.* 1959, 13 5.
ort describes the fuel eletheir arrangement in the reactivity calculations.

Experience at Vallecitos. *Engng.* 1959, 63 (Aug.)

g water reactor supplies tly to a 5 MW turbout is mainly used for test, such as the fuel ele- the Dresden nuclear reation levels in the turctor building are low, the exposure for any individexceed 390 mr in one and Turbine and generator essible at all times, but els at the demineralizer, and steam purifier mainly 16 are higher. Stability or has been very good at 900–1000 psi and out-30 MW (thermal) and at es from 0 to full load in minute.

nd Manufacturing Processes

Reactors and Processing Watkins. *Nucl. Engng.* uly/Aug./Sept.) 296–303.
w of the special properties or application of mild steel reactors under the head- Physical properties; 2. l properties (tensile, creep); ical compatability; 4. 5. Nuclear considerations. et is included.

mic Coatings. Anon. *Nucl. ngr.* 1959, 13 (Sept.) 448–9,

mposition of the new coatteels in nuclear reactors de- the U. S. Bureau of Standabulated and the properties sed.

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Abstracts From the Technical Press—Abroad and Domestic

(Drawn from the Monthly Technical Bulletin, International Combustion, Ltd., London, W. C. 1)

els: Sources, Properties and eparation

e Oxidation of Bituminous Coal by :. Formation, Composition, and operties of Oxidized Coals and mic Acids. O. Grosskinsky, G. ick and W. Lange. *Brennst Chemie* 59, 40 (Aug.), 252–61 (In German). Experimental studies are presented the way in which oxygen is built o the molecular structure of the l, its components and the humic ds during oxidation. The results the studies are discussed mainly h regard to the chemical structure coal and humic acids.

e Chemistry of Carbonization Intigated on Polymeric Model Subnces of Bituminous Coal. IV. olysis of Model Substances with-Special Functional Groups. P. M. Wolfs, H. I. Waterman and D. W. Krevelen. *Brennst Chemie* 1959, Aug.), 241–51 (in German).

he of radioactive formalde- ie ... e possible a determination he number of bridges in the original erials and also to follow the hanism of pyrolysis by a combina- of radiochemical, thermogravi- ric and analytical methods. Two ses could be distinguished, a nary one of depolymerization. aromatic hydrogen is liberated ng the secondary phase in which ar formation occurs. This hydro- forms methane the carbon being en from the whole carbon skeleton.

hanical Handling

v of Bulk Granular Materials. I. Barre. *A.S.M.E. Preprint* No. A-46 1959, (June), 4 pp.

brief review of what is known at the flow of materials from bers and the factors affecting it is wed by a discussion of means of oving the flow under various mstances.

es and Transmission

t Transfer in the Critical Pressure ge with Forced Flow of the kin- Medium. M. A. Styriko- ... Mikropolsky and M. E. man. *Mitt. V.G.B.* No. 61, 1959 .), 288–94.

heoretical and experimental work on heat transfer at high pressures and temperatures is described and the good agreement of results emphasized. Nomograms are presented for the determination of local heat transfer coefficients.

Steam Generation and Power Production

The Experimental Investigation into the Heat Capacity of Water at Temperatures from 10 to 500 C and Pressures up to 500 kg/cm². A. M. Syrota and B. K. Malzev. *Teploenergetika* 1959 (Sept.), 7–15 (in Russian).

The results obtained are presented in tables and graphs and compared with those of other authors.

Precision Analysis and the Combined Table of Experimental Values of the Specific Volume of Water and Water Vapor Obtained in the Moscow Power Institute. V. A. Kirilin and S. A. Ouilibin. *Terploenergetika* 1959 (Sept.), 3–7 (in Russian).

The accuracy of the results obtained for specific volume of water and water vapor at temperatures up to 650 C and pressures up to 900 kg/cm² has been analyzed and two tables are presented, one giving reliable and the other giving unreliable data.

The Viscosity of Water Vapor at Atmospheric Pressure. A. S. Shifrin. *Teploenergetika* 1959 (Sept.), 22–7 (in Russian).

The viscosity of water vapor at atmospheric pressure and temperatures up to 866 C has been measured by the two capillaries method. The results are presented in tables and graphs.

Unstable Thermal Stresses in Cylindrical Hollow Cylinders. J. Böhm and R. Ehrich. *Mitt. V.G.B.* No. 61, 1959 (Aug.), 307–14 (in German).

The equations are derived for sudden and linearly occurring changes of temperature of the steam flowing through a pipe. The application of the equations is illustrated by examples.

Investigations into Pressure Drop due to Friction of Water-Steam Mixtures and the Slip Velocity of the Steam in

(*Continued on page 66*)

Vertical Boiler Tubes. K. Jaro and F. Brandt. *B.W.K.* 1959 (Sept.), 407–13 (in German).

Laboratory tests on a full- plant with an inner tube dia 57.5 mm (2.25 in.) were made pressures up to 200 atü (2900 to determine the slip velocity of steam and the friction coeffic Increased turbulence of the wa steam mixture is thought to be sponsible for the higher friction efficients found. It is believed the diameter of the tube has also influence on the friction coeffic but its verification must await furt tests. A theory for the slip velo of the steam is put forward.

Thermal Design of a Steam Gene ing Unit with the Assistance of "Ural" Computer. M. P. Simo F. A. Voulman and S. A. Stavtze *Teploenergetika* 1959 (Sept.), 3 (in Russian).

The method developed for using computer in steam generator desig described.

Packaged Fire-tube Boilers. G. Wh tingham. *J. Inst. Fuel* 1959, (Aug.), 370–4.

The important design features liquid-fuel fired shell-type boilers described and combustion contr feedwater treatment and performan discussed briefly.

Application of Cyclone-Furnace Fir to Industrial Boilers. C. T. Smit *A.S.M.E. Preprint* No. 59-SA-53 19 (June). 20 pp.

The advantages of the horizont cyclone furance over pulverized co firing are outlined and examples installations described. The fuel us is coal. lignite, bark, gas and oil eith singly or in combination. Boil sizes range from 125 klb/h to 5 klb/h.

The Economic Purchasing of Coal f Small Boiler Plants. G. Armstron *Steam Engr.* 1959, 28 (Aug.). 327–9.

The coal evaluation system worke out by I.C.I. is explained and illu trated by examples. The level coal stock to be held is also discusse

Dimensionless Coefficients of Mix ture Formation in Combustion Cha bers. Part IV. W. H. Fritsc *Energie* 1959, 11 (Aug.), 340–3 (German).

The determination of the mixtu coefficient from results of maximu load tests on the combustion chamb described in Pt. III (abstract 481 is described and from this the relatio ship between Fourier number an excess air established. It is co cluded that the field of concentrati in this combustion chamber was muc more uniform than in the usual one

heat release rates were ether with extremely times and the mixing a function of excess air pressure increasing with lues of both.

Corrosion and Water

itions of Weak Mineral nsition from Boiler Feed Saturated Steam and the eed Water Alkalinity (pH) ocess. M. A. Strykovitch, nova, I. H. Haybullin and ngoulina. *Teploenergetika*), 50–6 (in Russian).

Tests of Inhibitors to Chloride Stress Corrosion. illips and W. J. Singley. 959, 15 (Sept.), 18–22.

ct of various inhibitors on orrosion attack of austentic eel by chloride contained phosphate boiler water studied in the laboratory. tion of sodium nitrate and lfite seemed to be the best ut in subsequent tests on tube model boilers with itrate cracking was found. ests are in progress to discrepancy.

er Water Treatment Test R. G. Murray and M. E. *Corrosion* 1959, 17 (Sept.),

pparatus used to study cor- copper condenser tubes and made at two levels of water nd two water temperatures bed. Pitting corrosion was tubes with water at low and this was more severe in than low water temperature correlation was found be- amount of silt deposited everity of pitting.

nce of Copper Deposits ted with a Boiler Tube Failure. purr. *Corrosion Techn.* 1959, 6 233–7.

noticed that the tube failures sociated with considerable of copper around the bursts. examinations and laboratory ggest that the method of on of metallic copper deposits ubes was by overheating of ontaining a layer of copper e or copper oxide sludge ntergranular copper penetra- ue to the action of molten The temperatures in this e must have been at least A further requirement was urrence of stresses due to hock.

Gas-Side Corrosion and Deposits

A Review of Available Information on Corrosion and Deposits in Coal- and Oil-Fired Boilers and Gas Turbines. Report of ASME Research Committee on Corrosion and Deposits from Combustion Gases. Battelle Memorial Institute, H. W. Nelson, H. H. Krause, E. W. Ungar, A. A. Putnam, C. J. Slunder, P. D. Miller, J. D. Hummel, and B. A. Landry. *Pergamon Press*, London, 1959, 198 pp.

The contents of this detailed review are: 1. Introduction (gaps in our knowledge on external deposits and corrosion in boilers and gas turbines); 2. Mineral constituents in coal and their behavior during combustion; 3. Ash-forming constituents in heavy fuel oil and their behavior during combustion; 4. Oxides of sulfur in boilers and gas turbines; 5. The physical aspects of deposition in boiler and gas turbine systems; 7. High-temperature corrosion; 8. Corrosion of metals exposed to combustion gases below 400 F; 9. The removal of solids from combustion gases. Each chapter has its own summary and list of references.

Flue Gas Side Corrosions. Pt. III. SO_2, SO_3, Dew Point and Measuring Techniques. Pt. IV. Summaries and Material Problems. W. Gumz. *B.W.K.* 1959, 11 (Sept.), 425–9 (in German).

A review of the literature of recent years in the two fields. An appendix reviews some of the latest (1959) contributions, especially those relating to oil firing.

Fire Side Corrosion in Oil-Fired Boilers. L. K. Rendle, R. D. Wilson, and G. Whittingham. *Combustion* 1959, 31 (Aug.), 30–41.

Laboratory, pilot-scale and full-scale plant investigations are reported, divided into high-temperature and low-temperature studies. In the former, various steels differing in Cr content (cooled) and heat resisting alloys (uncooled) were exposed to combustion gases from fuel oil with low and high V content, without and with addition of dolomite. It is concluded that the corrosion resistance of superheater tubes at 900–1300 F increases with increasing Cr content and that uncooled stainless steels at 1500 F are more resistant to combustion gases from low V and high S content oil than nickel base alloys. The addition of dolomite led to rapid blockage of the tube banks. In the low temperature corrosion tests the beneficial effect of ammonia injection was confirmed.

Suppression of the Sulfuric Acid Dew

Point by Teramin. K. \ *Energie* 1959, 11 (Apr.), 344 German).

The reasons for the corros hibiting properties of Terami been studied in the laborato: the tests carried out at tempe. of 20, 60, 100 F and higher an. results are described. Teramin with H_2SO_4 to form Teramin s which have the same inhibiting as Teramin itself. The sulfat water soluble and the heatin faces can thus be easily clean water washing. They are also flammable and incombustible.

Flue Gas, Ash and Dust

Building Materials Produced Combustion Residues of Slag and Granulating Boilers. H. Eryt pel. *Mitt. V.G.B.* No. 61, (Aug.), 257–61 (in German).

German experience in the uti tion of fly ash and granulated for building materials is presen costs of plants given and the c petitiveness of the new with c ventional products discussed.

Survey of Present and Future D velopments in the Utilization of I Ash in Great Britian. H. W. Dedman. *Mitt. V.G.B.* No. 61, 19 (Aug.), 261–5 (in German).

Limit values of the various co stituents of fly ash for different us are tabulated and the main fields utilization described: 1. Standar light concrete building bricks; Building bricks; 3. Light aggregates 4. Partial replacement of cement or a addition to cement or sand in con crete; 5. Road and dam building 6. Filling-up of building land.

Some Practical Examples of the Utilization of Fly Ash for Dams, Road Foundations and Bituminous Surfaces. J. Glover. *Mitt. V.G.B.* No. 61, 1959, (Aug.), 266–73 (in German).

Various applications in Great Britain are described and the results obtained are discussed.

Stack Emission Control during Power-Plant Load Cycling. J. F. McLaughlin and G. V. Williamson. *A.S.M.E. Preprint* No. 59-SA-28, 1959 (June), 4 pp.

Avoidance of smoke nuisance from older boiler plants, especially during rapid load changes, is discussed. Replacement and modernization of older boilers, changes in fuel used, improved instrumentation, changes in operating procedures and application of schedules avoiding sudden load swings are recommended measures; examples of their application are cited.

ncentration of Sulfur Dioxide Atmosphere Near Power W. G. Cummings and M. Hearn. *J. Inst. Fuel* 1959, **32** 358–63.

Results of measurements with a le SO_2 meter in the neighbourof 11 power stations with ys from 150–450 ft. height ulated. It is shown that the ration of SO_2 at ground level stations was low.

Generation and Power Plant

rmoelectric Power. An Investigaof its Possibilities. Part 1. ent Methods of Power Generaa. Part 2. Engineering Design meters and Performance. Part General Discussion and Approxi- Analysis of Economics. G. W. on and B. C. Lindley. *Engineer-* 1959, **188** (Aug. 28), 97–9; (Sept. 29–32; (Sept. 11), 161–2.

The first part deals with thermo- ric devices, efficiency of thermo- ic generation, thermionic diode verter and the gas-filled diode; second with materials, thermo- ments, thermopiles, heat sources and sinks, configurations of thermo- ic generator and its use with organic-moderated reactor; the third with a general discussion of the ious types, and applications.

ency of Steam Generation III. N. Williams. *Pwr and Wrks* ng. 1959, 54 (Aug.), 463–9.

This third part deals with methods direct measurement of efficiency and the instruments required for this purpose, viz. fuel sampling and analysis, coal weighing, feedwater and steam flow metering, pressure and temperature meters.

Design Features of New Coal-Burning Plants. Anon. *Coal Utilization* 1959, **13** (Aug.), 22–7.

Some examples of typical installations from the largest steam generators to the smallest hot water boilers are described. Most of these have both automatic coal feed and ash removal systems.

Aasnaes Power Station (Denmark). Anon. *Elektroteknikeren* 1959, **55** (June 8), 160–7 (in Danish).

An account is given of all features of this station which is equipped with two 120 MW sets each unit-connected with a 400 tons/hr. dual-fuel boiler. Steam temperature is 540 C at T.S.V., pressure 130 kg/cm². From cold, the best start-up time is 55 minutes to paralleling and 115 minutes to 100 M after 6 hours shut-down, 30 an minutes respectively.
From *C.E.G.B. Digest* 1959, 11 (Apr. 15), 2022.

Combustion

DEVOTED TO THE ADVANCEMENT OF STEAM PLANT DESIGN AND OPERATION

volume 31 number 9 **March 1960**

Published monthly by COMBUSTION PUBLISHING COMPANY, INC., 200 Madison Ave., New York 16. A SUBSIDIARY OF COMBUSTION ENGINEERING, INC.

Joseph V. Santry, President

Charles McDonough, Vice-President

Otto Strauss, Treasurer

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COMBUSTION is sent gratis to engineers in the U. S. A. in charge of steam plants from 500 rated boiler horsepower up; and to consulting engineers in this field. To others the subscription rate, including postage, is in the United States, $5.50 in Canada, & $8 in Latin America and other countries Single copies: Domestic, 40 cents, Foreign, 60 cents plus postage.

Publication Office, Easton, Pa. Issued the middle of the month of publication.

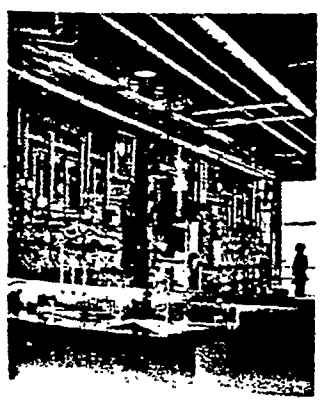
Acceptance under Section 34.64, P.L. & R., authorized by United States Post Office.

COMBUSTION publishes its annual index in the June issue and is indexed regularly by Engineering Index, Inc. and also in the Applied Science & Technology Index.

The magazine is now reproduced and distributed to libraries on microfilm by University Microfilms of Ann Arbor, Michigan. BPA

Printed in U. S. A.

Free use of space and environment in modern boiler room is characterized by the cover view of the installation at the Procter & Gamble Co. plant, Sacramento, Calif., see page 42.



Fuels: Sources, Properties and Preparation

Coal ience. I. G. C. Dryden. *Nature* 1959, **184** (Aug. 8), 412–14.

Summaries are given of papers pre-ented to the 3rd biennial Interna-ional Conference on Coal Science held .t Valkenburg, Holland, on Apr. 7–30, 1959. Research into chemical eactions of coal, ultra-fine structure f coals and chars, spectroscopy of oals and carbonization was described.

tudies of Coal. Staff of B.C.U.R.A. *Jature* 1959, **184** (Aug. 8), 425–7.

The first article deals with carboni-ation of coals in the presence of ac-vated charcoal and the second with noke emission from coal and low-:mperature chars.

.ate of Discharge of Granular Mate-als from Bins and Hoppers. H. E. ose and T. Tanaka. *Engineer* 1959,)8 (Oct. 23), 465–9.

From results obtained on models an quation has been derived for the lculation of the rate of discharge of ost materials from bins and hoppers normal type. The accuracy of the lculation is considered sufficient r al' -actical applications.

:gt: Cycles and Transmission

eat Transfer at High Pressures. ion. *Engineering* 1959, **188** (Oct. , 286–7; (Oct. 9), 317–9.

Research on heat transfer in nuclear wer boilers operating with hot gas 10 and 20 atm pressure is reported.)th an open and a closed circuit re used and results are presented the latter. A general relation for : Nu number could be established.

:at Transfer and Draft Loss in the be Banks of Shell Boilers. D. J. I. derick, M. V. Murray and A. G. ill. *J. Inst. Fuel* 1959, **32** (Oct.),)–63.

Tests on an Economic type boiler re carried out to determine the uracy of dimensionless equations the heat transfer by forced convec-a from hot gases flowing through ter-cooled tubes. The effect of erting retarders on draught loss in tubes has also been investigated. pendix 1 presents an evaluation of draught loss, Appendix 2 the results of tests with turbulence promoters or retarders and Appendix 3 design curves for shell boiler tube banks.

Steam Generation and Power Production

About Calorific Properties of Water under Pressures up to 500 kg/cm² and Temperatures up to 300 C. A. M. Sirota and E. P. Beliakova. *Teploenergetika* 1959 (Oct.), 67–70 (in Russian).

New experimental data of C_p of water are compared with those of other authors and with calculations from p-v-t data. The enthalpy of water is calculated up to 500 kg/cm² and 300 C.

An Experimental Investigation into Thermal Conductivity of Water. N. B. Vargaftik and O. N. Oleschuk. *Teploenergetika* 1959 (Oct.), 70–4 (in Russian).

Values obtained by experimental investigations are tabulated for the temperature range 20 to 350 C.

An Experimental Determination of Specific Volumes of Water up to 1200 kg/cm.² M. P. Voukalovich, V. N. Zoubarev, A. A. Alekdsandrov and U. J. Kalinin. *Teploenergetika* 1959 (Oct.), 74-7 (in Russian).

Experimental data are presented of specific volumes of water at pressures up to 1200 kg/cm² and temperatures up to 300 C and compared with results of earlier investigations.

Experimental Investigation into the Effects of Cross Flow with Condensation of Steam and Steam-Gas Mixtures on a Vertical Tube. T. Furman and H. Hampson. *Proc. Inst. Mech. Engrs.* 1959, **73**, No. 5, 147–69.

As part of a study of film and dropwise condensation of steam an experimental investigation was carried out into the effect of cross flow velocities of steam, containing some non-condensable gas, on the overall and steam side coefficients for the steam condensing on a tube with either filmwise or dropwise mode. The results are presented and discussed.

The Big Waste Burning Plants are a Source of Heat and Power. J. H. D. Many plants use the heat to generate hot water or steam for various purposes. On average 1.2 lb. of steam can be produced from 1 lb of waste. Several modern incinerator and waste heat utilizing plants are described.

The Shell Boiler: An Historical Review: M. V. Murray. *J. Inst. Fuel* 1959, **32** (Sept.), 425–33.

Fuel Firing

Choice of Coal Preparation Systems for Pulverized-Fuel Firing. J. M. Beer. *Engng. Boil. Ho. Rev.* 1959, **74** (Sept.), 274–9.

The direct and indirect (open and closed circuit) methods of pulverizing and transporting the coal to the burners are compared. Equations are developed to obtain criteria for the application of one or other of the methods.

Automatic Stokers. Anon. *Engineer* 1959, **208** (Oct. 23), 487.

A water-cooled precombustion chamber for shell-type boilers has been introduced to this country from the Continent which differs in essential details from other designs. The coal is moved by a screw conveyor to the top center of the chamber and drops through a vortex chamber and in a thin layer on the grate of the combustion chamber. One third of the combustion air is injected through the grate, one third in a tangential direction through a duct in the vortex chamber and one third into the combustion gases at the throat between the combustion chamber and boiler. All types of coal with an upper size of 1 per cent, maximum fines content of 35 per cent below $^1/_8$ in. and maximum moisture content of 15 per cent can be burned. A consistent CO_2 figure of $^{14}/_{16}$ per cent without smoke production is obtainable.

Unit Wide-Ram Coking Stoker. Anon. *Engng. Boil. HO. Rev.* 1959, **74** (Sept.), 279–80.

A new stoker has been introduced which fully complies with the Clean Air Act and can be used in all shell type and small water-tube boilers. It has infinitely variable hydraulic speed control of the grate and feeding mechanism.

Chain Grate Ash Extractor. Anon. *Engineer* 1959, **208** (Oct. 16), 441.

A new extractor has been developed by Riley (I.C.) Products Ltd. for use with the "T" chain-grate stoker. The conveyor has apron plates on

which the ash is carried to the front ash box and is driven by a $^1/_8$ hp geared motor to give it a speed of $3^1/_8$ ipm. The conveyor incorporates a steam cleaning device to remove fine ash particles.

Pressure-jet Oil Burners for Boiler Use. A. M. Brown. *J. Inst. Fuel* 1959, **32** (Sept.), 409–17.

The development of this type of burner is reviewed. It is stressed that present day knowledge of high combustion intensity, liquid sprays, furnace aerodynamics and flame stabilization is insufficient and requires intensive research, if possible by model studies, to obtain higher combustion efficiencies, larger turndown rates and higher efficiencies.

Furnaces and Combustion

Combustion. R. Friedman and J. H. Grover. *Ind. Engng. Chem.* 1959, **51** (Sept.) (Pt. II), 1067–74.

The annual review of the literature for 1958.

An Investigation into Radiant Heat Exchange in the Furnace of a Steam Generator Burning Natural Gas. F. P. Kazakevich, A. M. Krapivin, G. I. Anofriev and I. G. Vesley. *Teploenergetika* 1959 (Oct.), 34–8 (in Russian).

The experimental data are compared with results obtained by calculation and the good agreement is noted.

Similarity Criteria for the Study of Furnace Flames by Means of Cold Models. G. G. Thurlow. *Comb. and Flame* 1959, **3** (Sept.) 373–88.

The conditions necessary for obtaining similarity between a model and a furnace are considered in detail and criteria developed for the conditions under which these can be applied. Criteria are derived for two cases dependent on whether the momentum of the secondary air is appreciable or not. Tests on a small gas-fired and a cold model of similar dimensions are reported. Reasonable agreement of the order $\pm 20\%$ between the mixing of fuel and air in a hot and a cold furnace is thought to be attainable.

Laboratory Investigations into the Behavior of Fuels in Furnaces. K. Wickert. *B.W.K.* 1959, **11** (Oct.) 455–62 (in German).

The experiments concerned the combustion velocity of carbon and sulphur alone and together as a function of temperature, time and particle size, of gases containing H_2S, CO, H_2, CH_4 and O_2 as a function of temperature and excess air, and of oil coke as a function of pretreatment temperature (volatile content). The results show that the fly ash particles contain a C-S compound of unknow composition which is very stable t to temperatures of about 1300°(It follows that in furnaces with rel tively low temperatures (dry as removal) most of the sulphur in th coal is carried away in the fly ash whilst in furnaces with high tempera tures (liquid slag removal) much o the sulphur is liberated and able t form new compounds with oxygen hydrogen and the mineral constitu ents of the ash. From temperature of 1 200°C upwards S reacts with SiO_2 and alkali forming silicon disulphide, alkali sulphates and alkali pyrosulphates of which the latter are mainly responsible for deposit formation and corrosion.

Power Generation and Power Plant

I.E.E. Local Centres. Anon. *Electr. Times* 1959, **136** (Oct. 15), 400–1.

In his address "Past, Present and Future" the chairman of the North-Western Centre, F. J. Hutchinson, discussed the future of thermal power stations. He believed that 800 MW sets would be built with steam conditions of 5000 psi and 1200/1500 F within the next 10 years. The heat rate would decrease by 6.7 per cent, compared with 2350 psi and 1050/1000 F, to 8400 Btu/kwhr. Boilers would be of the forced-flow once-through type with pressurized furnaces and liquid slag removal. Capital cost per kw installed would then fall to below $112 compared with $117.60/kw for Thorpe Marsh. Mr. H. Watson Jones, the chairman of the North-Eastern section, gave some details of the Trawsfynydd nuclear station and the advances made in design compared with the earlier stations.

11th Steam Station Cost Survey. Anon. *Electr. Wrld.* 1959, **152** (Oct. 5), 71–86.

The comparison of various data of steam power stations operations and costs between 1956 and 1958, given in tables and graphs, shows that the average cost of energy production has decreased from 7.15 mill to 7.04 mills per net kwh, construction costs from $146/kw to $140.6/kw, fuel costs from 83 to 80.8 per cent, average annual plant factor from 69 to 61.8 per cent and utilization factor from 103 to 100.4 per cent. The predominant steam parameters remained constant at 1800 psi and 1000/1000 F and use of reheat decreased from 80 to 76 per cent. The average station heat rate continued to decline and now stands at 10,934 Btu/net kwh. Installations of outdoor plant has made further progress and boiler room volume decreased from 12 to 11 cu ft/kw.

90.

Block diagrams and tables give details of conventional and nuclear power station units which were commissioned or under construction during 1959. (1) Boiler sizes are remaining fairly constant with a trend to pressures of 2400 psi, although 1800 psi is still predominant; (2) pulverized coal continues to be the main fuel; (3) pressurized furnaces are gaining ground; (4) heat release rates of 6,000 to 20,000 Btu/cu ft/h predominate.

Steam Turbine Cycles in Power Stations. K. Fenton. *Electr. Rev.* 1959, 165 (Oct. 2), 373–7.

The improvement in cycle efficiencies achieved in recent years is reviewed with reference to non-reheat, reheat and supercritical pressure plants. The dual-pressure cycle used in gas-cooled nuclear power stations is also discussed.

Efficiency of Steam Generation. J. N. Williams. *Pwr. and Wrks. Engng.* 1959, **54** (Sept.), 515–25.

The setting up of a heat balance is discussed and the investigations required additionally for this purpose described. Examples of application are given.

Industrial Plant Design Survey. Anon. *Power* 1959, **103** (Oct.), 105–

Block diagrams and tables give a survey of trends during the past year: (1) Boiler size; (2) fuels (mainly gas-oil combination); (3) firing equipment; (4) heat release rates; (5) controls; (6) feed water treatment; (7) dust collectors; (8) air heaters and ash handling systems.

New Ways to Make In-Plant Generation Pay. Anon. *Power* 1959, **103** (Oct.), 80–5.

The following problems are discussed and examples of solutions described: (1) Steam and electric power generation can be balanced by the installation of air conditioning plant to use at times when the heating load is low; (2) waste heat recovery by burning bark and wood waste presently discarded, by utilizing CO gas from burning off cracking-unit catalyst in specially designed boilers with or without supplementary fuel, from oil refining plants, cement kilns, steel mill processes and petroleum refineries for which packaged waste-heat boiler have been designed; (3) packaged boilers of smaller capacity shipped as a unit, for capacities 150–450 klb/h in prefabricated sections resulting in 25–30 per cent savings in erection costs.

More Power for Nation's Capital. Anon. *Coal Utilisation* 1959, 13 (Sept.), 14–7.

The peak load of Washington, D. C., now occurs in summer with a load of 1156 Mw compared with a winter peak of 822 MW. To satisfy this demand a new unit has been installed at Dickerson station, Maryland, consisting of a 1300 klb/h boiler operating at 2485 psi and 1050 1000 F and a 175 mw cross-compound turbine generator; an identical second unit is under construction. The boiler is of the wet bottom type and contains 32 tilting tangentially firing burners served by 4 bowl mills, each rated at 38,000 lb/h, 66 sootblowers, two air preheaters and an electrostatic precipitator. Furnace ash removal is hydraulic, fly-ash removal pneumatic. The net heat rate is calculated at 8700 Btu/kwh.

A Boom in Paradise. Anon. *Electr. Wrld.* 1959, 152 (Oct. 12), 90.

The first completely new power station to be built by TVA since 1953 will be located at Paradise, Ky. It will contain four 600 MW units, the first to be commissioned in 1962. Peabody Coal Co. will supply 65 million tons of coal over a 17-year period at a price one-fourth less than the average price TVA are paying now. GE is to supply the turbogenerator, CE probably the steam generator.

Philo 6 Produces Design Data as well as MWhr. Anon. *Power* 1959, 103 (Oct.), 164–7.

Experience gained during 30 months running of this supercritical pressure unit is reported. (1) Severe corrosion of turbine bypass valves eliminated by design changes; (2) boiler feed pumps sealing trouble requiring new design of seals; (3) plant heat rate in tests was 8954 against design figure of 8759 Btu/kwh, due to higher power consumption of feed pumps; (4) slagging in the secondary furnace affecting also the gas recirculating parts was met by installing additional soot blowers but was not yet wholly successful; (5) cracking of dissimilar welds occurred where also the cross-section was changed from 4 1/2 to 5 in.; these welds were replaced by shop-fabricated joints; (6) cracks in attachment welds on stainless steel required removal of all attachments where possible, grinding out and re-welding or plugging and welding; (7) heavy deposits in the turbine contained mainly cuprous and cupric oxides and iron oxides; increasing the pH level by addition of ammonia has given best results in reducing copper pick-up but this continues to affect the turbine; to obtain minimum

ɔpper concentration in the cycle, :arting takes up to three days.

old "B" Generating Station. Anon. *lectr. Rev.* 1959, 165 (Sept. 11),)9–15

Thi tion will contain, when com-eted, ɔ units each consisting of a ɔiler rated at 550 klb/h at 950 psi and 25 F and a 60 MW turbogenerator. he ash in the furnace hoppers is moved by a dry vacuum system to container-filter units where the air separated and from which the ash discharged after conditioning with ater into ash lorries. The ash is ed for making building bricks and r constructional purposes at the heidol hydroelectric plant and the estiniog pumped storage project. ne first generator is hydrogen-oled at 15 psi, the second and third 30 psi and the stator of the latter is ater-cooled.

:its Galore—A Kingston Experi-ent. K. S. Matts and D. Turner. *ectricity* 1959, 12 (July/Aug.), 270–

The coke breeze fired at Kingston wer station on chaingrate stokers l to the production of a large amount grits with a combustible content of –80 per cent. Experiments in briq-tting the grit and to refire it are scribed. The first briquettes pro-ced proved to be too large and rth experiments with smaller iquettes (1/4″ × 3/4″) are to be ade.

ɔntracts Signed for 52-Utility Nu-ar Project. Anon. *Electr. Wrld.* 59, 152 (Sept. 7), 47.

The contracts signed between AEC d Philadelphia Electric Co. and eneral Dynamics Corp. are for a 40 W (*e*) high-temperature gas cooled actor to be commissioned in 1963. ne fuel elements of the second core ll contain slightly enriched uranium d thorium mixed with graphite in mogeneous carbon compacts, but e first core will have metal clad ments limiting the steam tempera-re to 850 F; the second core should ow a helium coolant temperature of 32 F and a steam temperature of 00 F. The costs are estimated at) million.

aterials and Manufacturing ocesses

e High Temperature Properties of ur Wrought Steels Used in the emical Industry. B. J. Connolly d G. Boyd. *Proc. Inst. Mech. gr* 58, 172 (No. 31), 889–900. ort-time high-temperature (up to) C) tests on low-carbon 1 per cent -Mo, medium-carbon 1 per cent -Mo, low-carbon 3 per cent Cr-Mo

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aterials and Manufacturing ocesses

e High Temperature Properties of ur Wrought Steels Used in the emical Industry. B. J. Connolly d G. Boyd. *Proc. Inst. Mech. gr* 958, 172 (No. 31), 889–900. ort-...ne high-temperature (up to) C) tests on low-carbon 1 per cent -Mo, medium-carbon 1 per cent -Mo, low-carbon 3 per cent Cr-Mo

and 18-10 Mo-Ti Cr-Ni austenitic steels were made to study their tensile and creep properties. The results are presented in tables and graphs.

Report of Project SP-4 to Steam Power Panel of the A.S.M.E.-A.S.T.M. Joint Committee on the Effect of Temperature on the Properties of Metals. J. S. Worth. *A.S.M.E. Preprint* No. 59-Met-12, 1959 (Apr.), 13 pp.

Short-time high temperature tensile and creep-rupture tests on SA 212 Grade B steel are reported. The effect of welding on high-temperature properties has also been investigated.

Plasma—A Substitute for the Oxy-Fuel Flame. J. A. Browning. *Weld. J.* 1959, 38 (Sept.), 870–5.

The fundamental properties of the plasma arc and the methods developed for its application are described. The gases to be used for forming the plasma are discussed; a plasma flame with non-transferred arc can reach a temperature of 30000 F with a heat transfer rate of 42 Btu/in.^{2} sec. The operating costs of the plasma system are low, about half those of those using an oxy-acetylene burner.

Instruments and Controls

Temperature Control by Damper-controlled Flue Gas Passes in the Fortuna Power Station. R. Müller. *Mitt. V.G.B.* No. 61, 1959 (Aug.), 27, 4–6 (in German).

Superheated and reheated steam temperature control by spray desuperheaters and by damper controlled flue gas passes is compared and the advantages of the latter with regard to reheated steam temperature control discussed. The time until the new temperature is reached is about 10 minutes in both cases.

Control of Benson Boiler-Turbine Units. A. Fischer. *Mitt. V.G.B.* No. 61, 1959 (Aug.), 294–302 (in German).

The various possibilities of controlling a Benson boiler-turbine unit under fixed or fluctuating load with and without network frequency changes are discussed and the ability of the Benson boiler stressed to follow the changes rapidly without excessive fluctuations in temperature and pressure. The results of tests on a 100 t/h and 450 t/h Benson boiler are reproduced; the temperature fluctuations were in an extreme case ±5 C but generally did not exceed ±3 C and the pressure fluctuation maximum 7 atm but generally not more than ±4 atm.

easurement of Grit Emission. kson. *Steam Engr* 1959, 28 868–74.

ples of dust measurement in are considered and the instru- developed by BCURA for iso- sampling described. The first one contains a cyclone probe for ming the corase dust, the second includes a filter for the additional retention of the find dust; both instruments are intended for the smaller boiler plant. The procedure to be followed to obtain isokenitic sampling is outlined.

Operating Safety Shapes Today's Control Systems. Anon. *Power* 1959, 103 (Oct.), 167–9.

Control of power station operation by computers or data-logging systems is believed to increase efficiency by ½ per cent and these are being installed in increasing numbers. A new control panel of much smaller dimensions than previous ones has been developed for boiler-turbine control to facilitate the work of the operator; wherever possible indicators are replaced by annunciators; the greater compactness also increases safety.

Nuclear Energy

The Investigation of Controlled Thermonuclear Reaction in the USSR. Artsimovich. *Vestnik Akad- Nauk SSSR* 1959 (1), 11–23. *LLU Transl. Bull.* 1959 (*Sept.*), 28–41.

Research into thermonuclear processes in Russia is reviewed and the results obtained so far are described and discussed. The necessity for international cooperation in this field is stressed.

Atomic Review. Departures in Gas Cooling. Anon. *Engineering* 1959, 188 (Sept. 11), 156–8. Several reactors with different gas cooling systems to allow higher fuel and consequently higher steam temperatures are discussed. These include the Brown Boveri-Krupp pebble-bed reactor, the Canadian Daniels-Boyd reactor, the General Nuclear Engineering Corp., pressure-tube reactor, the ORNL intermediate-temperature reactor, high-temperature reactor of the Philadelphia Electric Co. and General Dynamics Corp. and the General Electric Co.'s land versions of the gas-cooled ship reactor.

The Economics of Gas-Cooled Reactors. G. S. Vincent. *Nucl. Pwr* 1959, 4 (Sept.), 88–92.

e factors involved in unit cost lations, viz. capital charge, capital charge on fuel, fuel replacement costs, are discussed and curves are developed for various interest rates and

amortization periods. The graphs show also the effect of taking into account interest during construction and enable the calculation of unit cost for any combination of capital cost, interest rate, amortization period, efficiency and load factor.

The Future of Gas-Cooled Reactors. W. S. Banks. *Nucleonics* 1959, 17 (Sept.) 96–102.

A coal burning combined gas and steam turbine and a gas-cooled reactor including a turbine driving a gas compressor are compared. It is suggested that to be competitive the reactor must operate at 2000 F with gas temperature above 1500 F and burnup above 15000 MW d/t, fuel costs of about 2 mills/kwh and a size of 1100–1500 MW (th). The fuel elements would be of UO_2, the moderator graphite and the gas helium. It is also assumed that the coal burning plant would operate at 1400 F and 7000–10000 psi.

Argonne Evaluates Process-Steam Reactors. Anon. *Nucleonics* 1959, 17 (Sept.), 112.

A pressurized-water boiling-water and organic moderated reactor to produce 125 klb/h of steam at 380 F saturated were compared as to costs and ease of control. On both points the PWR appears to be superior although the differences are not large.

Nuclear Marine Propulsion. A Review of Developments in America. J. R. Finniecome. *Mech. Weld* 1959, 139 (Aug.), 356–61.

A concise review with tables giving relevant data but it is stressed that detailed information on reactors and turbines are not available.

Soviet Fast Reactor—BR 5. R. R. Matthews. *Nucl. Engng.* 1959, 4 (Oct.), 359–60.

The reactor uses plutonium as fuel and sodium as coolant with an exit temperature of 450 C and an inlet temperature of 375 C. A breeding blanket has not been installed to simplify the design. Brief details are given of the core and shielding.

Development of Thermal Breeder Reactors. Anon. *Engineer* 1959, 208 (Sept. 25), 325.

The U. S. Atomic Energy Commission has decided to discontinue for the time being much of the work on the fluid fuel reactor program and institute instead a program of research on the conversion of thorium into a fissionable material as this would appear to be a more economic proposition. It is possible that part of the work on the fluid fuel reactor will be incorporated in the new research at a later date.

Combustion

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volume 31 · number 10 **April 1960**

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Pub-:, Easton, Pa. Issued the middle of publication.

nder Section 34.64, P.L. & R., United States Post Office.

I publishes its annual index in e and is indexed regularly by Index, Inc. and also in the ice & Technology Index.

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The process of turning out a boiler drum for today's units requires both individual trade skills as well as heavy duty equipment.

Fu Sources, Properties and Preparation

Structure of Bituminous Coals: Evidence from Distribution of Hydrogen. P. H. Given. *Nature* 1959, **184** (Sept. 20) 980–1.

A type of structure has been found that fits the requirements of X-ray and infra-red studies and those of the elementary analysis: any one aromatic nucleus is linked to any other by two aliphatic linkages.

Abrasivity of Coals and the Resistance to Wear of Metals in Milling. N. V. Sokolov and V. P. Osokin. *Teploenergetika* 1959, (Nov.) 37–41 (in Russian).

A method is described for determining the abrasivity of coals and the resistance to wear of metals in pulverizing coals. The results are presented in tables and graphs.

Coal Handling at Waterside Plants. W. G. Hudson. *Power* 1959, **103** (Nov.) 68–9.

The coal handling plant at the T. H. Allen station is designed to move 2000 t/h at at Gannon station for 500 t/h and that at Detroit Edison's River Rouge station for 2500 t/h. Brief details are given of each installation.

Coal Transport Plant of the Chalon-sur-Saône Power Station. W. Seidel. *Fördern und Heben* 1959, 9 (Oct.) 33–5 (in German).

The system is designed for stocking ut 1000 t/h and reclaiming 500 t/h nd to mix various fuels in prescribed roportions. The coal is emptied nto a hopper from which two conveyors transport it to a central tower; here the coal is directed to either two onveyors to the storage, two conveyors to the mixing plant near the oiler house or to the screening and ushing plant. The coal is stored a circular heap of 260 ft diam and 40 height by means of a combined reading (belt conveyor) and reaiming (bucket wheel) machine running on a circular rail, and then comcted by bulldozers.

ansport Problems of Low-grade al for Electricity Generation. E. ienfeld. *Fördern und Heben* 1959, O 636–8 (in German).

Cc arisons are made of the cost of building small power stations at each colliery or a large central generating plant and the costs involved when transporting the coal by Federal railways, works-owned railway or aerial rope way.

A Safe Method of Storing Pulverized Coal at Trenton Channel. E. L. Embach. COMBUSTION 1959, 31 (Oct.) 45–7.

The boiler bunkers of Trenton Channel power station are supplied with pulverized coal from a central pulverizing plant and the coal is liable to ignite when stored for more than a few days. Tests carried out showed that the zone of greatest heat development was about 2 ft below the surface. The solution was found in excluding all air ingress through the coal feed line, air vent line to the furnace and coal gates at the bottom. It is recommended to install a thermometer and pressure indicator in the air space above the coal to watch for temperature rise and gas generation. In this way it is possible to keep coal in the bunkers for months without risk of autoignition.

Steam Generation and Power Production

Stresses in Hollow Cylinders Due to Asymmetrical Heat Generation. H. Kraus and G. Sonnemann. *J. Engng. Pwr.* 1959, 81 (Oct.) 449–54.

Equations are derived for the radial, tangential, shear and axial stresses in nuclear reactor vessels and thermal shields due to internal heat generation by the absorption of γ-radiation.

Hydrodynamics of Uniflow Boilers. A. A. Davidov and B. I. Sheynin. *Teploenergetika* 1959, (Nov.) 53–7 (in Russian).

Data are presented of the resistance of the steam-water cycle, loop pulsation, thermal sweep, distribution of steam-water mixture and its division into layers in uniflow boilers.

The Little Giant. D. A. Cassino. *Heat Engng.* 1959, 34 (July/Aug.) 56–61.

The packaged boiler is of the natural circulation, water-tube type with two drums and includes an economizer, furnace and interchangeable oil or coal firing front. Either a spreader stoker with a pulsating ash discharge can be fitted. The duplex pumping and heating set supplies 300 gph No. 6 fuel oil at 220 F. Further included are a unit comprising a mechanical dust collector and i.d. fan, f.d. fan and drive, soot blowers, fly-ash reinjection system and combustion controls. The boiler is supplied to the site in 7 subassemblies. The boiler under test was rated at 30 klb/h but was able to generate up to 54 klb/h and its thermal efficiency exceeded 80 per cent. Change over from coal to oil or vice versa takes 4 men about 7h. Stoker-fired packaged units of 43, 50 and 63 klb/h at pressures up to 250 psi saturated can be supplied.

AGM-144-HS Foster Wheeler Packaged Boilers. J. Terry and W. B. Carpenter. *Heat Engng.* 1959, **34** (Sept./Oct.) 74–9.

Three boilers each rated at 39.5 klb/h at 500 psi and 650 F have been installed at Eddystone station to supply auxiliary steam for fuel oil heating, space heating, soot blowers, etc. The boilers are fired with No. 6 fuel oil, completely automatic in operation, and of D-type cross-section.

Chemical Cleaning of Benson Boilers. H. G. Heitmann. *Mitt. V.G.B.* No. 62 1959, (Oct.) 319–34 (in German).

A new method of acid cleaning of boilers has been worked out based on laboratory tests which uses much lower acid concentrations without inhibitors and thus makes possible the cleaning of the whole boiler system including austenitic superheaters and reheaters. The main features are the use of hydrazine (and ammonia) to obtain a pH above 5 in front of the pump and of hydrochloric or sulfuric acid (and fluoric and citric acid) behind the pump to obtain a pH of 3.5–4, a temperature of the cleaning medium of 100 C and relatively high circulation speeds. In addition, thorough flushing with condensate or dermineralized water and blowing with steam before and after cleaning is recommended. The treatment has resulted in a tube system free of rust, scale and welding beads, almost complete removal of silicic acid (sand) and the formation of a film of Fe_3O_4 on all tubes resistant to corrosion even for prolonged periods of shutdown.

Humidity Control During Boiler Erection. A. S. Miller. *Nucl. Engng.* 1959, 4 (Nov.) 404–5.

A portable air conditioning plant is described which has been developed for prevention of condensation inside nuclear boilers during erection on site. The air is heated in winter to 50–60 F

at 20 per cent rel. humidity and in summer to 65 F at 30 per cent r.h. and a flow rate of 1500–2500 cu ft/min.

Solid Fuel Firing

Problems of Coal and Air Distribution in Pulverised Coal Burners. R. Jung. *Mitt. V.G.B.* No. 62 1959, (Oct.) 371–82 (in German).

Investigations are reported aimed at improving the uniformity of pulverized coal distribution in branch lines and the design of a circular burner with adjustable flame length and uniform density of the coal and air at the burner mouth. The effect of elbows, splitters and baffles and of burner position has been studied. Finally, the effect of the parallel arrangement of slot-type and circular burners on ignition and the mixing process is discussed on the basis of model tests.

A Circular Burner for Different Fuels. H. Ullrich. *B.W.K.* 1959, 11 (Oct.) 465–7 (in German).

The main improvements in this burner for the separate or combined firing of oil and coal is the inclusion of a ring carrying guide vanes moving axially in a conically shaped housing with which the angle of swirl of the secondary air can be altered by varying the proportion of secondary air with swirl to that without. In a modification of the burner the pulverized coal-air mixture can also be given different swirls by means of adjustable guide vanes at the entry into the burner. It is possible by these means to obtain optimum mixing of fuel and air at the burner mouth, reduce ignition time and vary the flame length to suit the properties of the fuel and the furnace design. Experience with these burners in a boiler fired wih bituminous and brown coal and oil has been very satisfactory.

Furnaces and Combustion

Excess Air and Combustion Efficiency in Incomplete Combustion. F. Schuster. *BrennstChemie* 1959, 40 (Oct.) 326–9 (in German).

A method has been worked out for calculating combustion efficiency and excess air when combustion is incomplete. The method is applicable to all fuels and combustion conditions.

Water-Side Corrosion and Water Treatment

Pilot-Plant Water Studies for Eddystone Station. F. N. Megahan. *A.S.M.E. Preprint* No. 59-A-260 1959, (Dec.) 4 pp.

After prolonged tests with various anion resins for feedwater treatment a two-bed, mixed-bed system was chosen to obtain the quality required for the supercritical pressure unit at Eddystone station. In all units 8.5 per cent cross-linked cation resin and non-porous Type I anion resin will be used which should give an effluent from the mixed bed of 0.07 μ mho and 3 ppb SiO_2.

Water-Treatment, Corrosion, and Internal-Deposit Studies for Eddystone. R. C. Ulmer, H. A. Grabowski and R. C. Patterson. *A.S.M.E. Preprint* No. 59-A-147 1959, (Dec.) 8 pp.

The extensive tests carried out to determine feed water treatment for the 5000-psi 1200 F Eddystone unit are described concerning deposition of salts, corrosion of steel, copper and iron pickup and deposition on tube walls. Complete demineralization of the feedwater and bypass demineralization of the condensate, addition of hydrazine at a rate of 10 ppb and addition of ammonia to maintain the pH at 8.5–9.5 are considered essential to prevent failures.

Gas-Side Corrosion and Deposits

Experience with Dolomite as Additive in Oil-fired Boilers. H. Ulrich. *Energie* 1959, 11 (Oct.) 474–6 (in German).

A German refinery has undertaken research into the injection of dolomite into oil-fired boilers on their own boiler plant. In a new boiler dolomite was not used at first and in consequence its output fell by 15% over 3000 h, due to deposit formation on the economizer and air preheater. After injection of dolomite (not mixed with the oil) ground to 14.2 per cent residue on No. 240 sieve and 4.5 per cent residue on No. 170 sieve at a rate of three times the ash content of the oil or about 3.3 lb/t of oil the deposits formed could easily be removed by soot blowers or brushing and no new corrosion was found. In addition, very hard deposits on the superheater tubes containing a high percentage of V_2O_5 encountered previously were no longer formed.

Flue Gas, Ash and Dust

Determination of the Dew Point of Flue Gases from the Evaporation Equilibrium of the System Water-Sulfuric Acid. R. Haase and M. Rehse. *Mitt. V.G.B.* No. 62 1959 (Oct.) 367–71 (in German).

From the measurements of the evaporation equilibrium graphs of dew point as a function of partial pressure of H_2SO_4 for different values of partial pressure of H_2O have been obtained. Their application to the plotting

curves of dew point of flue gases of fuel oils as a function of their S content and its conversion into SO_3 is shown. Similar measurements for the system H_2O-H_2SO_4-Cl are in progress.

Ash Utilization in the U.S.A. J. Rose and H. H. Russell. *Mitt. V.G.B.* No. 62 1959, (Oct.) 335–44 (in German).

The main fields of utilization of fly ash reviewed are: 1. In Portland cement concrete and mortar for road building and civil engineering; 2. As mineral filler in bituminous asphalt and tar roads and surfaces; 3. In mixtures with lime and soil for soil stabilization. A large number of these applications are described and illustrated.

The Utilization of Fly Ash in France. A. Jarrige. *Mitt. V.G.B.* No. 62 1959, (Oct.) 345–55 (in German).

In France fly ash is used in road building, concrete and as addition to Portland cement. France is the only country so far where fly ash (20 per cent) is regularly mixed with Portland cement in the cement works; in 1958 about 290,000 t of fly ash were thus utilized. A French mine produces building bricks containing 25 per cent fly ash (unground) or 35 per cent fly ash (ground). Results of laboratory and pilot-scale studies are described.

Fly Ash + Slag + Gypsum + Lime = Cements. J. Pochebonne. *Flamme et Thermique* 1959, **10** (Aug./Sept.) 13–20 (in French).

Laboratory tests with various mixtures are described and the results discussed. A mixture containing Portland cement, 49 per cent fly ash, lime and gypsum has proved entirely satisfactory and is proposed to alleviate the acute shortage of cement for concrete.

Experience in Utilization and Sale of Granulated Slag in a West-German Power Station. E. Goecke. *Mitt. V.G.B.* No. 62 1959, (Oct.) 356–8 (in German).

The slag is used in foundations of houses as a lower layer of 2–4 in. thickness on which a concrete base is laid with a thickness of 2 in., as filler in cable and pipe ducts mixed with sand in a ratio of 1:1 and well consolidated, for drainage of soils of sewage plants, air and sports fields, gardens and roads. About 90 per cent of the slag produced is now sold and utilized.

Measurements of Dust Deposition in Essen from November 1955 to February 1957. K. Schwarz, T. Gilbert, E. Kessi and M. Diem. *B.W.K.* 1959, **11** (Oct.) 483–7 (in German).

The measurements were made by

means of 600 sticky foils although simultaneous comparative measurements with two other collecting methods showed that sticky foils tended to give low results when the deposition was heavy. The local distributions as a function of wind direction and weather conditions is shown in 3 graphs. The highest depositions of over 100 g/m² 30 days occurred with North wind which carried with it large amounts of dust from the industrial towns to the North of Essen. In the northern part of Essen the dust deposition averages 50 g/m²/30 days, in the southern part it is less than 30 g/m², 30 days.

Flow Induced Noise in Heat Exchangers. A. A. Putnam. *J. Engng. Pwr.* 1959, 81 (Oct.) 417–22.

Types of vibrations involved and measures used to reduce these are described.

Problems of Improving Steel Shot Installations for Cleaning Heating Surfaces from Ash Deposits. N. V. Kouznetzov, G. I. Louzhnov, A. I. Krasovitzky, B. B. Soloviev and K. M. Taldikin. *Teploenergetika* 1959, (Nov.) 8–11 (in Russian).

Various improvements introduced recently and their effectiveness are described.

Power Generation and Power Plant

Review: The Work of the First Five Years of the National Industrial Fuel Efficiency Service. Anon. *J. Inst. Fuel* 1959, 32 (Nov.) 556–61.

The expansion of the activities of N.I.F.E.S. during the first 5 years of its operation is reviewed. A total of 3499 factories are being served involving 12,000 units. On average, a fuel saving of 20.8 per cent has been achieved. Details are presented of economies achieved in the cotton finishing industries, paper, printing and allied trades, and metallurgical furnaces. The work of N.I.F.E.S. is to be extended to other industrial processes to improve productivity and reduce heat consumption.

Magnetohydrodynamics — Future Power Process? P. Sporn and A. Kantrowitz. *Power* 1959, 103 (Nov.) 62–5.

In this process electric energy is directly generated by a highly heated gas flowing through a magnetic field and recent research makes it appear possible to apply this process to large-scale power generation. A power plant cycle is proposed which would have a heat rate of 6200 Btu/kWh when generating 462 MW net output. The main parts of the proposed plant

are described and studies still to be carried out are indicated.

A New Performance Criterion for Steam Turbine Regenerative Cycles. J. K. Salisbury. *J. Engng. Pwr.* 1959, **81** (Oct.) 389–402.

The flow-weighted average extraction enthalpy embodying in a single variable all the effects of extracting steam for feedwater heating permits quick and direct estimation of the effect of any cycle change on heat rate and the improvement to be realized by regeneration.

The 100 MW Unit in the Hattingen Power Station. J. Schubert. *Elektrowirtsch.* 1959, **58** (Nov. 5) 737–43 (in German).

The unit consists of a Benson boiler, rated at 350 t/h at 260 atü and 605 C with reheat to 530 C, with a polygonal slagging furnace. The first pass (upward) is entirely constituted of radiant wall surfaces, the second pass (downward) contains tube platen superheater surfaces, the convection surfaces start in the third pass with a flue gas entry temperature of 950 C. The turbine is divided into 4 sections with 10 stages of feedwater preheating to 303 C. The feedwater is treated in parallel cation and mixed bed demineralizers. The turbines for the feed pumps receive their steam from the 6th extraction stage. The steels used for the boiler, pipe lines and turbine are detailed. The calculated net heat rate is 2109 kcal/kWh or a thermal efficiency of 40.7 per cent. A special starting system is used until the boiler output has reached 90 t/h; full output is reached after 6–7h when starting from cold.

Power Station Unit Installations for 600 C Superheated Steam Temperature. The 80 MW Unit in the Neuhof Power Station. E. Strange. *Elektrowirtsch.* 1959, **58** (Nov. 5) 729–36 (in German).

This unit was the first for a superheated steam temperature of 600 C erected in a public power station. The Benson boiler is rated at 250 t/h at 155 206 atü and 605/615 C with reheat to 525 C, has 2½ passes and an octagonal furnace with dry ash removal. Four mills of 8.5 t/h capacity supply the corner burners, the primary air constituting 15 per cent of the total. The net heat rate optimum is 2250 kcal/kWh. The unit was started 60 times in this period after shutdowns of 5 to 48 h. During starting a temperature gradient of 6 C/min up to 480 C and of 3 C/min above that has been fixed to reduce thermal shock in austenitic steel; to reach temperatures above the saturated as quickly as possible starting is carried

out without pressure. Starting from cold takes 4–4.5 h, after 48 h shutdown about 3 h, after 5–8 h shutdown 2.5 h. The average net heat rate has been 2320 kcal/kWh including 6.5 per cent consumption of auxiliaries and a boiler efficiency of 92.5%. The feedwater is not treated with ammonia or hydrazine and has a pH of 7. Light deposits of silicic acid form.

Steam Generator of 650 t/h for 200 MW Units. T. Geissler. *B.W.K.* 1959, 11 (Oct.) 463–5 (in German).

The Polish power station at Turow will contain 6 units each consisting of a German boiler rated at 1450 klb/h at 2000 psi and 1005/1000 F and a 200 MW Russian turbogenerator. The furnace is octagonal, has a volume of 17,000 cu ft (22,600 cu ft including the space for the tube-platen superheater) and contains 8 corner burners served by eight beater mills (one reserve) each of 36/45 t/h output. The fuel is brown coal with 45–50 per cent moisture, 20–25 per cent ash, 45 per cent V.M. and a net C.V. of 3240 Btu/lb. There are two separate water-steam circuits, i.e., 2 economizers, 2 steam drums and 2 primary and 2 secondary superheaters. The steam is first reheated in 2 heat exchangers (outside the boiler) by superheated steam and finally in 2 conection reheaters by flue gas. The superheated steam temperature is controlled by 3 spray desuperheaters, the reheated steam temperature by varying the temperature of the superheated steam. The 3 parallel Ljungstrom air preheaters heat the air to 520 F and cool the flue gas to 320 F; steam heated air preheaters are used additionally when bunker C oil is fired (ignition torches and low-load support burners). The turbogenerator is of the single-shaft type with 2 parallel condensers and requires 12 h heating up until it can be connected to the grid. There are 4 l-p stages, main deaerator and 3 h-p stages of feedwater preheating.

The new Zolling-Anglberg Power Station of the Isar-Amperwerke A.G. Munich. II. W. Fadinger and K. Kohler. *Tech. Überw.* 1959, 11 (Oct.) 365–72 (in German).

The methods used for carrying out the tests on the boiler and turbine are described and the results tabulated. The thermal efficiency of the boiler was 93.1 per cent at normal and 91.7 per cent at m.c.r. and the thermal efficiency of the whole unit 33.35 per cent at an output of 40 MW and 30.65 per cent at 16 MW or 10200 Btu/kWh and 11,100 Btu/kWh, resp.

The Klöckner Power Station at Castrop-Rauxel. A. Brackel and H. Emonts. *Siemens Ziets.* 1959, 33 (Sept.) 542–556 (in German).

The boiler plant, turbo-generating unit and feed-heating plant form a single block, the boiler plant consisting of two half-load Benson boilers. The turbine is designed for an inlet pressure of 2560 psig and a live steam and reheat temperature of 520 C. The maximum continuous output is 120 MW. A description is given of the construction and equipment of the power station.

From C.E.G.B. Digest 1959, 11 (Oct. 24) 2807.

Trawsfynydd Nuclear Power Station. 1—Engineering Design. J. W. Ashley. *Nucl. Pwr.* 1959, 4 (Nov.) 90–4.

Design details of this 500 MW (e) net nuclear power station include: 1. Core; 2. Pressure vessel; 3. Fuel Elements; 4. Charge discharge; 5. Reactivity control; 6. Boilers; 7. Gas flow; 8. Turbogenerators; 9. Station Control.

Trawsfynydd. 2—Technical Calculations. S. A. Young. *Nucl. Pwr.* 1959, 4 (Nov.) 95–7.

The calculations of reactor performance, control conditions, flux stability, and shielding and radiological safety are set out.

Trawsfynydd. 3—Civil Engineering. D. H. New. *Nucl. Pwr.* 1959, 4 (Nov.) 97–9.

The considerations are outlined on which the civil engineering design has been based.

Materials and Manufacturing Processes

The Corrosion Resistance of Magnesium and Its Alloys in Nuclear Engineering Environments. P. E. Gallant. *Corros. Prev. and Contr.* 1959, 6 (Oct.) 42–5.

A review of the literature under the headings: 1. Oxidation behavior of magnesium; 2. Oxidation behavior of magnesium alloys; 3. Alloy development; 4. Metallurgical behavior; 5. Cooling pond corrosion; 6. Current work; 7. Future prospects.

Progress in Stainless and Heat-Resisting Steels. J. Lomas. *Engng. Boil. Ho. Rev.* 1959, 74 (Oct.) 318–19.

A review of recent literature in the field of corrosion and high-temperature resistant steels, welding techniques and electrodes, abrasion resistant steels and the production of stainless steel by extrusion for conventional and nuclear power stations.

The Effect of Alloying Mild Steel upon Its Resistance to Stress-Corrosion Cracking. R. N. Parkins and

...n. *J. Iron & Steel Inst.* 1959, (Sept.) 45–7.
...he resistance to stress-corrosion ...king of mild steels could be im...ed by addition to Cr and of up to ...cent Al.

Influ...e of Chromium Diffusion ...n the Thermal Oxidation Proper... of Steels and of Nickel- and ...lt-Base Alloys. R. L. Samuel T. P. Hoar. *Metallurgia* 1959, Sept.) 75–80.
...he increased resistance to oxida... of steels and Ni and Co base ...s by the surface treatment with ...demonstrated. Chromising may alter the nature of the oxidation.

...lts and Problems of Develop... of Graphite for Reactors in ...many. E. Fitzer, M. Beutell, E. ...opil and K. W. F. Etzel. *Atom...energie* 1959, 4 (Nov.) 449–55 (in ...man).
...his first part deals with the pro...tion of graphite of 99.999 per cent ...carbon and presents data of elec...al and thermal conductivity, ther... and volumetric expansion.

...icator Scores Breakthrough in ...ing Titanium Clad Steel. Anon. ... 1959, 145 (Oct. 19) 152–3.
...he mild steel plate of 0.5 in. thick... and titanium cladding plate of ...8 in thickness were bonded to... ...er a brazing metal under ...uum. The welds between plates ... fittings were made by an inter...liary silver inlay with a titanium ...er strap.

...ded and Rolled Joints in High...ssure Preheaters. H. Haferkamp ...t. *V.G.B.* No. 62 1959, (Oct.) ...-7 (in German).
...n rolled and welded joints of tubes ...ube plates for high-pressure feed... ...er preheaters leakage occurred ...n the welding was carried out by the ...on arc process but not if oxyacety... welding was used. In the former ... weld pool is small and solidifies so ...ckly that gas bubbles from evapo... ...ng moisture are trapped, in the ...er the pool is larger and its solidi... ...tion takes longer so that the gas ...bles can escape.

... Application of Dimensional An...sis to the Determination of the ...ximum Temperature Difference in ...indrical Fuel Elements. W. Katt...kel. *Atomkernenergie* 1959, 4 ...pt.), 356–9 (in German).
...he analysis shows that a fuel ele...nt ...uld be so designed that the ...pe. ...re difference becomes a ...imum and the resultant thermal ...sses remain within the given limits.

Combustion

DEVOTED TO THE ADVANCEMENT OF STEAM PLANT DESIGN AND OPERATION

volume 31 number 11 **May 1960**

ned monthly by COMBUSTION PUB-IG COMPANY, INC., 200 Madison New York 16. A SUBSIDIARY OF BUSTION ENGINEERING, INC.

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Striking use of modern architectural lines for outdoor power plants feature new City of Burbank, Calif. plant.

Abstracts From the Technical Press—Abroad and Domestic

(Drawn from the Monthly Technical Bulletin, International Combustion, Ltd., London, W. C. 1)

rinding, Screening and Filtering

ne Grinding in Mechanically Driven apact Mills. W. Beushausen. *Chem. g. Tech.* 1959, **31** (Sept.), 553–60 n German).

The features particular to grinding impact are described and compared th other methods and the fields of plication outlined. Various designs impact mills are illustrated. The lationship between energy consumpon and fineness of grinding, effect d influence of air as carrier, the mminution process in the machines, e influence of impact velocity on eness of grinding and the efficiency the comminution process by impact e discussed.

perational Data on a Ring-Ball ulverizer. F. J. Hiorns and C. P. yles. *J. Inst. Fuel* 1959, **32** (Oct.), 4–75.

Tests were carried out on a ring-ll m'' with different coals and the sult a statistical analysis of the sts with two coals are presented. ne significance of the effects of air te, classifier and fuel: air ratio set-gs on fineness and rate of output d power consumption is shown. simpler analysis is used to relate ntrol board readings to these same ctors and recommendations for the eration of such mills are made. xamples of nomograms are given ich permit obtaining fineness and te of output from control board adings; these give the mill operator formation that is not normally avail-le.

ectro-Hydraulic Crushing of Coal. L. Losev, A N. Mel'Nikova, F. Ya. prykin and L. A. Yutkin. *Vestnik kad. Nauk SSSR.* 1959 (6) 62–5. *U Transl.* 1959 (Oct.), 34–8.

In this process electrical energy is ectly converted into mechanical ergy by passing a continuous suc-ssion of high voltage transient elec-cal discharges with very steep front d short current-impulse through ter in a tank in which the coal is omerged. Two hydraulic shocks are nerated, a primary effect and a vit al; in the first the spark ann.. enlarges and forms an ex-nding cavity which then collapses ultrasonic speed and generates a cond hydraulic shock. Results obtained with Moscow bituminous and brown coal are given. The ash and sulfur contents of the coal were reduced but its chemical composition was not changed, nor was it oxidized to a significant extent.

Capacity, Separating Effect and Dimensions of Solid-Bowl Centrifuges. H. F. Trawinski. *Chem. Ing. Tech.* 1959, **31** (Oct.), 661–6 (in German).

Phase segregation in the centrifuge is governed by Stokes' law by which the suspension is characterized by the settling velocity in a gravity field. The controlling parameters are the bowl surface and the centrifugal acceleration. In these the length, diameter and rate of rotation are contained. Diameter and rate of rotation can be eliminated by introducing the tensile strength to spec. gravity ratio of the material. It is shown that the separation effect of the rotor can be increased only by increasing its length but not its diameter.

Radiometric Absorption Analysis. I. Possibilities of Chemical Ultimate Analysis with a Methane Flow Counter as Ray Detector. L. Wiesner. *BrennstChemie* 1959, **40** (Sept.) 273–8 (in German).

The advantages of the methane counter over the Geiger-Müller counter are discussed and the instrument and its application are described. The quantitative determination of hydrogen, oxygen, phosphorous, sulfur, lead, chlorine and iodine is presented; simultaneous determination of several elements is possible. The question of costs is discussed.

Analysis and Testing

The Differential Thermal Analysis as a Method of Evaluation of Coals. C. Kröger, H. Hovestadt and E. Bade. *BrennstChemie* 1959, **40** (Sept.), 286–9 (in German).

The influence of inert, oxidizing and salt forming oxides and of iron and copper on the behavior of macer-

als during differential thermal analysis is described. Characteristic effects are obtained with cuprous oxide which make possible a characterization of the coal substance. The mineral content of coals, especially of enriched fractions, can be determined by differential thermal analysis faster and almost as far as with X-ray analysis.

Problems of Air Pollution in Germany. H. Lent. *J. Inst. Fuel* 1959, **32** (Oct.), 485–501.

The ways in which the air pollution problem is being tackled in Germany are outlined. Pollution caused by large and small industrial power plants and by domestic heating is discussed. Sulfur dioxide is regarded as the most common pollutant and recent evidence of damage to flora and fauna caused by SO_2 cited. The task of the Clean Air Commission set up in Germany is defined.

Instruments and Controls

Engineering Design by Digital Computers. B. J. Chalmers. *Research* 1959, **12** (Oct./Nov.) 390–4.

The application of digital computers to design problems in general and their ability to optimize a design owing to their discrimination facility are presented. It is shown that computers can be used for both design details and complete designs and that results are obtained in a fraction of the time needed by human effort.

Electronic Boiler Control. Anon. *Elect. Rev.* 1959, **165** (Nov. 13) 635–42.

At Little Barford "B" station an electronic control system has been installed in which the controlling parameters are the steam pressure and air/steam flow at the superheater outlet. Transmitters, three-term process controllers, single analogue computers and electro-hydraulic positioners control combustion, steam temperature and mill feed. The system is described in detail.

A New Sensitive Temperature Detector for Use in High Pressure Fluid Piping. D. Robertson. *A.S.M.E. Preprint* No. 59-A-201 1959, (Dec.) 7 pp.

A new composite thermocouple in a swaged plug has been developed for measuring temperature changes in the steam flowing through a heavy-wall pipe. Details of design and response time are given.

A Thermocouple for Reactor Control. J. L. Ayre. *Nucl. Pwr.* 1959, **4** (Dec.) 117–8.

The design of the thermocouple for measuring the outlet temperatures of the gas and the tests made to find the best way of its installation in th channel are described.

Radioactive Level Gauges. J. F Cameron and E. W. Pulsford. *Brit Chem. Engng.* 1959, **4** (Nov.) 605–7.

Instruments employing radioactive sources for detecting the liquid level inside tubes, tanks and drums are described.

Nuclear Energy

Neutron Research. Anon. *Nucl. Energy Engr.* 1959, **13** (Oct.), 491–4.

Research carried out at the U. S. Bureau of Standards and the establishment of a national neutron standard are described. Details are given of improvements in the accuracy of neutron measurements, neutron cross-section measurements, selection of sources, "button" detectors, γ-ray dosimeters and the checking of theory by experiments.

Approximate Calculation of the Surface Loss of a Reactor. M. Ledinegg. *Atomkernenergie* 1959, **4** (Sept.), 351–6 (in German).

Good agreement has been found in calculating neutron losses by the simple diffusion law and the two-group theory, the former being much simpler and less time consuming.

Perturbation Methods for Reactor Diffusion Equations. L. H. Holway. *Nucl. Sci. Engng.* 1959, **6** (Sept.) 191–201.

A new method for solving the diffusion equations has been developed and is illustrated by examples.

Heat Stresses in Steel Walls of Reactor Pressure Vessels under Neutron Bombardment and One-Sided Cooling. G. Grass. *Atomkernenergie* 1959, **4** (Sept.), 364–8 (in German).

Equations are derived for the temperature gradient and thermal stresses in steel walls under neutron bombardment as a function of number and energy of the neutrons, steel properties and vessel dimensions. The results are given in tables and graphs.

Structural Design in High-Temperature Reactors. N. H. Triner. *Nucleonics* 1959, **17** (Oct.), 78–81.

For the design of high-temperature reactors more emphasis must be put on experimental investigations into the load stress, displacement stress, thermal stress and creep of the materials to be used to be sure that the calculations are based on valid data.

Atomic Energy and Public Health. Anon. *Atom* 1959, (Oct.) 9–11.

In his address to the Cambridge conference of the Food and Agriculture Organization of the U

ations Sir John Cockroft spoke of e danger of leakage from air-cooled actors (escape of iodine-131, stron-ım-90, strontium-89 and caesium-7), gas-cooled reactors and fast acto·· and efforts to reduce hazards. e s ed the many variables in-lved in the spread of these poisons d their uptake by animals and hu-ans, the necessity for reliable meas-ements, and international coopera-n in this field and finally discussed scharge of radioactive effluent into ers and storage methods.

omic Review. Thermonuclear Re-al. Anon. *Engineering* 1959, 188 ct. 30) 406–7.
Brief abstracts are presented of the pers to the Uppsala conference on ization phenomena and the London nference on very high temperature ysics, both topics being related to earch into thermonuclear fusion.

e Industrial Future for Large Radia-n Sources. S. Jefferson. *Nucl. r.* 1959, 4 (Nov.) 104–5.
Useful applications of large sources radiation were discussed at a con-ence in Warsaw in September 1959. survey of the proceedings is pre-ted.

idation of Graphite in Reactors. Tomlinson. *Nucl. Pwr.* 1959, 4 ov 7–8.
The asons for the large discrep-cies found in recent publications are cussed. It is shown that reason-e agreement is possible if allowance nade for the differences in the pa-neters used.

ermal Instability Due to Graphite idation. P. J. Robinson and J. C. vlor. *Nucl. Engng.* 1959, 4 (Nov.) 3.
t is shown that once the heat ierated by oxidation of the graph-exceeds that lost to the surround-s the rise of temperature is rapid l leads to fires difficult to extin-sh.

nperature Distribution in Double-w Reactor Cooling Channels. II. D. Baehr and W. Strewe. *Atom-nenergie* 1959, 4 (Oct.) 398–402 (in man).
The second part compares parallel counterflow with regard to heat nsfer and pressure drop and shows t counterflow heat transfer is far erior to parallel flow but that this antage may be nullified by the itly increased pressure drop. In ·t· ooled by superheated steam iqu.. the higher pressure drop is lesser importance than in gas-led reactors. A calculated ex-ple shows these effects.

A New Method for the Calculation of Thermal Utilization in Heterogeneous Reactors. A. Kirchenmayer. *Atomkernenergie* 1959, 4 (Oct.) 395–7 (in German).
A method for simplifying the calculation is described.

The Thermal Utilization of the Heterogeneous Reactor in the Light of the Two-group Theory. A. Kirchenmayer. *Atomkernenergie* 1959, 4 (Oct.) 397–8 (in German).
The application of the new method of calculation described in the previous article is presented.

Calculation of Fast Neutron Multiplication in Thick Fuel Elements. K. O. Thielheim. *Atomkernenergie* 1959, 4 (Nov.) 429–37 (in German).
Fast neutron multiplication has been calculated by means of a digital computer taking into account change of neutron collision probability in the course of a chain reaction initiated by a fast primary neutron and the reduction of kinetic energy of fast neutrons by inelastic scatter on fuel atom nuclei and their influence on multiplication. In thin fuel elements both these factors need not be taken into account. The results are tabulated.

The Power of a Heavy Water Reactor During an Emergency Shutdown. I. M. El-Ibiary. *Nucl. Energy Engr.* 1959, 13 (Nov.) 545–9.
Experimental results and those obtained by a simulator are compared and from the best fit of various theoretical solutions the value of the shut down reactivity determined.

The Breeder Goes Critical. Anon. *Nucl. Pwr.* 1959, 4 (Dec.) 93.
The Dounreay fast breeder reactor (15 MWe) went critical on November 14, 1959. The main reactor data are given.

Commissioning and Start-Up. J. L. Phillips. *Nucl. Pwr.* 1959, 4 (Dec.) 94–100.
The steps leading up to the commissioning of the Dounreay reactor are detailed: 1. Construction tests; 2. Staff training; 3. Commissioning: (*a*) dry testing; (*b*) metal charging; (*c*) wet testing; (*d*) final approach.

Instrumentation and Control. K. R. Sandiford. *Nucl. Pwr.* 1959, 4 (Dec.) 100a–102a.
The instruments for neutron flux, coolant flow and temperature measurement and the control system based on the insertion of 12 mobile fuel element rods from below and three boron rods from above are described.

Behavior of Ultrasonics in the Presence of Various Types of Defects Which May Be Found in Welds. P. Bastien and M. Evrard. *Soudage* 1959, **13** (Sept./Oct.) 347–57 (in French).

Tests were carried out by various laboratories on identical pieces exhibiting three types of defects, lack of penetration, blow holes and slag inclusions. The results have led to the determination of the behavior of ultrasonics with respect to the typical defects considered and the definition of the nature of these defects from the form of the recorded oscillograms.

A Test to Anticipate the Performance of Steam Piping at 5000 Psi and 1200 F. G. C. Wiedersum. *A.S.M.E. Preprint* 59-A-230 1959, (Dec.) 8 pp.

A test rig has been set up containing a length of welded pipe of the material used in the plant in which operating conditions are simulated as nearly as possible and periodic checks can be made of the changes in the weld and material due to thermal and internal pressure stresses. The rig and the type of tests to be made are described.

Fuel Research. Annual Report for Year Ending 30th June, 1959. Commonwealth Scientific and Industrial Research Organisation. Coal Research Section. P.O. Box 3, Chatswood N.S.W. 1959, 18 pp.

The research undertaken by the Coal Research Section is outlined under the headings: 1. General; 2. Coal Utilization: (*a*) carbonization; (*b*) chemicals from coal; (*c*) combustion and gasification; 3. Examination of coal seams.

Fuels: Sources, Properties and Preparation

Factors to Consider in the Use and Application of Industrial Coals. U. B. Yeager. *ASME Preprint* No. 59-Fu-2, 1959 (Oct.), 9 pp.

Coal properties and their effects are discussed in relation to the firing equipment intended to be used. It is stressed that in almost all cases a washed coal will be more economical than a run-of-mine coal.

Effect of Coal Characteristics on Combustion Performance. T. S. Spicer. *Coal Utiliz.* 1959, **13** (Nov.), 19–23.

The coals most suitable for single-retort, multiple-retort, spreader stoker, traveling grate, pulverized fuel and cyclone firing are discussed and the properties most important for each type of firing tabulated.

High Pressure Water Loop in Dido.

(Dec.) 103–8.

An account is given of the installation of the loop in the reactor, measurements and safety arrangements, leakage from the loop and welding precautions, in-pile test section, valves and ...missioning tests. These latter ...sisted in measurements of leakage rate, in testing the emergency blowdown system and instrumentation, and in establishing a start-up procedure.

Grinding, Screening and Filtering

Some Experience of Coal Grinding Plant Tests on a Ring-Ball Mill and a Tube Mill. A. Fitton and R. Jackson. *J. Inst. Fuel* 1959, 32 (Nov. 520–9.

The results obtained with these two types of mills tested (ring-ball mill at Little Barford and tube mill at Brimsdown) and published earlier have now been compared and some conclusions drawn of power consumption, drying capacity, fineness of grinding and output. The ring-ball mill appears to be more suitable for varying loads, the tube mill for steady conditions at high loads; the drying capacity and fineness of grinding of the former is higher. Power consumption shows little difference.

The Effect of the Speed of Rotation and the Design of the Lining on the Performance of a Drum-type Ball Mill. B. L. Koutman. *Teploenergetika* 1959, (Nov.) 24–8 (in Russian).

The results of experimental investigations are presented and recommendations made on the speed of rotation and the design of the mill lining.

Analysis and Testing, Research

Analytical Determination of Moisture Content of Brown Coal and Low Temperature Brown Coal Coke by Drying with High Frequency Heating. Jandasek. *BrennstChemie* 1959, 40 (Oct.) 309–14 (in German).

Tests are described which had the following results: 1. Moisture determination of brown coal and moist coke difference using high frequency heating (17Mc/s, 3–6 kV) was sufficiently accurate and agreed well with the xylol distillation method; 2. The time required was about 15 min; 3. The method is specially useful for series determinations; 4. Avoidance of oxidation and of chemicals are added advantages. The procedure used is described in detail.

Penetrants for Non-Destructive testing. Schnurmann. *Engineering* 59, 1968 (Nov. 20) 515.

A brief review of the techniques and

Relationship of Coal Ash Viscosity to Chemical Composition. W. L. Sage and J. B. McIlroy. COMBUSTION 1959, 31 (Nov.), 41–8.

Two methods are described for assessing the suitability of a coal for use in a slagging furnace. One is the calculation of the USBM equivalent silica percentage in which the ferric percentage is also calculated by a given equation, and which gives an indication of the temperature of the critical viscosity. The other is the basic-to-acid-ratio method which is carried out at or corrected to 20 ferric percentage. This latter method is specially useful for calculating the amount of flux required to obtain a desired viscosity.

The Suitability of Foreign and Home-produced Fuels for the Operation of Slagging Furnaces. Pt. I. Bituminous Coals. T. Geissler. *Energie* 1959, 11 (Nov.), 526–34 (in German).

Based on large-scale investigations an equation has been established for the calculation of a coal coefficient K_z from which the suitability or otherwise of a coal for slagging furnace operation can be deduced. The equation is: $K_z = K_1.K_2.K_3.K_4.K_6 + K_5$, where K_1 is dependent on ash content, K_2 on moisture, K_3 on volatiles, K_4 on ash fusion point, K_5 on air preheat temperature with V.M. as parameter, and K_6 on boiler output. The values of these coefficients can be taken from graphs. Values of K_z: from 0.7–1.2 (Class I) very suitable, 0.5–0.7 (Class II) suitable, 0.3–0.5 (Class III) just suitable, 0.2–0.3 (Class IV) difficult operation, 0.1–0.2 (Class V) very difficult operation, 0–0.1 (Class VI) unsuitable. The influence of slagging furnace design is to be discussed in a following article.

The Removal of Chlorides from Coal by Leaching. I. Laboratory Experiments. G. N. Daybell and E. W. F. Gillham. *J. Inst. Fuel* 1959, 32 (Dec.), 589–96.

The laboratory tests have shown that the chlorine content of slacks can be materially reduced in a very short time by washing with water. It is suggested that coal of high chlorine content could be transformed into a harmless fuel by exposing it in a thin layer to weathering (rain).

Further Studies on the Mechanism of the Oxidation of Coal. B. K. Mazumdar, S. K. Chakrabartty, M. Saha, K. S. Anand and A. Lahiri. *Fuel* 1959, 38 (Oct.), 469–82.

The studies indicate two stages in coal oxidation: below 200 C the coal structure is reduced to its aromatic skeleton, above 200 C rupture of the rings starts.

Combustion

DEVOTED TO THE ADVANCEMENT OF STEAM PLANT DESIGN AND OPERATION

volume 31 number 12 **June 1960**

monthly by COMBUSTION PUB- COMPANY, INC., 200 Madison w York 16. A SUBSIDIARY OF TION ENGINEERING, INC.

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e under Section 34.64, P.L. & R, by United States Post Office.

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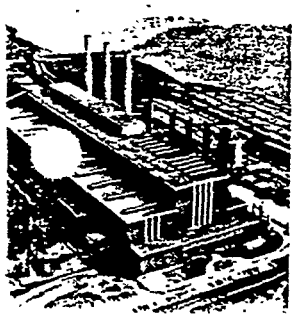


Fuel Sources, Properties and Preparation

The Chemistry of Carbonization Investigated on Polymeric Bituminous Coal Model Substances VII. Application of the New Insight to Bituminous Coal. D. W. van Krevelen, P. M. J. Wolfs and H. I. Waterman. *Brennst Chem.* 1959, **40** (Dec.), 371–7 (in German).

The new knowledge gained from the results of the studies described in the previous articles is discussed with reference to its application to the coking mechanism of bituminous coal. Analogies have been found for the temperature range of decomposition and plasticity, selectivity of gas and tar formation, course of composition of decomposition products and influence of temperature-time history. A new equation for the condensed ring number has been derived and the average number of bridges per average structure unit is probably 1–1.3 for bituminous coal. Tentative conclusions are drawn of the functional distribution of the elements, especially hydrogen.

Thermo-gravimetric Studies of Coal and Model-substances. J. A. Corrales and D. W. van Krevelen. *J. Inst. Fuel* 1960, **33** (Jan.), 10–6.

The investigations included: (1) physical devolatilization and chemical decomposition of pure substances; (2) vaporization of mixtures; (3) mixed vaporization and decomposition; (4) vaporization of substances absorbed inside porous materials; (5) decomposition of coal; (6) devolatilization of impregnated coals.

Prediction of the Coke Quality from Composition of Coking Blends of Medium- and Low-volatile Coals. D. W. van Krevelen, F. J. Huntjens and A. H. Wilms. *J. Inst. Fuel* 1960, **33** (Jan.), 3–9.

It is shown that results obtained by the dilatometer test can be used to decide to what particle size the coals in a blend have to be ground to produce a coke of satisfactory quality.

Steam Generation and Power Production

Thermo-dynamic Properties of Natural and Heavy Water. V. A. Kirilin and S. A. Oulibin. *Teploenergetika* 1959 (Dec.), 77–80 (in Russian).

Experiments have been carried out into the density of heavy water. The thermal properties of D_2O and H_2O are compared.

Reference Values of Specific Heat c_p for Water and Steam. A. E. Sheindlin, E. E. Shpilrain and V. V. Sichev. *Teploenergetika* 1959 (Dec.), 80–3 (in Russian).

Existing experimental values for c_p for water and steam are analyzed and a table of reference values has been compiled for pressures of up to 700 kg/cm.² and temperatures up to 650 C.

Reduced Coefficients of Frictional Resistance during Flow of a Steam/Water Mixture in Pipes. N. I. Semenov and B. I. Sheinin. *Teploenergetika* 1960, **7** (Jan.), 33–7 (in Russian).

Test data on the resistance of slightly inclined pipes during the flow through them of a steam/water mixture are analyzed and compared with such information in regard to an air/water mixture.

C.E.G.B. abstract

Pressure Vessel Overtemperature Hazards. D. B. Rossheim, J. J. Murphy, G. P. Eschenbrenner and R. S. Eagle. *A.S.M.E. Preprint* No. 59-A-319, 1959, (Dec.), 13 pp.

The nature, sources, effects and means of detection and control of excess temperatures in pressure vessels are considered and suggestions made for design, operating precautions and establishment of a code.

Thermodynamic Investigations of Boiler Heating Surfaces at High Heat Release Rates. K. R. Schmidt. *Mitt. V.G.B.* No. 63, 1959 (Dec.), 391–401 (in German).

The occurrence of film evaporation, i.e., the formation of a steam cushion of low thermal conductivity on the inside of tube walls, has been investigated as a function of flow velocity, tube diameter, direction of flow, wall temperature, pressure and heat release rate. The results are presented in graphs and discussed.

Problems of Forced Flow Boilers with Special Attention to the Steam and Water Flow. R. Michel. *Mitt. V. G.B.* No. 63, 1959 (Dec.), 402–14 (in German).

The arrangement of the various heating surfaces in a forced flow cussed so that everywhere sufficient flow velocities are obtained, excessive temperatures prevented and the risk of film evaporation is avoided. Closed starting and stopping circuits are recommended.

Recent Boiler Designs with High and Ultra-High Steam Parameters. K. F. Roddatis. *Teploenergetika* 1960, **7**, (Jan.), 3–13 (in Russian).

A review is presented of the larger Russian-produced boilers and their elements based on materials supplied by the Ordzhonikidze Krasnyi Kotelschik Factory, and of decisions of technical committees of the Rostov and Moscow Councils and Ministry of Power Station Construction. Details of numerous boilers are set out in 7 tables for comparison.

C.E.G.B. abstract

An investigation into the Performance of a TP-170 Natural Gas Fired Boiler with Variable Feed Water Temperature. G. M. Poliakov, A. V. Ilyin, A. V. Zimachinsky and G. A. Schapov. *Teploenergetika* 1959 (Dec.), 51–5 (in Russian).

The results of tests are presented of operating the boiler at loads from 110 to 190 t/h and feedwater temperatures from 150 to 215 C. The relation of heat loss in the flue gas to the feed water temperature at constant evaporation is shown.

Industrial Boiler Design. T. B. Hurst and C. C. Hamilton. *A.S.M.E. Preprint* No. 59-A-78, 1959 (Dec.), 7 pp.

The design of boilers with gas, oil or coal firing is discussed and figures presented of heat liberation (Btu/cu ft/hr), heat release rates (Btu/sq ft/hr), relationship between furnace depth and heat release rate per ft burner wall, heat release rates for various types of grates (Btu/sq ft grate/hr), superheater tube spacing and range of steam mass flow values. Designs of furnace walls for pressure-fired and stoker-fired boilers are shown.

Modern Steam Generators for the Firing of Blast Furnace Gas and Pulverized Coal. K. Nuber. *B.W.K.* 1959, **11** (Dec.), 566–9 (in German).

The difficulties of designing steam generators for the firing of blast furnace gas and pulverized coal either singly or in any proportion are discussed and two examples shown of how these have been solved. In one plant with 3 boilers each rated at 110 klb/h, 1200 psi and 975 F the gas burners are installed in the rear wall of the furnace: to improve the mixing of air and gas there are five rows of six burners each with inserts in each

burner mouth to "tear up" the gas stream as it is mixed with the air; the coal is pulverized in a central plant, stored in intermediary bunkers and injected through corner burners. In the other plant with 2 boilers each rated at 90 klb/h, 1000 psi and 950 F gas burners of similar design are installed below the p.f. burners in each corner. Since the fly ash from these boilers contains up to 40 per cent combustibles there are added to each boiler small vertical water-cooled slagging furnaces in which a mixture of pulverized coal and fly ash is burned, the combustion gases being added to those in the main furnace and the water-cooling system forming part of the main circulation system.

Inspection of Large Boilers. G. Barnard. *Elect. Rev.* 1960, **166** (Jan. 1), 8–11.

It is suggested that in addition to the generally very careful inspections during fabrication of parts, erection on site and annual statutory overhaul, inspections of all electrical equipment and controls, steam lines, feedwater, tube samples and instruments be made by an independent authority to ensure trouble-free operation during the following operating period.

Boiler Furnace Fuel Explosion Survey. J. B. Smith. *A.S.M.E. Preprint* No. 59-A-303, 1959 (Dec.), 4 pp.

The causes of boiler explosions, especially of pulverized coal fired boilers, have been analyzed and the most frequent types detailed. Measures to prevent such accidents are discussed.

Some Observations on the Specific Surface of Coals. S. J. Gregg and M. I. Pope. *Fuel* 1959, **38** (Oct.), 501–5.

The specific surface of vitrains has been determined by nitrogen and n-butane adsorption at 273 K. The specific surface calculated by n-butane adsorption agrees with the heat of wetting values using methanol as wetting agent.

Chemical Structure and Properties of Coal XXIV—Sound Velocity and Fraction of Aromatic Carbon. D. W. van Krevelen, H. A. G. Chermin and J. Schuyer. *Fuel* 1959, **38** (Oct.), 483–8.

A method for calculating the fraction of aromatic carbon in coal from the velocity of sound, density and elementary analysis is described. The results obtained by this method are practically equal to those from the densimetric method.

Contribution to the Research into Coal Structure by van Krevelen's Method. V. Rona. *Brennst.-Chem.* 1959, **40** (Nov.), 346–54 (in German).

The calculation of the volumina of atoms, the accuracy of the determination of aromaticity and the theoretical basis and extension of van Krevelen's method are discussed. The results of these considerations are claimed to confirm that bituminous coal consists of individual molecules of average molecular weight and is not a polymeric substance built up of structural units.

The Chemistry of Carbonization Investigated on Polymeric Bituminous Coal Model Substances. VI. The Plastic Behavior during Carbonization. P. M. J. Wolfs, H. I. Waterman and D. W. van Krevelen. *Brennst.-Chem.* 1959, **40** (Nov.), 342–6 (in German).

Two extreme processes are shown to be possible during carbonization of these model substances analogous to the behavior of different coals and their plastic behavior can be explained simply by the position of the decomposition curve relative to the softening curve.

Mechanical Handling

Coal Bunker Explosions—Cause and Prevention. W. W. Hagnauer and K. W. Hamming. *Coal Utiliz.* 1959, **13** (Nov.), 24–6.

The conditions in which gas may be evolved in coal stored in bunkers are discussed and the means described by which accumulations of gas and the possibility of explosions can be avoided. These include: (1) Sufficient ventilation to remove explosive gases; (2) elimination of coal dust in conveyor rooms by proper ventilation; (3) improved design of bunkers to reduce hang-up of coal with an illustration of preferred bunker design; (4) operating factors including ventilation, cleaning and inspection.

urnaces and Combustion

'he Prevention of Acidic Smut Emis-ion from Oil-Fired Boilers. Anon. *'team Engr.* 1960, **29** (Jan.), 114–5, 22.

Acidic smut emission from oil-red ereconomic boilers has been .oppe.. by the injection into the ue gas of a finely divided alkaline ygroscopic powder (D.C.P.58) the articles of which provide nuclei for ıe absorption of acid and greasy articles. The agglomerated particles re subsequently extracted in a spe-ally designed "Turbocell" dust col-ctor. The design of the injecting evice is described briefly. The intro-uction of this powder resulted in a duction of the acid dew point of the ue gas by 20 F.

n Experimental Investigation of uel Additives in a Supercharged oiler. R. J. Zoschak and R. W. ryers. *A.S.M.E. Preprint* No. 59--160, 1959 (Dec.), 10 pp.

Pilot plant experiments are de-ribed in which various magnesium ıd aluminum compounds were used additives to washed fuel oil and h accumulations and corrosion stud-d. The ash deposits were generally ery heavy but could be removed by ot blowing. The inhibited ash was ot corrosive at temperatures up to 00 F with an additive ratio of 1.5 g: IV. Tentative suggestions are ad garding the process of ash po. ormation.

eam Generation and Power Produc-on

ıe Critical and Two-Phase Flow of eam. W. G. Steltz. *ASME Pre-int* No. 59-A-223, 1959 (Dec.), 8 pp. nalytical and digital-computer udies have been made and are com-ıred to the critical flow of steam. ıoking velocity, critical pressure tio and critical flow per unit area e presented as a function of inlet nditions. A Mollier diagram gives e exponent in the wet and super-ated regions.

The Effect of Non-Uniform Heat stribution on Steam Generation in ıbes. P. G. Morgan. *Engng. Boil. o. Rev.* 1959, **74** (Nov.), 336–8.

A summary is presented of a ıssian paper dealing with the effect non-uniform heating on the transi-ın from bubble to film boiling. An uation for the calculation of the tical heat flow has been developed.

evelopment of Boiler Design by .lzer Brothers Limited. Anon. *ıgng. Boil. Ho. Rev.* 1959, **74** (Nov.), 0–

A . .ew of the boilers built by this m and particularly of the monotube iler and its controls.

Steam Generators for Indirect Stea Generation. O. H. Hartman *Energie* 1959, 11 (Nov.), 546–8 (German).

The inventor of this type of boil surveys the development and fields application which are mainly sma and medium industrial plants. Th great advantage of this boiler is th the steam generated directly flows i a closed circuit which has to be fille once only with demineralized wate when starting up and requires ver little make-up, while the steam fo consumption is generated in a drum b heat exchange with the directly gener ated steam and the feedwater require ments are thus less onorous. Variou designs of boilers are illustrated.

Small Boilers for High Heating Temperatures. K. Perl. *Energie* 1959 11 (Nov.), 548–9 (in German).

The corner-tube boiler has proved particularly suitable for the generation of 100,000–200,000 kcal h either at high pressures (up to 100 atü) when using steam as heat carrier or at low pressures (up to 6 atü) using a liquid heat transfer medium. Designs proved successful in operation are illustrated.

Automatic Coal-Fired Boiler Plant. Anon. *Steam Engr.* 1959, **29** (Dec.), 75–9.

A summary is presented of the papers to the conference held by the Combustion Engineering Assoc. in November 1959 dealing with various aspects of mechanical handling of fuel and ash, mechanical firing of boilers and automatic controls for smaller and larger plants. A few case histories showed the improvements obtainable by such controls.

Vibration Cleaning Boiler Heating Surfaces. V. I. Chastoukhan and E. L. Zarechansky. COMBUSTION 1959, **31** (Nov.), 39–40.

A system of vibrating the tubes of a La Mont waste heat boiler to free them from deposits is described. Vibration periods of $1^1/_2$–2 min. every 15–20 min. at a frequency of 28–30 c/s have proved successful.

Belongs the Future to the Gasifying Burner? F. Wilkens. *Energie* 1959, 11 (Nov.), 552–3 (in German).

The "Intherma" burner has been designed for use with Bunker C oil preheated to 160 F and gasified with superheated steam at 1020 F to produce a gas consisting mainly of methane. The resulting flame is soft and hot (1600 F) and because of very low excess air requirements the CO_2 content of the flue gas is about 15 per cent. Absence of corrosion in the low-temperature surfaces despite an exit flue gas temperature of 265 F

s ascribed to the fact that in the production of the methane all the hydrogen in the steam, oil and air is consumed so that any SO_3 formed annot combine with hydrogen to orm H_2SO_4.

Water-side Corrosion and Water reatment

resent-Day Feedwater Treatment or High-Pressure Boilers. P. Hamer. *ngng. Boil. Ho. Rev.* 1959, **74** (Dec.), 68–71, 374.

An abridged version of the author's aper to the I.M.E. is presented which iscussed: (1) Control of steam urity; (2) deaeration of boiler feedater; (3) solids in steam and deosits; (4) steam washers; (5) control corrosion in boilers; (6) corrosion the absence of oxygen; (7) idle oilers; (8) acid cleaning.

he Water in Power Station Operaon. P. Pracht. *Energie* 1959, 11 Nov.), 514–26 (in German).

A review dealing with: (1) Components of boiler water; (2) acid eaning of boilers on site or of boiler arts in the works; (3) feedwater quirements; (4) steam-water sepation in the drum; (5) feedwater eatment methods; (6) feedwater eatment in industrial power stations;) cooling water treatment; (8) ldi · to the feedwater.

ide-Out Effect and Decomposition henomena in Heating Surfaces of eam Generators at High Heat elease Rates. E. A. Ulrich. *Tech. erw.* 1959, **11** (Nov.), 395–8 (in erman).

The occurrence of hide-out and m evaporation, their dependence on at release rate, mass flow and salt ntent of the boiler water, and their ect on scale formation and tube lure are discussed.

lubility of Ferric and Cobalt Oxides Dilute Hydrazine. R. S. Young. *d. Chem.* 1959, **35** (Nov.), 549.

Experiments have shown that the otection against corrosion of a ndby boiler filled with water conning hydrazine at normal temperae and pressure is due to direct ction of hydrazine with dissolved gen rather than with ferric oxide.

ctors Determining the Purity of mpletely Demineralized Water. · Richter. *Tech. Mitt.* 1959, **52** ov.), 409–12 (in German).

Th ollowing factors are conere (1) genuine ion exchange; ion exchange with subsequent ctions; (3) adsorption processes;

(4) change of charge: (5) chromatographic effects. Their influence on the final quality of the water is discussed.

Fundamentals of Complete Demineralization Plant Circuits. H. Lis and J. Tregl. *Tech. Mitt.* 1959, 52 (Nov.), 417–23 (in German).

Arrangements of complete demineralization plants for obtaining and maintaining maximum efficiency and economy are discussed and illustrated by some actual examples.

Semi- or Fully-Automatic Demineralization Plants. H. V. Nodel. *Tech. Mitt.* 1959, **52** (Nov.), 428–32 (in German).

Both semi- and fully-automatic plants are described and the difference in their operation outlined. It is argued that although the capital costs of a semi-automatic control are 9 per cent and that of a fully-automatic control system are 28 per cent higher than a manually controlled plant it is almost always economically justifiable to install an automatic control system.

Flue Gas, Ash and Dust

The Residual Oil Ash Corrosion Problem. C. J. Sunder. *Corrosion* 1959, **15** (Nov.), 61–6.

This review is mainly concerned with the problems of high temperature corrosion and their prevention. It is believed that steels containing silicon and aluminum may be developed and/or coatings resistant to corrosion temperatures above 1200 F. Oil additives giving equal protection for all variations of impurities, operating conditions and materials are less likely to become available.

Control of Air Pollution from Oil-Burning Power Plants. H. C. Austin and W. L. Chadwick. *ASME Preprint* No. 59-A-71, 1959 (Dec.), 4 pp. Pilot and full-scale plant tests are reported on reducing the amount of particulate matter, SO_2, SO_3 and NO in the flue gases emitted from oil-fired boilers. Particulate matter and SO_3 can be separately removed in newly designed precipitators, the SO_3 also by adding a stoichiometrical amount of ammonia. SO_2 can be removed by oxidation over a vanadium catalyst; this method is very expensive. For the separation of NO, two-stage combustion has proved best and is at present under extended investigation in a large boiler. An infra-red gas analyzer has been developed for continuous recording of SO_2, SO_3 and NO which is much more accurate and reliable than previous instruments.

n the Design of Dust-Collector and Gas Duct Systems for Coal-Burning Electric Generating Stations. E. F. Wolf, H. L. von Hohenleiten and M. B. Gordon. *A.S.M.E. Preprint* No. 59-A-305, 1959 (Dec.), 5 pp.

Improved dust separation by han in design of the gas ducts to nd ...m the collectors have been ecured by means of transparent nodels. The difficulties experienced n a particular plant and the modi-cations introduced after model tudies are described in some detail.

. Superior Collecting Plate for Elec-ostatic Precipitators. H. J. White nd W. A. Baxter. *A.S.M.E. Pre-rint* No. 59-A-279, 1959 (Dec.), 7 p.

Experimental studies have shown nat the performance of a solid plate s collecting electrode is far superior o an expanded or perforated metal late. The design of the plate with s baffles is described.

ulverized Fuel Ash as a Concrete dditive. R. Hammond. *Mach. loyd* (Europ. Edit.) 1960, **32** (Jan.), 19–23.

The advantages and disadvantages f using fly ash in concrete construc-on are discussed and some applica-ons in heavy foundation work and rge dams described. Fly ash in oncrete is particularly useful where s resistance to aggressive water can e u...zed and early strength is of inc ...portance.

he Use of Fly Ash in Concrete by ntario Hydro. J. N. Mustard and . Macinnis. *Engng J.* 1959, 42 Dec.), 74–79.

The properties of fly ash concrete e discussed and the use of fly ash both high- and low-pressure grout-g mixtures at Niagara and to re-ace from 20–30 per cent of the ce-ent in appropriate mass and struc-ıral concrete applications at the .. Lawrence, Carribau, Whitedog ıd Otter Rapids projects are de-ribed. An account is given of the ethod developed for batching the h as a slurry.

From C.E.G.B. Digest 1960, **12** an. 30), 286.

eat Recovery Plant

ynamics of Heat Exchangers and eir Models. H. Thal-Larsen. *A.-M.E. Preprint* No. 59-A-117, 1959 Dec.), 12 pp.

Simple mathematical models are ed to analyze the dynamic characteristics of heat exchangers and paramers, such as dwell time of the fluid the heat exchanger and the metal d ...l time constants, are estab-hed to describe these characteris-

ties. A single dynamic parameter is proposed which is easily adjusted to different operating conditions and believed to be useful in the design, use, classification and standardization of heat exchangers.

Systematic Approach to the Design of Compact Heat Exchangers. W. B. Hendry. *A.S.M.E. Preprint* No. 59-A-193, 1959 (Dec.), 7 pp.

Equations are developed for designing a direct-transfer, cross-flow, single pass heat exchanger of minimum volume or minimum weight.

Design Performance of The Low-Level Economizer. J. H. Potter and R. C. King. *A.S.M.E. Preprint* No. 59-A-222, 1959 (Dec.), 12 pp.

The low-level economizer is installed behind the air preheater to remove further heat from the flue gases. Performance studies are presented which show that its installation is an economic proposition.

The Low-Level Economizer. S. Jewson. *A.S.M.E. Preprint* No. 59-A-226, 1959 (Dec.), 8 pp.

The design of the economizer, installed behind the air preheater and used to preheat feedwater, control of surface temperature, use of corrosion-resistant cast iron, and special washing equipment for the cleaning of the low-temperature heating surfaces are described.

Power Generation and Power Plant

Economic Selection of Steam and Power Supplies for Refineries and Petrochemical Plants. D. L. E. Jacobs and W. B. Wilson. *A.S.M.E. Preprint* No. 59-A-330, 1959 (Dec.), 12 pp.

A general consideration is presented of the factors involved in selecting boiler size, pressure and temperature, choosing between extraction-back-pressure or condensing turbine and pressure reducing stations, between turbine and motor drives, etc. Two case studies demonstrate how to arrive at the most economic solution in a given case.

Steam Power Plants for Peaking Service. A. R. Lebailly. *ASME Preprint* No. 59-PWR-8, 1959 (Oct.), 6 pp.

The calculations presented show that considerable reductions in investment can be achieved if units for supplying peak load (maximum 1500 h/year) are designed for lower pressures and temperatures, higher furnace heat release rates and simplified accessories. Based on a 100 Mw unit, conditions compared are 850 psi and 900 F, 1250 psi and 950 F, 1800 psi and 1000/1000 F and 1450 psi.

Combustion

DEVOTED TO THE ADVANCEMENT OF STEAM PLANT DESIGN AND OPERATION

volume 32 number 1 **July 1960**

Published monthly by COMBUSTION PUBLISHING COMPANY, INC., 200 Madison Ave., New York 16. A SUBSIDIARY OF COMBUSTION ENGINEERING, INC.

COMBUSTION is sent gratis to engineers in the U. S. A. in charge of steam plants from 20,000 lbs per hr capacity up; and to consulting engineers in this field. To others the subscription rate, including postage, is $4 in the United States, $5.50 in Canada, and $8 in Latin America and other countries. Single copies: Domestic, 40 cents, Foreign, 60 cents plus postage. Copyright 1960 by Combustion Publishing Company, Inc. Publication Office, Easton, Pa. Issued the middle of the month of publication.

Acceptance under Section 34.64, P.L. & R, authorized by United States Post Office.

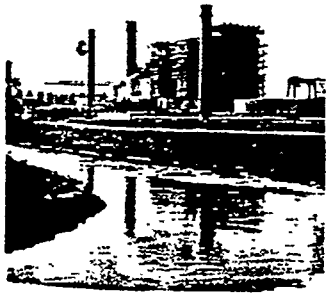
COMBUSTION publishes its annual index in the June issue and is indexed regularly by Engineering Index, Inc. and also in the Applied Science & Technology Index.

The magazine is now reproduced and distributed to libraries on microfilm by University Microfilms of Ann Arbor, Michigan. BPA

Printed in U. S. A.

COVER PHOTO

The ever handsome Cutler Station of the Florida Power & Light Co. is viewed from across the river.



...the Monthly Technical Bulletin, International Combustion, Ltd., London, W. C. 1)

...Properties and Preparation

...Structure and Properties of ...XV—The Carbonization of ...Models. P. M. J. Wolfs, D. W. ...evelen and H. I. Waterman. ...1960, **39** (Jan.), 25–38.

...maticity of Coal. B. N. Bose, J. ...opadhya, N. N. Das Gupta and ...hiri. *BrennstChemie* 1960, **41** (...) 11–4 (*in German*).

...shown that there is a close ...tionship between aromaticity of a ...and its carbon content and heat of ...on the one hand, and with ...and strength values of the ...made from these coals as determined by the Micum, Haven and ...tests.

...an Coal Characteristics and ... Effects on the Design of Steam ...ating Units. A. F. Duzy. *ASME Preprint* No. 59-A-242 1959 ...

...effect of coal characteristics ...especially, their ash constituents ...fusion temperatures on the ...and performance of bunkers, ...crushers, pulverizers, burners, ...convection surfaces, air pre... and dust collectors are con... Limiting values of coal size ... and ash properties are given ... various types of equipment.

The Combustion of European Coals in ... German Steam Generators. ... H. Henneke and G. ... *ASME Preprint* No. 59-A-... 1959 (Dec.), 11 pp.

A very general review of the influences of the use of low-grade German coals on the design of boilers and their accessories.

Effect of Ammonia on the Autoxidation of Coal. W. Pruss. *BrennstChemie* 1960, 41 (Jan.), 14–8 (*in German*).

Laboratory tests of treating coals with gaseous ammonia or ammoniacal salt solutions have shown that the tendency of autoxidation is thereby almost completely suppressed. Subsequent large-scale tests at a colliery have confirmed these findings where a stock pile of high volatile coal fines had reached a temperature of 60–70°C which was reduced by treatment with gaseous ammonia to 45°C within a few ... only occasional treatment was ... necessary to keep the temperature at this level. Similar reports have been received from other collieries with large stock piles. The economics of this treatment method are discussed briefly.

Mechanical Handling

Flow of Coal in Hoppers. Yee Lee. COMBUSTION 1960, **31** (June), 20–7.

Based on a review of the theory of flow of dry and wet granular materials in hoppers a hyperbolic design was evolved and tested in which arch formation and stoppage does not occur. In comparative tests at Peipu power station hoppers with stainless steel lined outlets, 70° side-wall angle and electrical vibrators suffered 353 interruptions of flow when handling coal with a surface moisture of 14.3 per cent whilst the hyperbolic hopper had not a single stoppage. All the other hoppers have now been replaced by the new design reducing operators by 13 men per day and increasing the plant output by 5 per cent.

Aluminum Chute Stops Coal Blockage. Anon. *Engineering* 1960, **189** (Feb. 5), 200.

Aluminum chutes have proved much more wear resistant against coal than mild steel chutes and because of the mirror finish they acquire in service also reduce blockage. At Early power station such a chute has been in operation for over 28,000 h and conveyed more than 60,000 t of coal; it is believed that it will have double the life of that of a steel chute. Their cost is the same as one made of mild steel.

The Effect of Fines Content, Moisture and Added Oil on the Handling of Small Coal. D. A. Hall and J. O. Cutress. *J. Inst. Fuel* 1959, **33** (Feb.) 63–72.

A vibrating cone was used to measure the effect on emptying time and bulk density of moisture, fines content and oil. The time to empty increases with moisture to a maximum and then decreases. The bulk density decreases to a minimum and then increases. Decrease of fines decreases emptying time at all moisture contents. Oil addition to high-rank coal reduces emptying time but has little or no effecting in low-rank coals. Oil generally increases the bulk density.

Heat: Cycles and Transmission

Heat Transfer from Solid Bodies to Liquids with Steam Formation taking into account the Flow Conditions. H. Bühler and F. J. Schmidt. *Atomkernenergie* 1960, **5** (Jan.), 18–22 (*in German*).

The determination of heat transfer coefficients evaporative cooling is discussed together with the influence of flow velocity of the coolant, surface finish of the heated body, additives to and temperature of the coolant. The processes during boiling and film phase and the transition from one to the other are described.

Heat Transfer to Heat Exchangers in the Moving Bed. R. Ernst. *Chem. Ing. Tech.* 1960, **32** (Jan.), 17–22 (in German).

Experiments were carried out on heat transfer to staggered heat exchange tubes over which particles passed in cross-flow and compared with results obtained in tests in which the particles passed axially through the tubes. In the former case the heat transfer coefficients are considerably higher and smaller heat exchange surfaces are required. The optimum values decrease with increasing particle size.

Steam Generation and Power Production

Location and Size of Transition Zone in a High-Pressure Once-Through Boiler. G. I. Aleinikov and I. I. Koshelev. *Energomashinostroenie* 1960, **6** (Jan.), 7–10 (in Russian).

Choice of the position of the transition zone is generally guided by the average quality of feed water, any sharp increases in impurity content being ignored. If the transition zone is in the region of reduced thermal flow (irrespective of pressure) no harm is done to the heating surface in the case of sharp deterioration of feed water quality; in the contrary case boiler shutdown is possible.

C.E.G.B. absiract.

The Temperature Distribution in the Wall of Cooling Tubes of Technical Furnaces. J. Böhm. *Energie* 1960, **12** (Jan.), 6–12 (in German).

Strict and approximate solutions are presented for the calculation of wall temperatures of radiant heating surfaces in pulverized coal fired furnaces.

High Capacity Gas and Fuel-Oil Boiler Unit for Outdoor Installation. A. A. Parshin, V. I. Reznik and Yu. A. Kharkin. *Energomashinostroenie* 1960, **6** (Jan.), 11–16 (in Russian).

A description is given of a prototype Soviet boiler unit, TGM-94 (500 t/h at steam pressure 140 kg/cm.² with main and intermediate superheat temperature 570 C), manufactured at the

Taganrog "Red Boilermaker" works, which was designed for outdoor construction and firing with natural gas and fuel oil. *C.E.G.B. abstract.*

Space Age Hydrostatic Test. R. A. Nickerson. COMBUSTION 1960, **31** (Jan.), 30–1.

It has been found that the use of a vacuum pump to extract all entrapped air has resulted in considerably reducing the time required to bring the boiler water to the pressure required for the hydrostatic test and pinhole leaks can be more easily detected.

Water-Side Corrosion and Water Treatment

The Removal of Rust and Scale from Steam Generators. E. Seyb. *B.W.K.* 1960, **12** (Jan.), 9–13 (in German).

After discussing the various acid treatment methods a new method originating from Sweden is described using a proprietary reagent called "Komplex-All" based on ethylenediaminetetraacetate. This amine reacts alkaline and thus avoids risks of corrosion; it reacts with calcium, magnesium and the scale. The generator was filled with 50m³ condensate to which 2.5m³ of the reagent was added, resulting in a pH of 12, heated to 240 C and 8 atü and 25m³ condensate was continuously added to replace the steam passed into the open. The Fe content was increased from 170 ppm in the first sample to 250 ppm in the last and a total of 36 kg Fe_3O_4 was removed. The drum and tubes were then free of scale and the boiler water remained completely clean. About 40 steam generators of up to 240 t h and pressures of up to 100 atü have been successfully treated by this method.

Con Edison Tests Prove High-flow-rate Demineralization. I. B. Dick and P. L. Silliman. *Power* 1960, **104** (Jan.), 78–81.

Tests in a pilot plant have shown that flow rates of 100 gpm per sq. ft are possible in a demineralizer plant without detriment to the quality of the effluent if larger resin bead sizes are used.

Treatment of Boiler Feed Water by Physical Means. E. Schumann. *B.W.K.* 1960, **12** (Jan.), 13–5 (in German).

Treatment of feedwater and boiler water by electrical radiation, magnetic fields or ultrasonics has proved successful for waters of medium and high carbonate hardness and low contents of sulphate ions and silicic acid. These methods are applicable only to shell-type boilers and not to water tube boilers.

Flash Evaporators for the Production of Boiler Make-Up in Power Plant Cycles. E. F. Stalcup, E. F. Cox and R. L. Coit. *ASME Preprint* No. 59-A-203 1959 (Dec.), 7 pp.

The design and application of large flash evaporators for converting salt water into potable water is described. The scaling problem has been largely overcome and flash evaporators can operate for a whole year without requiring cleaning. The distilled water contains less than 0.25 ppm impurities and is thus suitable for make-up water in power stations near the sea where fresh water is not available. Several schemes using either extracted steam or warm condenser cooling water are illustrated.

Gas-Side Corrosion and Deposits

The Influence of Factors of Raw Materials, Design and Operation on the Fouling of Heating Surfaces. W. Gumz. *Mitt. V.G.B.* No. 63 1959 (Dec.), 450–3 (in German).

An attempt is made to clarify the mutual influence of fuel properties, boiler design and its operation on the

heating surfaces and to indi- directions in which further should be carried out.

Corrosion of Superheater Reheater Tubing. J. Jonakin, Rice and J. T. Reese. *ASME* No. 59-FU-5 1959 (Oct.), 8 pp.

Severe corrosion of superheater and reheater tubes of up to half the wall thickness has led to extensive investigations into the causes and the search for remedial measures. The wastage of stainless steel is directly associated with ash constituents having low melting temperatures. The relation of metal wastage to metal temperature was a bell-shaped curve with a maximum at 1050–1150 F. The wastage can be reduced by selection of coals, finer grinding of the coal and the installation of shields of stainless steel on the tubes most exposed to corrosion. The good results obtained by this latter method is ascribed to the skin temperature of the shield being above the temperature (1300 F) at which heavy wastage occurs. Details are given of the nature and composition of the deposits on the tubes.

Corrosion of Superheaters and Reheaters of Pulverised-Coal-Fired Boilers. W. Nelson and C. Cain. *ASME Preprint* No. 59-A-89 1959 (Dec.), 8 pp.

T led studies of the deposits on sup ater and reheater tubes have shown that on the tube surface a layer of soft, crystalline, cream-white mass is formed consisting of water-soluble iron, potassium, sodium and sulfate. The formation of these molten complex sulfates takes place in a deposit when catalytically formed SO_3 combines with potassium sulfate and iron oxide from the coal ash. These molten complex sulfates decompose again when the temperature exceeds their thermal stability limits and/or the concentration of SO_3 becomes too low. The iron of the metal reduces the sulfate radical to sulfide and the ion is converted to iron-oxide scale. This reaction explains the rapid corrosion rates found in the laboratory and field tests.

ternal Corrosion of Superheaters in oilers Firing High-Alkali Coals. P. dor, E. K. Diehl and D. H. Barnrt. *ASME Preprint* No. 59-A-76 59 (Dec.), 10 pp.

Severe corrosion with over 50 per nt wastage of superheater tubes in clone-fired reheat boilers (1050 00 F) fired by coal with ash contain- 4.6 cent S, 0.63 per cent total ali 0.35 per cent chlorine is orted. Metallographic examination showed this to be pitting corrosion accompanied by surface carburization and subsurface sulfide formation where the surfaces had been at a temperature of 1250–1300 F. On the tube wall was found a white layer composed mainly of alkali and alkaline-earth sulfates, fly ash and corrosion products, the water-soluble fraction of the layer being particularly corrosive. The steel of type 321, 18-8 was susceptible to corrosion by this white layer in the temperature range 1200–1400 F with a maximum at 1300 F; type 310, 25–20 steel was less susceptible to this attack and the tubes in the most exposed region were clad with this steel. In addition, the gas temperature was reduced by an increased slag screen, higher excess air was used, MgO injected and the position of soot blowers altered. This reduced the corrosion rate to 5–10 per cent.

Oil-Ash Corrosion of Superheater Alloys in a Pilot-Scale Furnace. N. D. Phillips and C. L. Wagoner. *ASME Preprint* No. 59-A-281 1959 (Dec.), 8 pp.

The tests were conducted to elucidate the effect of a number of variables on the corrosion of superheater steels (18 Cr-8 Ni, 25 Cr-20 Ni, 16 Cr-13 Ni-Mo, 18 Cr-8 Ni-Ti) and of dry additives (MgO, $Mg(OH)_2$, $CaCO_3 \cdot MgCO_3$, $Al_2O_3 \cdot SiO_2 \cdot 2H_2O$) on reducing corrosion. The variables included: 1. Time; 2. Temperature; 3. Oil composition; 4. Metal temperature; 5. Gas temperature. The effectiveness of the additives were about the same. Kaolin producing the least amount of deposit and dolomite the most. Their application is thus a matter of economics; the most effective ratio of additives can be calculated from the formula: ratio by weight = sum of cations in additive divided by the sum of Na and V in oil. Of the steels tested the 25 Cr-20 Ni steel appeared to be more corrosion resistant than the others.

Flue Gas, Ash and Dust

Effect of Operating Variables on the Stack Emission from a Modern Power Station Boiler. G. C. Jefferis and J. D. Sensenbaugh. *ASME Preprint* No. 59-A-308 1959 (Dec.), 8 pp.

Tests were carried out on a twin-furnace boiler with tilting corner burners supplying steam at 1050/1000 F to a 186 Mw tubogenerator into the effect on dust loading, combustibles in the dust and oxides of nitrogen content in the flue gases of air admittance, oil temperature, burner tip size, burner tilt with and without flue gas recirculation, excess air and gas recirculation. The greatest effect in reducing dust

loading, combustibles and NO content had an increase in oil temperature, whilst increasing the excess air over the range of 2–4 per cent reduced the dust loading by 80 per cent and combustibles by 17 per cent, but increased NO content from 184 to 258 ppm. The smaller burner tips also reduced the dust loading and combustible content. In comparisons with front fired boilers it was found that the NO content of the flue gases from these boilers was always much higher than that from tangentially fired boilers.

Austrian Fly Ash as Binder Additives. O. W. Blümel. *Mitt. V.G.B.* No. 63 1959 (Dec.), 421–31 (in German).

Most Austrian fly ash results from the burning of brown coals and the tests were therefore almost entirely restricted to this type of fly ash. The fly ash either as received from the separators or finely ground was used with hydrated lime and/or Portland Cement to produce various kinds of mortar and with the latter to produce concrete. The strength of mortars and concretes containing various ratios of fly ash has been tested and the results are presented in graphs. For mortars a mixture of 40–60% fly ash and 60–40% hydrated lime is recommended, for concrete an addition of 20% fly ash.

Influencing the Properties of Concrete by Partial Replacement of Portland Cement by Fly Ash. J. D. McIntosh, J. P. R. Jordan and W. O. Callaghan. *Mitt. V.G.B.* No. 63 1959 (Dec.), 432–9 (in German).

Large-scale tests have shown that up to 25 weight per cent of Portland cement can be replaced by fly ash to obtain the same strength after one year as concrete without fly ash. Compressive strength is improved by a high specific surface of the fly ash and its grinding before use may be necessary. A high content of combustibles has an adverse effect on strength; this should be restricted to 10 per cent.

Power Generation and Power Plant

Steam-and-Gas Plant with High-Pressure Generators with 170–200 Mw Unit Capacity. M. I. Korneev and V. P. Drobot. *Energomashinostroenie* 1960, 6 (Jan.), 17–21 (in Russian).

Details are presented of a steam-and-gas installation in a high-capacity unit with two high-pressure steam generators having each an output of 210 t/h with gas turbines GT-700-12 and steam turbine PVK-150. Technical and economical characteristics and equipment layout are explained.

C.E.G.B. abstract.

New 5-MW Gas Turbine will Burn Coal Gas. Anon. *Elect. World* 1960, **153** (Feb. 1), 28–9.

At the Muskingum River power station a 5 Mw gas turbine will be added to one of the four 215 Mw boilers to increase the efficiency of the cycle; this is only a prototype plant to gain experience whilst a full-scale plant is expected to improve efficiency by 4 per cent. The plant consists of a coal carbonizer, a separator for the char and gas, a combustion chamber, a two-shaft gas turbine one driving the compressor and the other the generator, and a cyclone attached to the boiler in which the char and exhaust gas are burned, the combustion gases passing into the boiler.

Test Results of the First Pulverized Coal Fired Hot Air Turbine Plant for Power and Heat Generation. K. Bammert and C. Keller. *B.W.K.* 1960, **12** (Feb.), 62–4 (in German).

After more that 10,000 h of operation tests were made on the hot air turbine plant at Ravensburg and the results are compared with the calculated data. It was found that after the various modifications had been carried out the efficiency of the plant of 24.8 per cent at full load matched almost exactly the figure predicted. The graphs give details of input and output balance, pressure losses, generator output as a function of the air pressure at the turbine inlet, air heater efficiency, total efficiency, coal consumption, operating hours, electrical output and heat supply.

Towards the Automatic Power Station—Little Barford B. Anon. *Elect. Times* 1960, **137** (Feb. 4), 168–70.

This station consists of two 60 Mw units each served by a 550 klb/h boiler with steam at 950 psi and 910 F. The boilers are of outdoor design, only the burner face in the front wall (8 burners) and part of the basement being enclosed and the drum ends and water level detectors enclosed in a penthouse. Steam control is by hollow tube surface condenser. Ash is removed by a dry vacuum system. The turbine condensers are split into two sections each fed by a pump with variable-pitch blades. Each set has its own cooling tower. The automatic electronic control is used only for the steam side where steam pressure and temperature, water, air and steam flow are measured and adjusted by 3-term controllers incorporating proportional, integral and derivative controls and analogue computers.

Computers to Automate Huntington Beach Units. W. L. Chadwick. *Elec. World* 1960, 153 (Jan. 18), 50–4, 59–60.

10 Mw units No. 3 and 4 ction will be provided r-supervised controls to improve continuity of educe fuel and manpower solid-state digital com- 6,000 word magnetic drum ill continuously scan 900 nts at rates up to 300 points and log periodically 50 critical it will automatically start- and shut-down each unit and super- operation. The extent to which the controller is used in the various sections of the power station and the functions it carries out are described in detail.

Gas Turbine Plant has 100-MW Capacity. T. Ingledow. *Elect. World* 1960, 153 (Feb. 1), 36–9, 75.

At Port Mann a power station containing four 25 Mw gas turbines has been built which is remotely controlled from Vancouver 15 miles away. Starting, normal operation and stopping is completely automatic; any difficulties are automatically transmitted to the control center. The gas turbines are natural gas fired with oil as standby and require only 20 min. from cold to reach full load.

The Marchienne-au-Pont Power Station (Belgium). E. Maryssael and M. Simonart. *Votre Electricité* 1959, 40 (Dec.), 10–32 (in French).

The capacity of the existing 27 Mw pithead station has been increased by a 115 Mw reheat unit. The boiler plant, turbine alternator, auxiliaries and control equipment are described. The boiler is 350 t/h, 540/540 C, 131 kg/cm² fired with slurry containing 25 per cent moisture which is reduced to 2 per cent by "flash drying." The bin and feeder system is used. The coal storage area is semicircular in shape, stocking and reclaiming being carried out by a gantry pivoted at the center with the rail tracks running round the periphery.

From C.E.G.B. Digest 1960, 12 (Feb. 13), 391.

Combined Heat and Power Station Stuttgart-Gaisburg. H. Eickemeyer. *B.W.K.* 1960, 12 (Feb.), 51–62 (in German).

The operation of the new 10 Mw unit and auxiliary 14 Mw tubogenerator (see abstract 5205, 1959) together with the adjacent older heat-power station containing three boilers rated at 142–165 klb/h, 1850–1150 psi, 935 F, two oil-fired peak-load boilers rated at 180 klb/h, 340 psi and 710 F, and a 24 Mw extraction-condensing turbogenerator (extraction at 284 psi and 93 psi) at maximum electrical and minimum heat demand, minimum electrical and maximum heat demand and inter-

mediate stages is described. A further 10 Mw turbogenerator is to be added in the new power station to utilize steam at 93 psi and condense this in a calorifier for the planned hot water supply mains. Space in the new power station is also provided for two 15 Mw gas turbines for peak power supply and a further 100 Mw condensing turbogenerator. The description also includes starting and shut-down of the first 100 Mw unit, control of feed water flow, coal feed, air supply, temperature in the mill, steam temperature and pressure, auxiliary electrical requirements, the main turbine and its operation at various steam loads, the condenser, cooling water supply, and auxiliary turbine. When completed, the capacity of the new power station will be 252.8 Mw. The cost of the first unit, auxiliary turbogenerator and turbogenerator for hot-water supply is 554 DM kw (£37/kw) at rated capacity and 58[illegible] DM/kw (£49.5/kw) at maximum capacity. The built-over area is 0.324 sq. ft/kw and the building volume 35.31 cu. ft/kW.

Operational Experience with Oil Fired, Fully Automatic Three-Pass Boilers. H. Diehl. *Energie* 1960, 12 (Jan.), 17–20 (in German).

Four packaged three-pass smoke tube boilers were installed in a motor car works to provide process and space heating steam when the high pressure boilers were unable to supply the demand. The boilers have fully automatic controls of the on-off type at loads below 30 per cent and of the modulating type from 30 to 100 per cent load. Each boiler is rated at 15,500 lb/h at 140 psi and their thermal efficiency at full load is 90 per cent.

Materials and Manufacturing Processes

Effect of Velocity on Corrosion. H. R. Copson. *Corrosion* 1960, 16 (Feb.), 130–6.

A general discussion of the problem is presented and the results of tests on iron and other metals given in tables and graphs.

High-Temperature, High-Pressure Oxidation of Alloys caused by Carbon Dioxide. J. C. Bokros and W. T. Wallace. *Corrosion* 1960, 16 (Feb.), 117–22.

Corrosion tests were carried out on austenitic stainless and 10 ferritic steels, 6 nickel-base and 4 miscellaneous alloys exposed to CO_2 at a pressure of 1000–2000 psi and temperatures from 1100 to 1740 F to investigate their possible use in high-pressure high-temperature gas-cooled reactors. The results are presented in tables and discussed.

[illegible]ion Testing of Two Zirconium [illegible] S. Kass. *Corrosion* 1960, 16 [illegible] 137–43.

[illegible]rosion properties in high temperature water and steam and the effect of surface preparation and test arrangements on the results have been studied.

[illegible]els for Nuclear Reactors. H. F. Beeghly. *Nucl. Sci. Engng.* 1960, 7 (Jan.), 21–5.

Methods of fabrication, mechanical property data and compositions of carbon and alloy including low manganese, low residual element steels are summarized. The use of low manganese steels for various reactor parts is discussed in some detail.

Qualification of Inconel for Nuclear Power Plant Applications. H. R. Copson and W. E. Berry. *Corrosion* 1960, 16 (Feb.), 123–9.

The resistance of Inconel to corrosion in primary and secondary reactor water circuits has been studied. Under all conditions a tightly adherent film formed on the specimens and corrosion rates were similar to those of austenitic stainless steels. Intergranular attack and stress corrosion cracking did not occur.

The Creep and Rupture Properties of 2¼% Chromium-1% Molybdenum Quality Steel. A Summary of British Data (1% Creep Strain and Rupture). J. D. Murray, J. S. Blair, G. C. Foster, H. W. Kirkby and J. Blackhurst. *J. Iron & Steel Inst.* 1960, 193 (Dec.), 354–9.

The available data are presented in the form of scatter bands and extrapolated to 100,000 h.

Stress Corrosion of Steel. H. Gerbeaux. *Soudage* 1959, 13 (Nov./Dec.), 433–72 (in French).

A broad review of the mechanical and physical aspects of stresses and distortions in metals and their influence on corrosion. The characteristics of stress corrosion cracking in carbon and stainless steel in various corrosive media are described and stress relieving methods considered. Where a stainless steel is required the use of an austenitic-ferritic steel containing Mo is recommended.

Investigation of Creep in Welded Joints in Heat-Resistant Steels. Report I. Structural Changes in 15 KhMA Steel during Creep. N. L. Kareta. *Autom. Weld.* 1959 (June), 1–11. *B.W.R.A. Transl.*

In the creep conditions used in the research plastic deformation takes the form of shear and is accompanied by the formation of a substructure of ferritic grains which tends to strengthen the metal.

Combustion

DEVOTED TO THE ADVANCEMENT OF STEAM PLANT DESIGN AND OPERATION

volume 32 number 2 August 1960

Published monthly by COMBUSTION PUBLISHING COMPANY, INC., 200 Madison Ave., New York 16. A SUBSIDIARY OF COMBUSTION ENGINEERING, INC.

Charles McDonough, President

Arthur J. Santry, Jr., Vice-President

Otto Strauss, Treasurer

James A. Ennis, Secretary

COMBUSTION is sent gratis to engineers in the U. S. A. in charge of steam plants from 30,000 lbs per hr capacity up; and to consulting engineers in this field. To others the subscription rate, including postage, is in the United States, $5.50 in Canada, and $6.00 in Latin America and other countries. Single copies: Domestic, 40 cents, Foreign, 60 cents plus postage. Copyright 1960 by Combustion Publishing Company, Inc. Publication Office, Easton, Pa. Issued the middle of the month of publication.

Acceptance under Section 34.64, P.L. & R, authorized by United States Post Office.

COMBUSTION publishes its annual index in the June issue and is indexed regularly by Engineering Index, Inc. and also in the Applied Science & Technology Index.

The magazine is now reproduced and distributed to libraries on microfilm by University Microfilms of Ann Arbor, Michigan.

Printed in U. S. A.

COVER PHOTO

Seward Station, Pennsylvania Electric Co., capped a smoking stack with a ten-ton Venturi nozzle. *See p. 57*

Abstracts From the Technical Press—Abroad and Domestic

(Drawn from the Monthly Technical Bulletin, International Combustion, Ltd., London, W. C. 1)

Fuels: Sources, Properties and Preparation

Change of Rank, Rank Criteria and Classification of Coals on the Basis of Vitrain Analyses. Pt. I and II. K. Patteisky and M. Teichmüler *Brennst-Chemie* 1960, 41 (Mar.), 79–84 (Apr.), 97–104 (in German).

It is known that the change of rank of vitrain is not a straight but a broken line, the most important break occurring at 87 per cent C and 29 per cent VM. With these changes of rank the usefulness of rank criteria varies and the best criteria for various ranges or rank are discussed. The analysis diagrams are evaluated for a coal classification on vitrain basis. The boundaries of the large rank stages, especially between the various types of brown coal and between brown and bituminous coal for which previously no quantitative data were available, have been demarcated.

The Removal of Chlorides from Coal by Leaching: II. Weathering in Stockpiles. E. W. F. Gillham. *J. Inst. Fuel* 1960, 33 (Apr.), 193–8.

In follow-up studies washed and unwashed coal of high chlorine content was exposed to normal weathering conditions in stockpiles. After three years the chlorine content of the washed coal had fallen from 1 to 0.3 per cent. Unwashed coal takes a considerably longer time to achieve similar results.

Physical and Economic Problems in the Transport of Solid Particles in Liquids and Gases. W. Barth. *Chem. Ing. Tech.* 1960. 32 (Mar.), 164–71 (in German).

After outlining the problems encountered in pneumatic and hydraulic transport of solid materials an attempt is made at defining the conditions in which this type of transport is economical.

The Handling of Solid Fuels and the Removal of Ash in Private Power Stations. E. Dordain. *Tech. Mod.* 1960, 53 (Feb.), 46–58 (in French).

The various types of equipment used in France for moving solid fuels such as conveyors, elevators, cranes and hydraulic and mechanical ash removal installations are described.

Coal Handling Plants in Steam Power Stations. W. Fraass. *Elektwirtsch.* 1960, 59 (Mar. 20), 148–52 (in German).

The boilers at the Schwandorf power station are fired by brown coal which arrives in special wagons and is discharged into two bunkers of a total capacity of 10,000 tons. From these the coal is transported by a series of belt conveyors to the storage area or the boiler house bunkers. The various installations and their controls are briefly described.

Dust Control at Milliken Station. W. R. Wise. COMBUSTION 1960, 31 (Mar.), 39–40.

Spraying of dust with a solution containing a wetting agent is carried out at the car dumper, discharge from the pan feeders to the stocking out conveyor, discharge from vibrating feeders to the reclaiming belts and from the crushers to the boiler house conveyors.

Steam Generation and Power Production

Determination of Stresses in Pressure Vessels. H. Jung. *Chem. Ing. Tech.* 1960, 32 (Mar.), 217–22 (in German).

A simplified theory of a shell resistant to bending forces has been developed and solutions are presented for the cylinder, sphere and cone. The equations are tabulated. A calculated example shows good agreement between theoretical and experimental results.

Flow of Fluids. M. Murray. *Ind. Engng. Chem.* 1960, 52 (Mar.), 257–61.

The annual review of literature published in 1959.

The Effect of Temperature Drop Between Components of a Boiler Drum and the Stresses Set Up in It. Yu. A. Magnitskii. *Teploenergetika* 1960, 7 (Mar.), 48–51 (in Russian).

Methods are suggested for considerably reducing the drum stresses by means of a change of water level during start-up and shutdown.

C.E.G.B. abstract

Features of the Operation of the 67-4-SP Once-Through Boiler on High-Ash-Content Fuel. A. L. Bychkovskii. *Energomashinostroenie* 1960 (Feb.), 21–5 (in Russian).

A brief description is given of the basic features of operation of the 67-4-SP once-through boiler when high-ash-content fuel is used, with particular reference to stability of furnace operation, optimum firing conditions, thermal conditions of the heating surfaces and boiler economics.

C.E.G.B. abstract

Shot Cleaning of Convection Heat-exchange Surfaces. D. Humphrey. *J. Inst. Fuel* 1960, 33 (Apr.), 173–9.

The design and installation of shot cleaning equipment is described and the advantages of this technique, especially the cleaning during full load conditions, set out.

Liquid and Gaseous Fuel Firing

The Use of Heterocyclic Tertiary Amines for the Control of Corrosion caused by Flue Gases. E. Brett Davies and B. J. Alexander. *J. Inst. Fuel* 1960, 33 (Apr.), 163–73.

The theoretical basis for the use of tertiary amines as corrosion inhibitor in oil-fired boilers is explained and experimental and field experiences described. It was found that the injection into the flue gases of 0.03 per cent of these amines by weight of the rated fuel capacity afforded protection of economizers, air heaters and ancillary equipment, but that difficulties may arise in their uniform distribution in the flue gases. Deposits on air heaters can be removed by water washing as also any accumulations of carbon deposits.

Furnaces and Combustion

General Combustion Nomogram for the Assessment of Flue Gases and their Calculations by Means of Fuel Coefficients. H. Viereckl. *Energie* 1960, 12 (Mar.), 89–95 (in German).

A simple nomogram has been constructed for flue gas compositions and excess air determinations. The nomogram enables to rapidly assess the quality of the combustion from the fuel or flue gas analysis. The calculation of the various coefficients from the fuel or flue gas analysis is given in a first table and average values are given in a second table and graph. A further table gives the equations for the calculation of the gas and air volumes and their weights. An example shows the application of the nomogram.

The Release of Sodium Aerosols During the Combustion of Pulverized Coal: a Laboratory Investigation. D. Ounsted and J. Schoen. *J. Inst. Fuel* 1960, 33 (Apr.), 199–206.

The furnace for firing 100 gr of pulverized coal per hour and its equipment are described. The effect of ash content of the fuel and its particle size on the formation of sodium aerosols has been studied; this increases with increasing particle size and increasing ash content. Suggesti

'e made to reduce deposit formation ,used by sodium aerosols by burning ,al of high ash content, reinjection fly ash or finer grinding of coal.

'ate' 'e Corrosion and Water eatm.

Ultra-Pure" Boiler Feedwater. N. Hill. *Heat Engng.* 1960, **35** an./Feb.), 104–6.
Tests carried out by the TVA at the hnsonville power station's No. 9 and units have shown that suitable de-ned evaporators are able to produce nsistently feedwater with a vapor rity below 0.1 ppm (0.008–0.071).

edwater Treatment for Low-Pres-re Boilers. W. F. Gerrard. *Steam gr.* 1960, **29** (Apr.), 236–40.
One method for internal and one for ternal treatment are described. The st uses anhydrous trisodium phos-ate, anhydrous sodium sulfite, so-um hexametaphosphate, tannin or dium alginate and anhydrous or ystalline magnesium sulfate. The antities required and the manner of eir application are stated. The sec-d consists in preliminary base ex-ange, treatment of the water with lphuric acid to partially convert the dium bicarbonate to carbonate, forc-g the partially neutralized water rough a polythene spray to remove rt the CO_2 and then pass the ate. ough a bank filled with gran-ar magnesium oxide to absorb the sidual CO_2 and convert any bicar-nate into carbonate. The ad-ntages of the process over lime-soda ftening are outlined.

rrosion in Power Station Feed stems. A Trial of Cyclohexyl-nine and Morpholine and their Eval-tion as Corrosion Inhibitors. B. uck and E. M. Osborn. *Chem. and d.* 1960 (Mar. 26), 326–31.
Both cyclohexylamine and mor-oline at an amine concentration of 2 ppm reduced the iron content of e boiler feedwater from 20 pptm 5 pptm, but the copper content only om 20 pptm to 10–12 pptm. Mor-oline was slightly more effective in ntrolling metal pickup.

amage to Boiler Tubes due to Cop-r Deposits from Boiler Water. Splittgerber and F. Börsig. *Masch-enschaden* 1960, **33** (Feb.), 21–4 n German).
Investigation of the internal de-sits of corroded tubes of a 140 atm age) boiler revealed, in addition to agnetic iron oxides, considerable iar s of copper which was de-si from the boiler water due to gh local thermal stresses of the pff iler and led, by a catalytic action, increased oxidation of the tube wall

through decomposition of the steam. The observations made on investigation of this damage agree in nearly all respects with the results obtained in other countries and, recently, in Germany in similar cases.

From *C.E.G.B. Digest* 1960, **12** (Apr. 23), 1040.

Investigations of Impurities in the Cooling Water of the First Nuclear Power Station. P. N. Sljurasev, V. A. Ivanov and L. N. Nesterova. *Kernenergie* 1960, **3** (Mar.), 248–51 (in German).

The investigation concerned the corrosion of steel in the first Russian nuclear power station near Moscow and the rate at which the corrosion products were carried out by the cooling water. The rate of carrying away these products is a function of the flushing of the primary circuit by light water and the reactor output. Irradiation in a light water cooled reactor causes formation of nitric acid by oxidation of the dissolved nitrogen. It could be shown that the water contains ions of Na, Ca, Mn, Ni, Co, Cr and Si, but Fe and Cu are present as colloids.

Flue Gas, Ash and Dust

Testing the Rotary Regenerative Air Preheater. Part I and II. J. Waitkus. COMBUSTION 1960, **31** (Mar.), 30–7 (Apr.); 60–5.

This first part deals only with methods, equipment and procedures for the flue gas analysis. The second part deals with difficulties in measuring flue gas, air and metal temperatures, pressure and draught and the most suitable instruments for each application.

Heat Recovery Plant

Thermal Calculation of Steam-Heated Feed Water Preheaters. H. Kerwat. *Energie* 1960, **12** (Mar.), 98–101 (in German).

The difficulties of determining the heat transfer coefficients in the subcooling, condensation and condensate cooling zones are discussed and values obtained in extensive tests tabulated. An example illustrates the application of these coefficients in the calculation of the area of each of the three zones.

Hydraulic Analogue for Studying Steady-State Heat Exchangers. J. Prochazka, J. Landau and G. Standart. *Brit. Chem. Engrg.* 1960, **5** (Apr.), 242–7.

Hydraulic analogues for counter and mixed flow heat exchangers are presented and the results presented in tables and graphs.

Power Generation and Power Plant

Power Station Heat Cycles. P. J. Cameron. *Elect. Rev.* 1960, **166** (Apr. 8), 675–80.

The heat cycles of conventional and nuclear power stations are compared. The possibility of using reheating in nuclear stations are explored and a particular scheme involving a back-pressure turbine driving a circulator is outlined; the gain in efficiency is discussed.

Conduction and Radiation Losses and Ventilation in a Power Station. M. Sack. *Elektwirtsch.* 1960, **59** (Mar. 20), 142–8 (in German).

Investigations into the conduction and radiation losses in a power station and efforts to improve comfort conditions for the personnel are reported. It is shown that a considerable recovery of the losses can be combined with improved working conditions.

Efficiency Plus. E. R. Knight. *Electricity* 1960, **13** (Mar./Apr.), 76–7.

Spondon H is the first CEGB station specifically built to supply process steam to an industrial consumer (Brit. Celanese Ltd.). When finished it will contain four 180 klb/h stoker fired boilers supplying steam at 900 psi and 875 F to three 10 mw turbogenerators exhausting at 160 psi and 510 F. The thermal efficiency of this station exceeds 60 per cent.

Big Power Comes to Staten Island. M. L. Branin. *Coal Utiliz.* 1960, **14** (Feb.), 14–8.

The first unit of the Arthur Kill No. 2 station consists of a boiler rated at 2400 klb/h at 2100 psi and 1050/1000 F and a 335 mw cross-compound turbogenerator. The boiler has twin furnaces, one containing the reheater and the other the final superheater. Each furnace has 16 burners for coal, oil and gas firing supplied from 8 mills each with a capacity of 38,400 lb/h at 63 Hardgrove and a fineness of 77/200 mesh. Furnace ash is removed by a hydraulic system, fly ash by a vacuum system. The combined multicyclone and precipitators have a separation efficiency of 99 per cent. The furnace operates under positive pressure and there is no i.d. fan, but cold flue gas can be recirculated from the economizer outlet to the furnace bottom. The air is preheated by steam before entering the rotary preheater.

Progress of the Tennessee Valley Authority. Anon. *Engineer* 1960, **209** (Apr. 8), 626–8 (Apr. 15), 666–8 (Apr. 22), 700–4.

The power system of the TVA was increased by 775 mw during 1959 and 66 per cent is now generated in steam and 34 per cent in hydroelectric stations. At the Johnsonville Station three 150 mw units were completed and a fourth nearing completion giving a total capacity of 1275 mw. At Gallatin station a 275 mw unit was commissioned and a second 275 mw unit almost ready bringing the total capacity to 1050 mw. At Widows Creek the first 500 mw unit is to be commissioned in October 1960, consisting of a cross-compound double flow turbine with two 275 mw generators and a controlled circulation boiler rated at 3850 klb/h at 2450 psi and 1053/1003 F with feedwater at 530 F. The calculated heat rate is 8913 Btu/kwh. A further 500 mw unit is to be installed at Colbert station. Future developments are outlined.

The Second (French) Nuclear Power Station. Bienvenu, B. Saitcevsky, F. Bourdillat, C. Tourgeron, R. Millot, Lamiral and L. Laurent. *Nucl. Pwr.* 1960, **5** (Apr.), 118–23.

EDF2 to be in operation in 1962 will have an output of 791 mw (th) and 268 mw (e) using natural uranium in Mg cans, grafite as moderator and CO$_2$ at 368 psi as coolant with an inlet temperature of 195 C and an outlet temperature of 365 C. There are 4 heat exchangers producing h-p steam at 300 C and 473 psi and l-p steam at 126 psi and 340 C. Two 115/125 mw turbogenerators will be installed. Details of the design are presented.

Kahl Nuclear Power Station. H. Kornbichler. *Engineer* 1960, **209** (Apr. 8), 624–5.

This first German power reactor is rated at 60 mw (th) and 15 mw (e) and is of the boiling water type. Primary steam flow is at the rate of 118.5 t/h at 71.3 at and secondary steam flow

Editor's Note:

As we point out each month, the materaial for this department is drawn from the International Combustion Ltd. Monthly Technical Bulletin. The Bulletin's editor, K. R. Lenel, advises us of a new publication, "Fuel Abstracts and Current Titles," published by the Institute of Fuel, 18 Devonshire St., Portland Place, London, W.1, which does a very comprehensive job. We have seen it and endorse it for individuals and libraries of universities, consulting engineers, manufacturing organizations. Write to the Institute direct for subscription rates.

105 t/h at 47.8 at. Details are given of the reactor building, turbine hall, office block and water purification plant.

Instruments and Controls

The termination of the Optimum Design Data of the Steam Power Process by Electronic Computers. K. Knizia. *Elektwirtsch.* 1960, 59 (Mar. 20), 137–41 (in German).

The determination of the optimum process efficiency as a function of temperature and pressure of the superheated and reheated steam, enthalpy of the feedwater entering the boiler, number of preheating stages, thermal efficiency of the turbine, increase of enthalpy of feedwater in the pumps and saturation temperature in the condenser can only be effected by a computer. The preparations necessary for its use are described.

Automatic Power Control Improves Precipitator Efficiency. L. L. Little and C. R. Zink. *Pwr. Engng.* 1960, 64 (Mar.), 64.

The improvements in electrostatic precipitator efficiency due to the introduction of automatic control of power input are outlined.

The Behaviour of the Venturi Pneumatic Pyrometer in Industrial Furnaces. R. E. Holland, R. Jackson and C. G. Thurlow. *J. Inst. Fuel* 1960 33 (), 180–7.

The application of this pyrometer in open-hearth furnaces, converters, glass tanks, oil and pulverized coal fired boilers is described. The advantages of this type of pyrometer are that it is accurate at all temperatures, has a rapid response, is only slowly blocked by dirty gas and can easily be cleaned.

Metallic Thermocouples for the Measurement of Temperatures above 1600° Anon. *Metallurgia* 1960, 61 (Mar.), 141–2.

Thermocouples with iridium-60 per cent iridium-40 per cent thorium are suitable in oxidizing atmospheres up to 2000 C. Irridium-tungsten couples can be used in neutral (argon or helium) atmospheres up to 2300 C. Tungsten-tungsten-rhenium couples in neutral or reducing atmospheres can measure temperatures up to 2800 C.

Cast Iron from Steel Scrap. Anon. *Metallurgia* 1959, 60 (Dec.), 261–2.

Instead of pig iron Ferranti Ltd. will use steel scrap with added recarburising compounds, silicon and manganese in a 3 t capacity electric furnace the production of non-magnetic and spherical graphite cast iron or a combination of both. Economies and flexibility are the chief advantages of this new process.

Combustion

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volume 32 number 3 **September 1960**

Published monthly by COMBUSTION PUBLISHING COMPANY, INC., 200 Madison Ave., New York 16. A SUBSIDIARY OF COMBUSTION ENGINEERING, INC.

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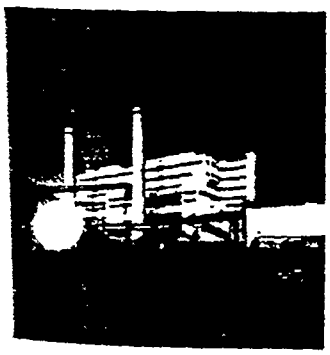
Printed in U. S. A.

COVER PHOTO

Impressive shot of the Eddystone Station of Philadelphia Electric, home of the highest pressure steam generator yet built.



Abstracts from the Technical Press—Abroad and Domestic

(Drawn from the monthly Technical Bulletin, International Combustion, Ltd., London, W. C. 1)

Fuels, Sources, Properties and Preparation

Chemical Structure and Properties of Coal XXVI—Studies on Artificial Coalification. J. P. Schumacher, F. J. Huntjens and D. W. van Krevelen. *Fuel* 1960, 39 (May), 223–34.

By hydrothermal carbonification of plant material and peat the natural coalification has been imitated. Cellulose thus treated in an acid medium is similar to vitrinites, lignin to micrinite, wood to vitrinite. When treated in an alkaline medium, cellulose, wood and peat become similar to natural asphaltites.

Remarks on the Study of the Pyrolysis of Bituminous Coals by Differential Thermal Analysis. A. F. Boyer and P. Payen. *BrennstChemie* 1960, 41 (Apr.), 104–6 (in German).

The sharp rise in the curves of a differential thermal analysis of swelling coals between 420 and 450 C is believed due to a sudden increase of the thermal conductivity of the coal at the moment the coal particles flow together.

The Suitability of Home-produced and Foreign Fuels for the Operation of Slagging Furnaces. Bituminous Coal: Pt. 2. T. Geissler. *Energie* 1960, 12 (Apr.), 136–47 (in German).

The following are discussed: (1) Influence of slagging furnace design; (2) Influence of burner design; 3. Flame temperature in the slagging furnace; (4) New characteristic coefficients for the different designs of slagging furnace. Examples are given of the application of the previously developed (see abstract 5635) and the new coefficients to estimating whether coal is or is not suitable for slagging operation.

Tillington Power Station. Anon. *Iron & Coal Tr. Rev.* 1960, 180 (Apr. 1), 867–8.

The coal supplied to this power station consists mainly of 2" × 0 stack and an admixture of slurry so that its moisture content may reach 15 per cent. For this reason vibrators and vibratory feeders have been installed at all important transfer points, such as the wagon tipplers, bunker inlets and the grid covering the receiving hoppers.

Assessment of Granulation of Granular Solid Fuels. I. N. Aref. *ASME Preprint* No. 59-A-150 1959 (Dec.), 12 pp.

The advantages and disadvantages, especially power loss, wear and sealing are compared of: (1) Lock hopper; (2) Lock hopper with a moving wall; (3) Positive displacement ram pump; (4) Solid extrusion; (5) Slurry pumps; (6) Positive displacement gear pump; (7) Multistage centifugal compression with air; (8) Peristaltic or rubber pumps.

Steam Generation and Power Production

Assessment of Resistance to Brittle Fracture in Pressure Vessel Design. Pt. II. K. Schaar. *Tech. Überw.* 1960, 1 (Apr.). 159–64 (in German).

The conclusions with regard to steel selection, design and construction of pressure vessels are set out.

Prediction of Creep Failure Time for Pressure Vessels. F. P. J. Rimrott, E. J. Mills and J. Martin. *ASME Preprint* No. 60-APM-7 1960 (June), 6 pp.

The creep-failure time for a thick-walled pressure vessel is defined as the time at which the true creep strain reaches infinity and used to predict the time to fracture. The solution is presented in the form of graphs. Simplified solutions for very thin-walled and very thick-walled vessels are presented.

Recent Boiler Design Practice. W. H. Rowand and E. G. Kispert. *ASME Preprint* No. 59-A-176 1959 (Dec.), 31 pp.

A review of American Babcock and Wilcox designs dealing with: (1) Jet ignition grate; (2) Mills; (3) Burners; (4) Cyclones; (5) Coal feeders and distributors; (6) Wall constructions; (7) Drum and drum internals; (8) Natural circulation and once-through boilers of which 18 different designs are shown.

Steam Generators. A. Bachmair. *B.W.K.* 1960, 12 (Apr.), 144–5 (in German).

In Germany 61 per cent of boilers above 335 klb/h output are of forced flow design and the largest on order for firing by bituminous coal is a Benson boiler rated at 1100 klb/h at 3000 psi and 990 F. Controls for these boilers have been improved so that they are no longer at a disadvantage compared with natural circulation boilers. Average output has risen from 400 to 465 klb/h, average efficiency is 90.3 percent pressures vary between 2200 and 3000 psi. One supercritical boiler rated at 4400 psi, 1120 F is in operation, another rated at 580 klb/h, 4630 psi and 1040 F under construction. Although 19 boilers with steam temperatures above 1100 F are operating new orders did not exceed 1040 F. Prefabrication of boiler parts and gas-tight casings are making progress.

Removal of Slag Deposits from Screen-type Superheaters by Vibration Methods. L. I. Kropp and D. L. Itman. *Elekt. Stantsii* 1960 (Mar.), 2–7 (in Russian).

The paper deals with the application of the method to a 160 t/h, 120 kg/cm², 500 C boiler: the vibration device is described and a test and its results are discussed. The working conditions of the metal are considered. The method effectively ensures long-period non-slagging operation and substantial reduction in ash deposits. Regular operation of the vibration equipment considerably increases the heat absorption of the screens. The screen heating surfaces can be kept clean in a gas-flow temperature up to 1350–1400 C and boiler efficiency is improved.

C.E.G.B. abstract.

Designing Boilers for Gas-cooled Reactors. B. G. Ediss. *Nucl. Pwr* 1960, 5 (May), 101–4.

Ways of reducing the work involved in calculating the most important dimensions of a boiler associated with a nuclear reactor using standard methods of heat exchange design are outlined.

Liquid and Gaseous Fuel Firing

Industry's Battle with Fuel Ash. R. C. Bellas. *Power* 1960, 104 (Apr.) 83–8.

A brief review of the causes of oil ash attack in boilers, gas turbines and diesel engines and of the countermeasures available.

Boiler Problems Associated with Use of Bunker C Fuel. J. J. McMullen. *Combustion* 1960, 31 (Apr.), 42, 46–7.

Deposit formation on high and low temperature boiler surfaces caused by the ash constituents of Bunker C oil are discussed. It is contended that washing of the oil to reduce the sodium content and the addition of water-soluble magnesium sulphate to the washed oil at a ratio of 3:1 Mg/V would solve most of the problems. Experience in ships with gas-turbines and oil fired boilers is cited where the effect of these measures has been pronounced.

Water Wash of Bunker C Retards Boiler Slag on Atlantic Tanker. W. A. Walls and W. S. Proctor. *Combustion* 1960, 31 (Apr.), 43–5.

In the American S/S Atlantic Seaman operating at a steam temperature of 1020 F at the superheater outlet slagging difficulties in the superheater were experienced. When using specially prepared oil containing up to 250 ppm of V but less than 10 ppm Na no slagging was found. An oil washing plant has now been installed on board ship to enable all bunker C oils to be used; experience after 6 months has been excellent.

What Oil Burning System for the Automatic Package Boiler? P. D. Goggin. *Pwr Engng* 1960, **64** (Apr.), 76–7.

The advantages and disadvantages of various types of burner (rotary cup, air atomizing, steam atomizing, mechanical pressure) for installation in different kinds of packaged boilers are discussed.

Furnaces and Combustion

Dimensionless Coefficients of Mixture Formation in Combustion Chambers. Pt. V. W. H. Fritsch. *Energie* 1960, 12 (Apr.), 156–61.

The determination of the coefficients of mixture formation is illustrated for: (1) Pressure and rotating-cup burners; (2) Pulverized coal fired cement furnaces; (3) Pulverized coal fired steam generators.

Water-Side Corrosion and Water Treatment

Feed Water Treatment. K. Wickert. *B.W.K.* 1960, 12 (Apr.), 155–6 (in German).

German experience during the past year has shown that difficulties in complete demineralization plants treating surface water can be overcome by using strongly basic exchangers. Since these strangely basic resins are sensitive against surface and pore fouling by iron salts and organic substances they must be frequently regenerated with a 10 per cent sodium chloride solution and flushed with caustic soda. The water has in many plants to be preheated to 100 F to obtain the desired effect. Evaporators supply water of a purity equal to demineralizers. Condenser tubes should no longer be made of copper; aluminum has proved superior.

Corrosion Prevention by the Deoxygenation of Water by the Desorption Method. P. A. Akol'zin. *Corrosion* 1960, **16** (Apr.), 114–6.

A Russian method of freeing water from oxygen dissolved in it is described in which the oxygen diffuses into a gas (free of oxygen) mixed with the water in an ejector. Water and gas are subsequently separated in a desorber. The results of tests are given in a series of graphs.

Tests on the Corrosion Resistance of Russian 12 XM Steel in Distilled Water at 330°C and 130 kg/cm². V. V. Gerasimov and A. I. Gromova. *Teploenergetika* 1960, (Apr.), 3–7 (in Russian).

The method and results of an investigation into the corrosion mechanism and corrosion resistance of a low-alloy steel subjected to the action of distilled water saturated with oxygen, with air and with the addition of hydrazine, at 330 C and 130 kg/cm², are discussed. Results obtained with other steels and drawn from American and Russian literature sources are quoted. *C.E.G.B.*

Embrittlement A Modern Menace. O. H. Preis. *Pwr. Engng* 1960, **64** (Apr.), 68–9.

It is pointed out that embrittlement of steels used in boilers is occurring quite frequently. The causes and remedial measures have been known for a long time. The existence of embrittlement

tion can be detected by an embrittlement detector containing a test piece and the feeding of sodium nitrate or coordinated pH-phosphate control prevent embrittlement.

Gas-, Corrosion and Deposits

Investigation of Corrosion Damage in Slagging Furnaces. K. Baatz, K. Späh and H. W. Thoenes. *Tech. Überw.* 1960, 1 (Apr.), 156–8 (in German).

Two cases of corrosion damage on the gas-side of slagging furnaces are described and discussed. The water-soluble fraction of the deposits contained sulfates and chlorides which determine at higher temperatures the rate of corrosion, but a reducing influence is also likely to have taken part in the reaction.

Power Generation and Power Plant

Large-Scale Power by Direct Conversion. B. C. Lindley. *Engineering* 1960, **189** (Apr. 22), 567–9.

Possibilities of direct conversion of heat (1500–3000 C) into electricity are considered. These are: (1) Thermoelectris; (2) Thermionic; (3) Magnetohydrodynamic. Design considerations are presented.

Experiences with Gas Turbines in French Power Stations. P. Chambaral. *ASME Preprint* No. 60-GTP-1 1960 (Mar.), 11 pp.

Gas turbines and free piston generating plants have been installed in several French power stations to meet peak load demands. The problems of using heavy fuel oils and remote control are discussed in some detail.

Gas-Steam Power Generation. P. Martinuzzi. *ASME Preprint* No. 60-GTP-6 1960 (Mar.), 12 pp.

The possibilities of a gas turbine producing power and its exhaust generating steam for a steam turbine have been examined and the efficiency of such cycles calculated. The study has been extended to include closed-cycle gas-steam power generation in connection with a high-temperature gas-cooled nuclear reactor. The results of these calculations are given in tables.

Gas-Turbine-Exhaust Heat-Recovery Cycle. G. L. Morris. *ASME Preprint* No. 60-GTP-9 1960 (Mar.), 8 pp.

Various schemes of gas turbine, waste-heat recovery and separately-fired boilers were considered to provide an industrial plant as efficiently as possible with 64500 lb/h steam at 425 psia, 900 F, additional to auxiliaries and starting turbines for the gas turbines and 100,000 lb/h of deaerated water at 550 psi for process. The optium solution was found to be the installation of two 7500 hp gas turbines for driving process equipment, two 30,000 lb/h pressurized waste-heat boilers with stack economizer for feedwater heating and a separate economizer for process water and two 40,000 lb/h water-tube oil fired boilers using either air or turbine exhaust gas for combustion. The heat balance calculations are presented.

Economics of the Steam-Gas Turbine Exhaust-Fired Cycle for Medium-Size Utilities. M. Eisler and W. M. Sybert. *ASME Preprint* No. 60-GTP-15 1960 (Mar.); 9 pp.

It is suggested that in many smaller networks the addition of a gas turbine exhausting directly into a steam generator will save considerable capital costs compared with a complete new unit. The results of calculations for various sizes of networks are tabulated assuming an average annual peak load growth of 8 per cent.

How Deere Plant Pressure-Fires a Spreader-Stoker Installation. H. H. Reisman. *Pwr Engng* 1960, **64** (Apr.), 89–91.

The advantages of pressurized firing are briefly enumerated and the special design details required for pressurizing described. The lower part of the boiler is surrounded by an airtight enclosure with revolving door. The fd fan passes the air to the windbox from which it flows through the grate in volumes controlled by a damper. Sufficient coal is kept in the duct from bunker to hopper to prevent outward leak of air. Overfire air is taken from the ash pit and injected from the rear. The ash pit has its own enclosure and door and the ash is removed pneumatically. At an average load of 87,000 lb/h the boiler efficiency has been 85.64 per cent with a CO_2 of 12.8 per cent when firing coal of 10 856 Btu/lb.

Ferrybridge B-300 Mw Station. Anon. *Elect. Times 1960*, **137** (May 5), 722-4.

This recently commissioned station contains three units each consisting of a boiler rated at 760 klb/h at 1600 psi and 985/953 F and a 100 Mw turbo-generator. Overall building volume is 31 cu ft/kw installed and overall cost of about $137.50/kw installed.

Consider Simplified 100 Mw Generating Unit for Peaking. W. Welch. *Elect. Wrld* 1960, **153** (Apr. 4), 28–31.

The growth of peak load at a higher rate than the average load causes concern to American networks since the supply of this peak load by reheat units designed for high efficiency at full load is very expensive if these units operate at low loads. The Long

Island Lighting Co. is therefore [illegible] stalling a 100 Mw peak load unit [illegible] minimum cost. It operates at st[illegible] conditions of 850 psi and 950 F, with [illegible] single heater for preheating feedwa[illegible] to 250 F and without air preheat[illegible] single full-load pumps for the fe[illegible] water, condensate and circulat[illegible] water. The boiler has a pressuri[illegible] furnace fired by heavy oil to elimina[illegible] equipment required for coal-firing a[illegible] both boiler and turbine are instal[illegible] out-of-doors and as closely together a[illegible] practical. The condenser is design[illegible] for water at 50 F in winter and th[illegible] loss of 4–5 Mw output with water a[illegible] 85 per cent F in summer is regarded[illegible] as less important. Similar cost re[illegible] ductions have also been effected o[illegible] the generator and electrical equip[illegible] ment. The total cost of the unit wi[illegible] be about 60 per cent of a 185 Mw re[illegible] heat unit.

The Second Extension of the Masnedovaerk, Denmark. H. Billeschou. *Elektroteknikeren* 1960, 56 (Mar. 7), 96–106 (in Danish).

The third and final section of th[illegible] station has a 250 t/h (m.c.r.) Benso[illegible] boiler with reheat and a 80 Mw three-[illegible] cylinder double-flow condensating tur[illegible] bine driving a hydrogen-cooled 10[illegible] mva 0.8 p.f. alternator. The boiler[illegible] house is of light steel construction[illegible] with 5m × 75 cm aluminium plates[illegible] assembled at ground level into 15 m[illegible] cladding sections with fastenings de[illegible] signed for installation from indoor[illegible] scaffolding. Provision is made for oi[illegible] and p.f. firing using slurry up to 2[illegible] per cent moisture content with mill[illegible] drying. The condensate circuit has[illegible] a complete demineralization plant[illegible] and purification equipment ("polish[illegible] filter"). The hydraulic ash and fly[illegible] ash-removal equipment, feedwater[illegible] treatment plant, electrical equipment[illegible] and control room and automatic boiler[illegible] control system are described.

From C.E.G.B. Digest 1960, 12[illegible] (May), 1274.

New Stockholm Plant Generates 80[illegible] Mw of Power and Heating for 60000[illegible] People. Anon. *Pwr Engng* 1960, 64[illegible] (Apr.), 80-1.

The plant contains three boilers[illegible] supplying steam at 1100 psi and 97[illegible] F to three turbines. The steam from[illegible] two of the turbines is condensed by[illegible] heating the water for the district[illegible] heating system to 155–250 F, the[illegible] third turbine has a regulated bleed[illegible] point for water heating. Hot water is[illegible] stored in three accumulators and two[illegible] expansion tanks under air pressure[illegible] and distributed to consumers over[illegible] three miles away. Coal is stored[illegible] partly below and partly above sea[illegible] level in a basin forming also the coal[illegible] loading dock.

Materials and Manufacturing Processes

The Electron Theory of Metals. B. L. Averbach. *Research* 1960, 13 (May), 179–80.

The new theory is described by which it is possible to explain conductance, semiconductors and the theory of alloys.

Steels for Energy Plants. K. Kreitz. *B.W.K.* 1960, 12 (Apr.), 142–4 (in German).

A review of recent developments in steel compositions for temperatures between 1000 and 1100 F, 1100–1200 F and for higher temperatures, connections between ferritic and austenitic steels, of standards and specifications, of basic research, cast austenitic steels and relaxation.

Electric Furnace Steel for Nuclear Applications. C. Jamieson and J. Mowat. *Nucl. Engng* 1960, 5 (May), 207–11.

Preliminary data are tabulated to show that steel produced in electric arc furnaces is likely to have improved properties for nuclear reactor applications than o.h. steels. Creep test data are not yet available.

Stress Corrosion of Austenitic Stainless Steel by High-temperature Solutions and Contaminated Steam. P. J. Snowden. *J. Iron & Steel Inst.* 1960, 4 (Feb.), 181–9.

The investigations concerned stress corrosion in 18–9 Nb-stabilized steel exposed to chloride and caustic solutions at various stresses and temperatures. The rate of attack depended on stress level, solution strength and temperature. Specimens contaminated with chloride and caustic were exposed to high-temperature, high pressure steam. The attack by sodium and potassium hydroxides can be either inter- or transcrystalline. Additions of sodium phosphate or nitrite greatly reduced the rate of attack.

The Aging of some Russian Austenitic Boiler Steels. I. N. Laguntsov and V. F. Zlepko. *Teploenergetika* 1960, (Apr.), 38–42 (in Russian).

Test data are given relating to the change in impact strength, hardness and elongation of three Russian boiler steels after aging for periods up to 5,000 h; all three showed considerable change in properties after aging. Embrittlement during aging did not reduce the impact strength below a dangerous level.

C.E.G.B. abstract.

Instruments and Controls

New Ultrasonic Test Instrument for Boiler and Apparatus Construction. V. Deutsch. *VDI-Z.* 1960, 102 (Apr. 21), 457–8 (in German).

A new instrument is described which enables to test steel plates and welds of more than 5 mm thickness with great accuracy. The instrument is put on wheels to facilitate making tests in less accessible places.

Cyclone O_2 Analysis Checks Combustion Efficiency. J. J. Osochowsky and E. A. Schempp. *Power* 1960, 104 (Apr.), 92–4.

A water-cooled probe able to withstand gas temperatures of 3000 F has been developed which can be installed at the outlet of the cyclone throat and allows continuous monitoring of the O_2 content of the combustion gases. It is hoped to develop from this an automatic control system for the optimum adjustment of the fuel and air ratio at all operating conditions.

Nuclear Energy

AEC Puts Together a Long-Range Power Reactor Program. Anon. *Nucleonics* 1960, 18 (Apr.), 71–82.

The program put forward to make nuclear power economic by the year 1968 is outlined. Research is to be concentrated on large reactors of around 300 Mw size and the 8 reactor concepts, their capital and power costs are presented. These include the pressurized water, boiling water, organic-cooled, sodium-graphite, gas-cooled, fast breeder, aqueous homogeneous and heavy-water moderated reactors. The main problems concerning the development of each type are set out, common to all are further developments in fuel elements.

The Instability Problem in Gas-Cooled Reactors. A. Fonda. *Nucl. Pwr* 1960, 5 (May), 93–6.

In addition to instability caused by temperature and xenon poisoning the control system may also cause instability if the control parameters are inappropriately chosen. The control system studies of the C.E.G.B. and the results obtained of kinetic response to three different control settings are described and discussed.

Small Power Reactor Survey. J. S. Burkett. *Nucl. Pwr* 1960, 5 (May), 97–100.

A brief survey of small reactors available or planned in U.S.A., Gt. Britain, Germany, Italy and Switzerland.

Even Smaller Reactors. Anon. *Engineering* 1960, 189 (Apr. 15), 515–6.

A review of small American stationary and portable reactors.

Study of 4 BWR Concepts Shows One-Unit 300-Mw Plant Feasible.

H. C. Ott and R. H. Gordon. *Wrld* 1960, 153 (Apr. 4), 33-6, 80, 84.

The four cycles considered (1) NIS natural circulation with ternal steam separation; (2) N natural circulation with external dr for steam separation; (3) FSC for circulation with external drum, FDC forced circulation, dual-cy with external drum. Calculat were made for a 200 and a 300 M unit which showed the FDC cycle Mw unit to be the most efficient able to produce 1 kwh at 1-1 higher cost than a coal fired unit a fuel cost of 35 cents per million Bt Development of nuclear superheat has not yet been developed sufficient to be taken into consideration fossil fuel superheating does not sh an advantage. Improvements m be obtained by combination natural and forced circulation.

A Closer Look at the Real KIWI-A. Anon. *Nucleonics* 1960, 18 (Apr.).

A few details are given of the des of this reactor, a prototype built use in nuclear rockets. The core co sists of graphite fuel plates impr nated with uranium, cooled by hyd gen and with control rods in the cent The performance of the reactor is classified.

Grinding, Screening and Filtering

Test on a Tubular Ball Mill Pulver ing System for Low-grade Coal Supplementary Fanning of Over Product. S. P. Tsigankov. *Stantsii* 1960, (Mar.), 10–17 (in R sian).

Supplementary fanning of the o size product of low-grade coal tubular ball mills improved the p formance only for screen $R_{88} > 6$ per cent with a gravity type classif and $R_{88} > 7\frac{1}{2}$ per cent with a centr fugal classifier. For $R_{88} = 12$ cent an improvement in performa of up to 13 per cent and a power sa ing of up to 5 per cent were obtai with a gravity-type classifier; improvement was only 6½ per c with increased power consumpti with a centrifugal classifier. In s cases, supplementary fanning can improve the performance of tub ball mills for pulverizing hard coals other types of coal.

C.E.G.B. Abstr

Fuels: Sources, Properties and Pr aration

Carbonization Studies. Fluidiz Technique. Anon. *Coal Res. in S.I.R.O.* 1960, No. 9 (Feb.), 2–7.

The laboratory plant with a c bonizing capacity of 50 lb/h of co

described and some of the results obtained with air or recycle gas at 400–700°C are tabulated. The char is to be used for blending with coals to produce a high-quality metallurgical coke. The tars as a base for a variety of chemicals.

Materials Handling. J. R. Arwood and R. W. Wesson. *Ind. Engng. Chem.* 1960, 52 (Feb.), 181–8.
The annual review of literature published in 1959.

The Application of Vibratory Power to Mechanical Handling. J. D. Latham. *Mech. Handl.* 1960, 47 (Mar.), 132–5.
Applications of vibratory power, based on a rotary motion (Vibromotor), to the handling of a wide variety of materials are described.

Operating a Coal Storage Area with a Mechanical Shovel. J. Oliver. *Bull. Inf. des Centrales Electriques* 1960, 27 (Jan.), 15-19 (in French).
When the coal yard equipment (a bulldozer and a scraper) were due for replacement, consideration was given to the use of a mechanical shovel and its advantages over the former system are demonstrated and the method of working is explained. The main reason for this is due to the nature of the coal storage area and the fact that a number of different quality coals are stocked. Over large distances in a yard served by fixed installations and requiring only one quality of coal the tape system has the advantage.
(From *C.E.G.B. Digest* 1960, 12 (Mar. 26), 765.

Hydraulic Transport of Lump Coal. Hon. *Fördern u. Heben* 1960, 10 (Feb.), 91–3 (in German).
The essential details of a Russian article are translated. The investigations concerned the transport of large coal pieces by a suspension of fine coal in water, the relationship between concentration of fines in water and size of coal transported, frictional resistance and wear. Cost of transport by this method is only ⅔ to ½ of that by railway.

Steam Generation and Power Production

Assessment of Safety against Brittle Fracture in Pressure Vessel Design. Pt. I. K. Schaar. *Tech. Rundsch.* 1960, 1 (Mar.), 101–8 (in German).
The revised German standards for carbon steels with regard to their brittle fracture performance is explained and the application of these standards to steels for pressure vessels discussed. The physical basis, the influence of notches, residual stresses, temperature, rate of deformation, for-

eign atoms and the significance c notch impact test, transition tem tures and susceptibility to agin presented.

The Edge Value Problem in the culation of Thermal Stresses in R tor Pressure Vessels. D. R. *Atomkernenergie* 1960, 5 (Feb.), (in German).

An equation is derived for cal ting the stresses caused by the ferential thermal expansion of cylindrical shell and the semi-sphe ends. The validity limits of the b formula are given.

Sulzer Steam Boilers. H. Vo *Sulzer Tech. Rev.* 1959, 41 No. 2, 73.

The development of steam gen tors from the first built in 1841 to latest monotube boiler of 750 klb 2420 psi and 1110/1060 F is descri

Steam Generators for the Paper dustry. Anon. *Energie* 1960, (Feb.), 74-5 (in German).

Two boilers are described b rated at 149 klb/h at 1950 psi 975 F with reheat to 825 F. On the boilers includes a slagging furn for the firing of pitch coal, bitumin coal and oil and an upper radi furnace with additional oil burn the upper part of the walls of radiant furnace are superheater s faces. The reheater is installed in damper controlled convection pa The Ljungstrom air preheater is the two-stage type and has an air pass to increase the flue gas tempe ture from normally 320 F to 375 wh burning fuels of high S content. T other boiler is exclusively oil-fir with the burners in the front wall a radiant superheater in the front wall

Damage to Superheaters and Preve tive Measures—Part 1. R. Malic *A.P.A.V.E. Bull.* 1960, **41** (Jan 3–35 (in French).

A number of superheater tube fa ures that have occurred during oper tion are described. These are divide into the following categories: those du to (*a*) the composition of the boil water, (*b*) the result of increase i steam temperature, (*c*) irregular ci culation, (*d*) external erosion, (*e*) sh down of plant, and (*f*) manufacturin faults. Some thirty cases are de scribed and discussed.

From *C.E.G.B. Digest* 1960, **12** (Ma 26), 759.

Distortion of a Radiant Superheat Panel. J. Simonne. *Bull. d'Inf. d Centrales Electriques* 1960, **27** (Jan 30–4 (in French).

The radiant superheater of a t/h boiler was found to deform break loose in the burner zone.

Combustion

DEVOTED TO THE ADVANCEMENT OF STEAM PLANT DESIGN AND OPERATION

volume 32 number 4 **October 1960**

Published monthly by COMBUSTION PUBLISHING COMPANY, INC., 200 Madison Ave., New York 16. A SUBSIDIARY OF COMBUSTION ENGINEERING, INC.

Charles McDonough, President

Arthur J. Santry, Jr., Vice-President

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COMBUSTION is sent gratis to engineers in the U. S. A. in charge of steam plants from [illegible] lbs per hr capacity up; and to [illegible] engineers in this field. To others the subscription rate, including postage, is $4 in the United States, $5.50 in Canada, and $8 in Latin America and other countries. Single copies: Domestic, 40 cents, Foreign, 50 cents plus postage. Copyright 1960 by Combustion Publishing Company, Inc. Publication Office, Easton, Pa. Issued the middle of the month of publication.

Acceptance under Section 34.64, P.L. & R, authorized by United States Post Office.

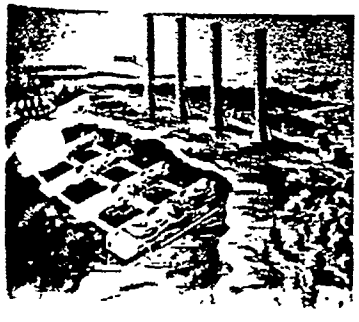
COMBUSTION publishes its annual index in the June issue and is indexed regularly by Engineering Index, Inc. and also in the Applied Science & Technology Index.

The magazine is now reproduced and distributed to libraries on microfilm by University Microfilms of Ann Arbor, Michigan. BPA

Printed in U. S. A.

COVER PHOTO

Cutaway sketch of Swedish State Power Board's underground Stenungsund steam plant planned for an ultimate capacity of 700,000 kw.



Abstracts from the Technical Press—Abroad and Domestic

(Drawn from the monthly Technical Bulletin, International Combustion, Ltd., London, W. C. 1)

Fuels: Sources, Properties and Preparation

Fuel Technology in Canada. A. Ignatieff. *J. Inst. Fuel* 1960, **33** (May), 223–7.

The following are discussed: (1) Coal industry; (2) oil, natural gas and associated hydrocarbons; (3) research on fossil fuels; (4) uranium industry.

Coalification Progress, Coalification Scales and Classification of Coals Based on Vitrain Analyses. Pt. III. K. Patteisky and M. Teichmüller. *BrennstChemie* 1960, **41** (May), 133–7 (in German).

The various coalification scales have been checked and it is shown that these scales have to be varied with the stage. The limit values (C, O, H contents, V.M., moisture, C.V.) for the 4 large coalification stages are given.

Structure of High-Rank Coals Deduced from Helium Densities. T. S. Polansky, H. J. Donald and C. R. Kinney. *Nature* 1960, **186** (June 4), 792–3.

It is shown that the density gives a closer correlation with hydrogen for high rank coal than specific volume and the equation deduced from a line drawn through the densities of some high-rank coal is: $y = 2.26 - 0.23\ x$, where y is density and x percentage hydrogen. This equation does not hold for bituminous coals for which the equation $y = 0.442 + 0.064\ x$ (y is specific volume or the reciprocal of density) is deduced.

Structure Parameter of Coal Based on Oxidation Experiments. S. K. Chakrabartty, B. K. Mazumdar, S. N. Roy and A. Lahiri. *BrennstChemie* 1960, **41** (May), 138–42 (in German).

The aromaticity in the range of 80–90 per cent C increases from 0.7 to 0.8 and approaches 1 in the anthracite stage. The aromatic hydrogen increases from 30 to 50 per cent of the total hydrogen and reaches 80 per cent and more in anthracite. The average size of the aromatic nucleus does not increase much and possibly consists of 4–5 benzene rings.

Investigations into the Processes in the Coke Oven. H. Echterhoff and M. T. Mackowsky. *Glückauf* 1960, **96** (May 7), 618–26 (in German).

Extended investigations in which samples were taken from various parts of an experimental oven and at various times have shown that the decisive phase in the coke formation is the plastic phase. The rate of heating in the plastic zone determines the mechanical properties of the coke, as well as the amount of fissuring.

Mechanical Handling

Coal Storage and Handling in the National Coal Board. S. Weinberg and D. G. T. Davey. *J. Inst. Fue* 1960, **33** (June), 283–4.

Storage of coal is today almost universally carried out by crawler tractors with a bulldozer blade which enables larger stock piles to be made and compacted and thus reduce the risk of selfignition. The piles are up to 40 ft deep with a density of 80 lb/ft³ and contain 1-in. vertical tubes for daily temperature measurement.

New Equipment for Stockpiling and Reclaiming. H. R. Keller. *Fördern und Heben* 1960, **10** (May), 319–26 (in German).

A newly developed mobile machine, a cutter-disk loader, is described which is used mainly for reclaiming. It operates either directly or with other mobile intermediate belt conveyors and applications in iron and steel works, gas works and similar plants are illustrated. The economics of such installations are discussed.

Hydraulic Transport of Coal. A. Wright. *Sheffield Univ. Min. Mag.* 1959, 47–70.

The whole subject of hydraulic transportation of coal is covered very fully from the fundamentals of solids flow in a pipeline and the methods of introducing solids into a pipeline, to descriptions of installations abroad and pilot installations in Great Britain. The future of this method of moving coal is discussed and in the appendix three sample schemes are costed in comparison with other methods of transport. (N.C.B. abstract.)

From C.E.G.B. Digest 1960, **12** (June 4), 1433.

Heat: Cycles and Transmission

Heat Transfer. E. R. G. Eckert, J. P. Hartnett, T. F. Irvine and E. M. Sparrow. *Ind. Engng Chem.* 1960, **52** (Apr.), 327–39.

The annual review of the literature of the past year under the headings: (1) Conduction; (2) channel flow; (3) boundary layer flow; (4) flow with separated regions; (5) transfer mechanism; (6) natural convection; (7) convection from rotating surfaces; (8) combined heat and mass transfer; (9) change of phase; (10) radiation; (11) liquid metals; (12) low density heat transfer; (13) measurement techniques; (14) heat transfer applications.

Thermodynamics. G. M. Brown. *Ind. Engng Chem.* 1960, **52** (May), 451–5.

The review of the literature published in 1959.

Pressure Drop in a Duct with Heat Transfer. J. S. Turton. *Engineer* 1960, **209** (May 27), 902–3.

A mathematical analysis.

Steam Generation and Power Production

Fluid Dynamics. C. A. Sleicher, R. A. Stern, L. E. Scriven and A. K. Oppenheim. *Ind. Engng Chem.* 1960, **52** (Apr.), 347–58.

The annual review of literature of 1959.

Temperature Recovery Factors in Steam. H. Barrow and D. J. Ryley. *Engineer* 1960, **209** (May 27), 903–6.

Temperature measurement of the boundary of a fluid in motion is discussed and the results obtained with two different probes are presented.

Steam Generators

Development of a Diagram for the Calculation of Natural Circulation in Water-Tube Boilers and Boiling-Water Reactors. K. Jaroschek and F. Brandt. *B.W.K.* 1960, **12** (May), 189–96 (in German).

The equations for constructing the diagram are developed. The numerical values for a range of parameters obtained by computers are entered in the diagram which facilitates the calculation of the circulation if the tube friction coefficients are known or can be assumed. The diagram can also be applied to boiling water reactors if the resistance of the fuel elements is known.

A New Method for the Rapid Analysis of Results of Thermal Calculations for Steam Generators. S. Kasprzyk. *B.W.K.* 1960, **12** (May), 208–11 (in German).

A single diagram has been constructed for presenting the essential relationships between operational parameters, heat balance and size of heating surfaces. This reduces the time required for calculating the drop in flue gas temperatures as a function of the design of the heating surfaces and facilitates comparison of various projects.

The Behavior of Forced Flow Boilers during Load Changes. M. Ledinegg. *B.W.K.* 1960, 12 (May), 197–206 (in German).

The changes in the heating surfaces occurring in the economizer, evaporating superheating sections of a Benson boiler during load changes expressed by a variation of the ratio (f fuel : water), the time elapsing rom one steady state to the next, nd the changes in the temperature evel of the tubes have been studied. he difficulties are discussed in assessng the changes at the transition points hich wander during the load changes. he times are calculated which elapse ntil a change of the fuel : water atio affects the steam temperature, so for the case in which the feed of ater is completely stopped.

igh Pressure Steam Power Plants. ulzer Frères S.A.

The tubes of tube-platen reheaters e protected from the direct effect of diant combustion gases by envelopg them with superheater, evaporatg or feed water heating tubes.

rnaces and Combustion

idging the Gap between Fundaental Science and Industrial Comstion. M. W. Thring. *Brit. Pwr gng* 1960, 1 (June), 88–90.

A brief review of the research card c nto the mixing and reaction ocesses in furnaces, the development the turbulent controlled mixing tory one-dimensional flame and the ults obtained with solid, liquid and seous fuels. Possible application on industrial scale is discussed.

aphical Method for the Determina- of the Combustion Air and Flue s Volumes of Solid Fuels. I. Luzsa. *ergie* 1960, 12 (May), 189–2 (in rman).

A nomogram has been developed the rapid calculation of the theocal combustion air volume and the ulting flue gas volume.

nensionless Coefficients of Mixture mation in Combustion Chambers. V. W. H. Fritsch. *Energie* 1960, (May), 192–7 (in German).

By means of the dimensionless fficients developed earlier front, op- ed and corner firing are compared. effect of the central air core in ier firing and the advantages of sting the burners to circles of dift diameters are discussed. From nsideration of the relative furnace ht (H/L), furnace hopper depth /L) and burner mouth diameter, mi limensions for corner-fired aces are deduced. Insufficient exmental material has been available ssess the influence of the size and

position of the rear arch in the upper part of a corner-fired furnace. Some ideas of the development of furnace design on the basis of ideal mixture formation are presented. Finally, it is shown that the occurrence of corrosion and slagging and of smoke formation can in many cases be ascribed to faulty mixture formation and improvements can be obtained by modifications resulting in better mixing.

Properties and Prospects of Directly and Indirectly Air-cooled Slagging Furnaces. Contribution to the Realization of a Slagging Furnace without Dry Operation in the Low Load Range. R. Dolezal. *Mitt. V.G.B.* No. 65 1960, (Apr.), 108–17 (in German).

The temperatures in directly air-cooled furnaces would be too high for prolonged operation but such small furnaces might be useful for investigations into ash properties and the evaporation of their constituents at very high temperatures. Indirectly air-cooled furnaces are cooled by media of high boiling point (liquid metals) and their heat transferred in part to the air and in part to steam to be reheated; they can be operated at very low loads with liquid slag removal.

Water-Side Corrosion and Water Treatment

Experiences with Ion Exchangers Operating on the Counter-flow Methods. K. Hofmann. *Mitt. V.G.B.* No. 65 1960, (Apr.), 92–101 (in German).

By using the counterflow principle of regeneration (water flowing upwards, regenerant downward) less regenerant is required. Laboratory, pilot-scale and full-scale plant tests have shown that little more (105 per cent) than the theoretical amount is actually required. The higher cost of these counterflow filters is more than compensated by the smaller number of filters needed to achieve the same degree of demineralization. The results of the tests are given in tables and graphs.

Cold Hardening Surface Layers for Corrosion Protection of Feed Water Treatment Plants. E. A. Ulrich and K. v. d. Heiden. *Tech. Überw.* 1960, 1 (May), 182–6 (in German).

Various kinds of lacquer and varnish were tested with regard to the protective effect for tanks and vessels used in feed water treatment. It is suggested to apply after careful cleaning by sand blasting a basic mass containing zinc dust followed by several layers of epoxy resins containing polyamides. The procedure to be followed is outlined.

Gas-Side Corrosion and Deposits

Corrosion Tests on Materials Exposed in Flue Gases from Oil Firing. Haneef. *J. Inst. Fuel* 1960, 33 (June), 285–94.

The relative corrosion rates of carbon steel, cor-ten, stainless steel and normalized or annealed cast iron were determined under controlled conditions. In addition the effects of machining the surfaces and of the angle of impingement of the flue gas were studied. Annealed cast iron showed the highest, cor-ten the lowest corrosion rates.

Problems Associated with Oil Firing of Power Station Boilers. W. S. Robertson and R. Ruddock-West. *Brit. Pwr Engng* 1960, 1 (June), 76–7, 80.

The difficulties experienced when oil firing was introduced in several power stations of the CEGB., are discussed under the headings: (1) Flame impingement; (2) superheat temperatures; (3) superheat fouling and corrosion; (4) low temperature corrosion and fouling; (5) reduction of corrosion; (6) excess air control; (7) smut emission. It is shown that the difficulties could be overcome and corrosion reduced to acceptable levels by using the minimum excess air possible and complete burning of the oil, so that the use of additives could be dispensed with.

Corrosion and Metal Wastage on the Flue Gas Side of Boiler Plant. W. D. Jarvis. *Brit. Pwr Engng* 1960, 2 (June), 81–5.

A summary of experience on coal and oil fired boilers in British power stations is presented giving average figure of coal and oil ash analysis and the constituents of flue gases assuming 30 per cent excess air and illustrating typical cases of high and low temperature corrosion. The formation of SO_3 and its rôle in the corrosion mechanism are discussed. It is concluded that by rigid control of the combustion conditions most of the difficulties can be avoided.

Experience of Corrosion and Erosion in Slagging Furnaces. H. Bendfeldt. *Mitt. V.G.B.* No. 65 1960 (Apr.), 18–25 (in German).

The occurrence of tube failures in boilers with vertical cyclones after 26,000 h of operation could be traced to CO formation at lower loads when the secondary air velocity was insufficient. By increasing secondary air volume and velocity CO formation could be suppressed but the decrease of the CO_2 content from 16.5 to 15 per cent and increase of the O_2 content to 3.5 per cent makes slagging operation below 75 per cent of full load impossible.

le. The secondary air nozzles are to e provided with special dampers to nsure uniform air velocity at all loads. he vertical cylindrical arrangement f cyclone and radiant furnace is re-arded as particularly suitable for good as fl nd prevention of difficulties ause by corrosion and erosion but oilers operating with widely fluctuat-ng loads are better served by dry-ottom furnaces.

xperience on a Benson Boiler Fired y Blast Furnace Gas and Oil—Es-ecially with Regard to Vanadium orrosions. F. Sieverding. *Mitt. .G.B.* No. 65 1960 (Apr.), 78–87 (in erman).

During the first operating period ith 2550 h of gas firing and 4300 h oil firing only dusty easily remova-e deposits and no corrosion were und. During the second period with 00 h of oil firing tube failure, heavy, rd deposits, corrosion of tube sup-rts, refractories and boiler casing ates occurred caused by incomplete mbustion due to insufficient pre-ating after a change of oil. In con-quence dolomite was added in the rnace and preheated air circulated tween the boiler casing and the re-actories. After a further 3000 h of firing fouling was much reduced ough the very hard deposits in the led tube air preheater were again esent and further tube supports re oded by attack from V_2O_5. nalyses of the deposits are tabulated d discussed.

w-Temperature Corrosion in Oil-ed Boilers. G. Weber. *Mitt. G.B.* No. 65 1960 (Apr.), 69–78 (in rman).

A review of the literature of mainly nerican, British and Swedish origin.

e Gas, Ash and Dust

mbined Flue Gas Dedusting in iler Plants. K. Schäff. *Mitt. G.B.* No. 65 1960 (Apr.), 88–91 (in rman).

After the conversion of the boilers Lünen power station to slag-tap ng it became necessary to supple-nt the fly ash separation in the ctrostatic precipitators by the in-llation of multicyclones. The rea-s for installing these after the pre-itators are detailed and figures pre-ted of total separation efficiency ieved: this varied between 0.977 l 0.88 per cent depending on the ign of the multicyclones. Wear on cyclones has been very heavy.

te evelopment of Electrostatic cipitators for Flue Gases. H. ndt. *Tech. Überw.* 1960, 1 (May), –81 (in German).

This review deals with the design of electrodes, generation of high voltages, difficulties and limitations of electrostatic precipitation, differences in the dust from slagging and dry bottom furnaces and correction factors to be applied to the dust removal efficiency where fuel and operating conditions differ from those on which the original design was based.

Influence of Flue Gas Emission on Design of Steam Power Stations. H. Eickemeyer. *Energie* 1960, 12 (May), 198–206 (in German).

The factors influencing flue gas emission from a chimney and its dispersion in the air are discussed. Wind tunnel model tests for obtaining optimum height of chimney and flue gas exit velocity for the Stuttgart-Gaisburg power station are described. The optimum solution could not be applied for architectural reasons.

Flyash Cuts Brentwood Paving Costs. N. Falkin. *Elect. Wrld* 1960, **153** (May 2), 42.

The site at Brentwood is a center for the storage of vehicles and materials belonging to the Long Island Lighting Co. In constructing the base course a 6-in. layer of soil was compacted, a 2-in layer of aggregate added together with 60 lb/sq. yd of fly ash and 30 lb sq. yd of hydrated lime and water, thoroughly mixed and compacted to 95 per cent density. The compressive strength reaches 1500 psi.

Power Generation and Power Plant

What May Be Ahead in Power Production. G. B. Warren. *Mech. Engng* 1960, **82** (May), 61–5.

It now appears likely that in the U.S.A. the installed capacity required will be 600,000 Mw by 1980, i.e., 3 to 4 times the 1959 capacity. Turbogenerators of up to 1000 Mw will be used, up to 400 Mw cross-compound, above that single shaft or cross-compound running at 1800 rpm. Neither gas turbines nor nuclear power are likely to contribute more than 10 per cent to the total demand.

European Energy Needs. Anon. *Iron & Coal Tr. Rev.* 1960, **180** (May 20), 1113.

E. Hirsch, president of Euratom, estimates that by 1980 Europe's energy needs will have risen from the present 450 million to 800 million tons coal equivalent. This would require the building of more than 250 units of 150 Mw and their construction should start at once. F. H. S. Brown, deputy chairman of the CEGB, thought that nuclear power was at present marginally uneconomic but developments promised competitiveness with coal by about 1970.

Power for Peaking. C. C. P... *Combustion* 1960, 31 (May), 28–...

A general review of the possibi... and economics of designing power s... tions for peak load supply.

American Power Conference in Review—I. Anon. *Combustion* 1960, 31 (May), 43–7.

Abstracts of papers dealing with: (1) Concrete chimneys; (2) tube life in high temperature boilers; (3) selection of boiler feed pumps; (4) stability of austenitic steels at 1450F; (5) mechanical draught fans; (6) peak load supply; (7) packaged oil, gas and coal fired boilers for up to 50,000 lb h; (8) slag tap boilers.

Application of Heat Storage in Nuclear and Conventional Power Stations. Fr. Marguerre and Fe. Marguerre. *Elektwirtsch.* 1960, 59 (May 20), 320–6 (in German).

Heat storage of up to 35 per cent of the primary output can reduce the cost of a unit from a conventional power station by 5–7 per cent, that of a unit from a nuclear power station by 15 per cent. Combination of heat storage and superheating by fossil fuel would reduce the cost of a unit generated in a nuclear station below that generated in a conventional station. Three appendices give the detailed calculations.

Potential Heat in Fuel: Direct Conversion to Electricity. M. W. Thring. *J. Inst. Fuel* 1960, 33 (June), 294–9.

Direct conversions in the fuel cell, thermo-electric generation and electric gas breaking and their prospects and limitations are discussed.

Boundary Dam Generating Station, Canada. Anon. *Engng Boil Ho. Rev.* 1960, 75 (June), 172–8.

This station contains at present two 66 Mw units but is to be extended to a total capacity of 352 Mw. The two boilers are each rated at 600 klb/h, 875 psi and 915 F and designed to burn lignite with a C.V. of 6000–7000 Btu lb and a moisture of 30–35 per cent. The description includes the coal and ash handling plant, boiler and turbogenerators, controls, water treatment, electrical system and auxiliaries.

Planning of Power Stations in the Cottbus Region—A Development towards Standard Plans for Large Power Stations. S. Kowallik. *Energietechnik* 1960, 10 (May), 188–92 (in German).

Fuel (brown coal) and river water appear to be sufficient for the erection of four power stations of the ... fundamental design each of 120... 1800 Mw final output. The ... Lübbenau, will have 3 sections, ... six 50 Mw sets, one of six 100 M...

and one of four 100 Mw sets. The second station, Vetschau, will have 3 sections, 2 with 6–100 Mw sets, the third possibly with 3–200 Mw sets but 6 boilers. Two further stations of 1200 or 1800 Mw are to be erected later. The steam parameters are standardised at 159 atü and 530/525 C, the cooling water cooled in mechanically ventilated towers. The reasoning behind these decisions are outlined.

On the Line at Lake Creek. E. E. Wawak. *Heat Engng* 1960, **35** (Mar./Apr.), 114–7.

Unit No. 2 at Lake Creek Station of Texas Power and Light Co. consists of a gas-fired, natural circulation boiler rated at 1600 klb/h at 1935 psi and 1005/1005 F and 160 Mw turbogenerator. Provision is made for lignite firing at a later date, but at present only 18 gas and oil firing burners are installed.

The 125 Mw Unit-type Installation at Langerbrugge Power Station, Belgium. J. Ryffranck. *Votre Electricité* 1960, **31** (Feb.), 10–40 (in French).

The 150 Mw station with five turbo-alternators and nine boilers, including one Benson boiler, has been extended by a 125 Mw unit-type installation comprising a 350/380 t/h, 127 kg/cm², 540/535 C reheat outdoor-type natural-circulation pff boiler by Cockerill-Stein and Roubaix driving a Mw hydrogen-cooled turbo-alternator by Ateliers de Construction de la Meuse and A.C.E.C. A full description of the plant is given.

From C.E.G.B. Digest 1960, 12 (June 4), 1417.

The Steam Generator and Preheating Plant for the 100 Mw Unit of the Stuttgart-Gaisburg Heat-Power Station. H. Eickemeyer. *B.W.K.* 1960, **12** (May), 211–7 (in German).

The reasons underlying the design of the Benson boiler (922 klb/h, 2630 F, 1010/1010 F), controls, air admission, slagging furnace, electrostatic precipitator and regenerative feed water preheating are discussed and details of design given. The losses used in the various parts of the boiler are tabulated. The optimum thermal efficiency when supplying the maximum amount of steam for heating (200 t/h) is 48.55 per cent.

Materials and Manufacturing Processes

Metal Borides and Carbides—Materials of the Future. W. R. Benn. *Engng Chem.* 1960, **52** (May), 42A–45A.

Boron and carbides are extremely hard and brittle but possess high temperature stability. Ways of overcoming brittleness are indicated. The essential properties of various borides and carbides are tabulated.

A Creep-resisting Steel Containing 7 Per Cent Cr. G. A. Mellor and S. M. Barker. *J. Iron & Steel Inst.* 1960, **194** (Apr.), 464–74.

A ferritic steel for operation at 600–650 C suitable for superheater tubes has been developed containing 7 per cent Cr with additions of 2 per cent Mo and 0.5 per cent Ti. The results of tests made with this steel are reproduced and discussed.

A New Low-Alloy Steel for High Temperature and Pressure Boiler Drums. T. M. Slutskaya. *Autom. Weld.* 1959, (Oct.), 125–7. *B.W.R.A. Transl.*

The composition of the steel is: 0.12–0.18 per cent C, 0.3–0.6 per cent Si, 1.25–1.65 per cent Mn, 0.8–1.1 per cent Cr, 0.4–0.8 per cent Ni, 0.05–0.2 per cent V, not more than 0.3 per cent Cu, 0.04 per cent S and 0.035 per cent P. It has high creep strength, and is easier to weld and resistant to corrosion cracking. Recommendations for welding by the electro-slag process are given.

Some Characteristics of Integron Mild Steel Tubing for Heat Exchangers in Nuclear Power Stations. F. E. Astbury and L. H. Toft. *Metallurgia* 1960, **61** (May), 193–200.

Integron tubing is produced by I.C.I. Ltd. by cold rolling plain tubes to obtain circumferential fins. Metallurgical characteristics and fatigue resistance in the "as-finned" and in the heat-treated conditions have been studied, as well as effect of service temperature on tensile properties and residual stress and of welding on parent metal. Heat treatment does not appear necessary for the conditions obtaining at Bradwell and Berkeley.

Boiler Model Tests of Materials for Steam Generators in Pressurized Water Reactor Plants. E. Howells, T. A. McNary and D. E. White. *Corrosion* 1960, **16** (May), 111–5.

Heat exchanger models made of stainless steel, carbon steel, Croloy 2¼, Croloy 16–1, nickel, Inconel and Monel were tested at a pressure of 2000 psi and 600 F for about 500 hr. The materials were then subjected to metallurgical examination. The occurrence and extent of corrosion and stress-corrosion cracking in these steels are discussed.

Semi-Automatic CO_2 Butt Welding of Main Pipe Lines without Permanent Backing Rings. V. Ya. Dubrovetskii and V. P. Livinskii. *Autom. Weld.* 1959 (Oct.), 106–10. *B.W.R.A. Transl.*

The semi-automatic weldi... CO_2 as shielding gas of steel... with a wall thickness of 8–10... described.

Automatic CO_2 Butt Welding of... Walled Tubes. D. A. Dudko, ... Litvinchuk and V. S. Mechev. ... *Weld.* 1959 (Oct.), 100–5. *B.W... Transl.*

A procedure for obtaining ... welds in steel tubes with wall ... nesses of 1–1.5 mm is described.

Service Failures of Pipe Weldm... H. Thielsch. *Weld. J.* 1960... (May), 488–95.

The reasons for defective welds ... maining undetected despite the ... plication of the usual non-destruct... testing methods are discussed. ... ods relating to design, electrod... base metal composition to reduc... possibility of the occurrence of ... welds are presented.

Instruments and Controls

Improvement of Pressure Cont... Steam Generators. H. Zwetz. ... *K.* 1960, 12 (May), 206–8 (in Ger...

The new control system is ba... the relationship between rate ... ing and steam flow, taking in... count the storage capacity o... boiler. The new scheme also imp... the temperature control.

We Monitor Silica Automatica... 2600-psig Boilers. T. Finnigan. ... *Engng* 1960, **64** (May), 58–9.

Since the silica carry-over ... steam is largely a function ... silica content of the boiler wate... this is easier to determine accur... Niagara Mohawk Power Corp. ... introduced the Technicon Aut... lyser for the continuous takin... analysing of boiler water samp... two boilers, the instrument ... switched from one boiler to the ... every 15 min. The silica conte... the steam should not exceed ... ppm and the limit for the boiler ... is thus set at 0.3 ppm. When ... approached the pressure is re... and the boiler blown down un... correct concentration is establi...

Automatic Protection for a ... Cooled Reactor. B. E. Eltha... M. J. Cowper. *Nucl. Engng* ... (June), 243–9.

Automatic protection against ... cessive rise in fuel element tem... ture and release of fission prod... discussed and the instrumen... provided for this purpose descr...

Nuclear Energy

Nuclear Power Prospects. ... *Elect. Times* 1960, 137 (June 9)...

Sir William Cook has predicted that ; advanced gas-cooled reactor the ototype of which is now under conuction, will be able to produce a t cheaper than a modern conventional r er station. The prototype ng l at Windscale is described; will operate with a coolant inlet nperature of 250–325 C and an out- temperature of 500–575 C, part inless steel and part beryllium clad ter fuel elements and 1.25 per t enriched uranium dioxide. The station efficiency is expected to be per cent.

clear Power for Ship Propulsion. E. Richards. *J. Inst. Fuel* 1960, (June), 271–83.

The following are discussed: (1) pe of ship; (2) tanker economics; nuclear fuel cycles; (4) types of ctors; (5) assessment of reactor es; (6) characteristics of civil plutium; (7) plutonium burning fuel le; (8) application to marine propsion; (9) conclusions; these show t no clear line can be drawn of dopment towards an economic reacfor merchant ships.

Nuclear Power Report. D. Bray- *Elect. Wrld* 1960, **153** (May 16), 32.

This report consists of: (1) An out- of the plans made by AEC to ce nuclear power competitive by 3; a review of the eight reacbuilt, building or planned which w the greatest promise; (3) a comé list of civilian nuclear power and erimental reactor projects built or ned in the U.S.A. The eight reactypes are: (1) Pressurized water; boiling water; (3) organic cooled; enriched gas cooled (5) sodium hite thermal; (6) sodium cooled ; (7) heavy water moderated; aqueous homogeneous.

gress Review No. 47: The Enering Aspects of Nuclear Power. . Gibbs. *J. Inst. Fuel* 1960, **33** y) 238–47.

ne review deals with: (1) Gas- ed, graphite-moderated reactors; uel elements; (3) moderator; (4) sure vessel; (5) shielding; (6) ge/discharge equipment; (7) inmentation and control; (8) boilers; CO_2 ductwork and circulators; future British reactors.

rican Nuclear Congress and ic Exposition. No. 1—IV. . *Engineer* 1960, **209** (June 3), 6, (June 10), 993–6, (June 17), –2, (June 24), 1086–8.

ie gress held in April 1960 ey rogress in the nuclear field.

Inversion in Gas-cooled Reac- H. Benzler. *Atomkernenergie* 1960, **5** (May), 165 (in German).

It is shown that in gas-cooled reactors with vertical downward flow of the cooling gas an inversion of the flow at low load may occur. It is suggested that this situation can be avoided if during starting about 5 per cent of the full-load gas volume is recirculated.

Grinding, Screening and Filtering

Experiments on Determining the Particle Motion in Gas Jets and the Stress Mechanism in Fluid Energy Mills. H. Rumpf. *Chem. Ing. Tech.* 1960, **32** (May), 335–42 (in German).

Since the boundary conditions for jet formation and particle motion in such mills are not yet sufficiently defined individual jets have been investigated by stroboscopic measurements. From the particle velocity the jet velocity along the particle path can be calculated. The maximum velocity of a particle in the jet axis can be predetermined. Estimates of the influence of turbulence on particle motion are presented. Comminution in a fluid-energy mill is mainly confined to the neighborhood of the nozzle exit.

Analysis and Testing, Research

Rapid but Accurate Method of the Determination of the Calorific Value of Coals. Moreau. *Chal et Ind.* 1960, **41** (Apr.), 105–12 (in French).

An improved method worked out by Georgiadis is described enabling at least 8 determinations per day to be made against 4–5 by the classical method. An estimation of the possible errors and correction factors are included.

Recommended Practice for Radiographic Inspection of Fusion Welded Joints. Circumferential Butt Joints in Steel Pipes up to 2 in. (50 mm) Wall Thickness. Intern. Inst. Welding. *Brit. Weld. J.* 1960, **7** (June), 410–4.

Simplified Method of Measuring Surface Areas by Gas Adsorption. R. Haul and G. Dümbgen. *Chem. Ing. Tech.* 1960, **32** (May), 349–54 (in German).

A simplified and rapid method has been worked out on the basis of the BET method. Reproducibility is high and the values obtained are 5–10 per cent lower than those of the BET method.

Editor's Note:

Due to a shortage of reviewable material the section "Technical Book Reviews" by John H. Cruise will appear next month.

Combustion

DEVOTED TO THE ADVANCEMENT OF STEAM PLANT DESIGN AND OPERATION

volume 32 number 5 **November 1960**

Published monthly by COMBUSTION PUBLISHING COMPANY, INC., 200 Madison Ave., New York 16. A SUBSIDIARY OF COMBUSTION ENGINEERING, INC.

Charles McDonough, President

Arthur J. Santry, Jr., Vice-President

Lambert J. Gross, Treasurer

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COMBUSTION is sent gratis to engineers in the U. S. A. in charge of steam plants from 10,000 lbs per hr capacity up; and to supervising engineers in this field. To others the subscription rate, including postage, is $5 in the United States, $5.50 in Canada, and $8 in Latin America and other countries. Single copies: Domestic, 40 cents, Foreign, 50 cents plus postage. Copyright 1960 by Combustion Publishing Company, Inc. Publication Office, Easton, Pa. Issued the middle of the month of publication.

Accepted as controlled circulation publication at Easton, Pa.

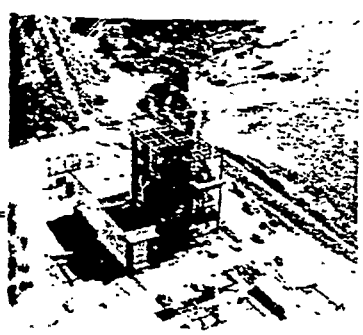
COMBUSTION publishes its annual index in the June issue and is indexed regularly by Engineering Index, Inc. and also in the Applied Science & Technology Index.

The magazine is now reproduced and distributed to libraries on microfilm by University Microfilms of Ann Arbor, Michigan. BPA

Printed in U. S. A.

COVER PHOTO

Aerial view of the new 115 Mw Holly Street Station of City of Austin, Texas. Three more units are planned for this site.



Abstracts from the Technical Press—Abroad and Domestic

(Drawn from the monthly Technical Bulletin, International Combustion, Ltd., London, W. C. 1)

Fuels: Sources, Properties and Preparation

Chemical Structure and Properties of Coal XXVII—Composition and Molecular Weight Distribution of Coal Extracts. H. N. M. Dormans and D. W. van Krevelen. *Fuel* 1960, 39 (July), 273–92.

The Dependence of the Swelling Pressure on the Temperature Conditions during Coking. W. Radmacher and H. L. Marié. *Brennst-Chemie* 1960, 41 (June), 166–70 (in German).

Since the various methods for the determination of the swelling pressure in the laboratory give very different results a new method has been developed in which the coal sample is inserted into a hot coking crucible. The temperature and rate of heating can be varied so that studies of the influence of rate of heating and coal rank on swelling pressure could be carried out which faithfully represented the results of full-scale plants. It could be shown that the swelling pressure and drum strength are dependent on the heating conditions.

Laboratory Investigations into the Behaviour of Salt-Coal Ash in Steam Generators. K. Wickert. *Energie* 1960, 12 (June), 240–6 (in German).

The behavior of the different constituents of brown coal ash with high contents of highly volatile sodium compounds (up to 25 per cent) and high S content was studied as a function of temperature, flue gas composition and additives. Conclusions are drawn with regard to the probable deposit formation in furnaces with dry and wet ash removal.

Mechanical Handling

New Means of Transport in the European Energy Distribution. H. Winkhaus. *B.W.K.* 1960, 12 (June), 238–43 (in German).

An attempt is made to assess the limits within which transport of solid, liquid and gaseous fuels by pipeline would be economic. Several projects in operation, under construction and in the planning stage are discussed.

Steam Generation and Power Production

Experimental Determination of the Specific Heat of Heavy Water. S. A. Rivkin and B. N. Egorov. *Kernenergie* 1960, 3 (June), 582–4 (in German).

The results of Russian investigations are reported for temperatures up to 300 C and pressures up to 100 kg/cm².

Experimental Determination of the Thermal Conductivity of Heavy Water. N. B. Vargaftik, O. N. Olescuk and P. E. Beljakova. *Kernenergie* 1960, 3 (June), 585–7 (in German).

These Russian studies were carried out in the range of pressures from 1 to 208 kg/cm² and temperatures of 25–360 C.

Strength Behaviour of Thick-Walled Hollow Cylinders under Inside Pressure in the Fully Plastic Range. Studies by Bursting Tests. K. Wellinger and D. Uebing. *Mitt. V.G.B.* No. 66, 1960 (June), 134–48 (in German).

Bursting tests on thick-walled hollow cylinders in a specially developed

test rig allowing application of pressures up to 8000 kg/cm² are reported. From the results the maximum permissible pressure can be calculated.

Calculation of the Laminar and Turbulent Pressure Drop at a Pipe Inlet. N. Scholz. *Chem Ing. Tech.* 1960, **32** (June), 405–9 (in German).

Simplified equations have been developed for the calculation of the laminar and turbulent flow at a pipe inlet; the results agree well with the strict theory and measurements. The transition from laminar to turbulent flow is also treated and suitable equations are presented.

Present State of Steam Generator Technique. Oil Firing in Steam Generators in Western Germany. H. Richter. *Mitt V.G.B.* No. 66, 1960 (June), 155–8 (in German).

Statics of numbers of boilers, year of erection, pressure and temperature ranges, outputs, combinations with other fuels and of coal, brown coal, oil, gas and multifuel fired boilers.

Firing of Low-Grade Fuels and of Different Fuels in a Single Plant. Wasserrohrkessel-Verband and T. Geissler. *B.W.K.* 1960, **12** (June), 257–66 (in German).

Boilers designed for the firing of low-grade bituminous coal, coke and coke breeze, brown coal and lignite, peat, oil, waste wood, blast furnace and coke oven gas either singly or in different combinations are described with special attention to the high efficiency obtained in their operation.

The Russian PK-33-83 SP High-capacity Once-through Boiler. Z. G. Model. *Energomashinostroenie* 1960 (April), 1–7 (in Russian).

The layout, components and fundamental design philosophy of the Russian 650 *t/h*, 1060 F/2060 psi (reheat to 1060 F/400 psi) once-through boiler are examined.

From, *C.E.G.B. abstract*,

Prefab Coal-Fired Boiler Wins Out in Navy Tests. L. F. Deming. *Pwr. Engng.* 1960, **64** (June), 82–4.

Two sizes of packaged boiler designed for rapid conversion from oil to coal and vice versa were tested. The smaller one for 12,000 lb/hr was fitted with a longitudinal drum, spreader stoker and vibrating grate overfire air from the front and cinder reinjection at the sides and rear (through the bridge wall), I.D. and F.D. fans and low-draught loss dust collector. At an average rate of 12,994 lb/hr the thermal efficiency was 85.31 per cent. The larger size has two transverse drums, a spreader stoker with oscillating grate and is rated at 30,000 lb/hr. In tests on oil efficiencies of up to 88 per cent were reached but combustion was incomplete and carbon deposited in the dust collector. In tests with a variety of coals efficiencies between 78.7 and 84.95 per cent were obtained. Further tests were carried out with lignite when the thermal efficiency reached 75.6 per cent.

Liquid and Gaseous Fuel Firing

Pressurised Oil Burners for Steam Generators. Pt. I. G. Weber. *Mitt. V.G.B.* No. 66, 1960 (June), 164–78 (in German).

A detailed theoretical analysis of oil atomization is followed by a description of the application of the theory to the design of various types of burners and their control. Volume and pressure of combustion air and their control are also discussed.

Water Treatment

New Specifications for the Silicic Acid Content of Boiler Water. H. E. Hömig. *Mitt. V.G.B.* No. 66, 1960 (June), 158–63 (in German).

The necessity for new specifications based on the latest scientific studies is explained and recommendations made for new values of the SiO_2 content of boiler waters for pressure up to 80 atu and from 80 atü upwards. The new values can be taken from two graphs.

Heat Recovery Plant

Here's a Unique Industrial Soot Blower Installation. W. Bois. *Pwr. Engng.* 1960, **64** (June), 88–9.

In an oil fired boiler rated at 40,000 lb/hr at 400 psi and 600 F a conventional rotary sootblower was used to clean the tube banks above the burners. After several years this was completely burned out and then replaced by a retractable sootblower oscillating 165 deg installed below the tube banks using steam at 100 psi as medium. The oscillating type was chosen so as not to interfere with the combustion and flame below. The oscillation of the motor was obtained by fitting limit switches. A second motor advances and retracts the lance. Because of the more efficient cleaning due to the oscillation sootblowing is now necessary only once per 24 hr.

Power Generation and Power Plant

American Power Conference in Review—II. Anon. *Combustion* 1960, **31** (June), 48–54.

The second part presents abstracts of paper on condensers, [illegible] control of oil and gas burners in large steam turbines.

Technical Trends in Steam Power Stations. Anon. *Techn. Mod.* 1960, 52 (Feb.), 284–90 (in French).

The development since 1921 is traced and several tables show the progress made in 40 years with regard to efficiency, reduction in personnel and capital costs.

The Direct Generation of Electricity —2. B. C. Lindley. *Nucl. Pwr.* 1960, **5** (July), 80–3.

The second part deals with magnetohydrodynamic generation and the fuel cell.

How Coal Can Fuel the Turbo-Charged Steam Plant. J. L. Yellot. *Pwr. Engng.* 1960, **64** (June), 68–70.

Various possibilities of using coal as fuel in a combined gas and steam turbine plant are discussed: (1) Partial gasification; (2) total gasification; (3) direct coal firing under high pressure.

The Typical Power Station of 600 MW. S. Kowallik. *Energietechnik* 1960, **10** (June), 239–48 (in German).

For the typical new power station of the German Democratic Republic steam generators are rated at 350 t/h, 35 atü and 530 C. They will contain swirl burners high up in the furnace front wall so that the gas flow is downward in the furnace, upward in the 2nd pass containing evaporator and superheater tube platens downward again in the convection pass. Possibly also boilers with opposed burner ring will be installed later. Because of the high S content of the brown coal (2.5–3 per cent) the air will be preheated by steam to at least 80 C before entering the air preheater to prevent corrosion and clogging. The description includes the heat flow diagram, layout, coal and ash handling plant, turbines and generators, pipelines, and water treatment, controls and treatment of cooling water and electrical installations.

The Chalon II Power Station. F. Scheurer. *Techn. Mod.* 1960, **52** (May), 272–83 (in French).

This power station has been built to utilize mainly Blanzy coal with an ash content of up to 45 per cent, S. content of up to 33 per cent and a moisture content of up to 11 per cent. Because of the high ash content boilers with four cyclone furnaces have been chosen which supply 125 Mw turbogenerators.

The Steam Power Station at Champagne - Sur - Oise. M. Mascarello. *Techn. Mod.* 1960, 52 (May), 260–3 (in French).

This is one of the first French power stations in which a 250 Mw unit is being installed. Steam is generated at 141 atü and 565 C with reheat to 565 C, a feedwater temperature of 260 C and a flue gas exit temperature of 120 C. The calculated net heat rate is 2240 kcal/kwhr.

The Brown Coal Power Station "Citta di Roma." Anon. *Energie* 1960, 12 (May), 219 (in German).

This power station 20 miles south of Perugia utilizes brown coal with an average C.V. of 2340 Btu/lb in two Benson outdoor boilers each rated at 270 klb/hr at 2060 psi and 986/975 C and two 36 Mw turbogenerators. Each boiler is supplied from 4 mills with an individual output of 23 t/h. Electric power is transmitted to Rome at 158 kv over a distance of 94 miles.

The Lacq-Artix Power Station. F. Scheurer. *Tech. Mod.* 1960, **52** (May), 241–5 (in French).

This power station is being constructed to supply energy to a new aluminum producing factory. It will contain four units of 125 Mw capacity, each supplied by natural gas fired boilers rated at 360/400 t/h at 140 atü and 542 C with reheat to 542 C; the flue gas exit temperature at the air preheater is 110 C.

The Recovery of Expansion Energy at the Artix Power Station. H. Lescoeur. *Techn. Mod.* 1960, **52** (May), 246–51 (in French).

The gas is supplied to this station at a pressure of 568 psi and a temperature of 10 C. The gas is preheated to 350 C and then passed through a gas turbine generator of 3500 kw capacity in which the pressure is reduced to 31.3 psi at a temperature of 150 C before it is supplied to the burners of the boilers. The gas is first heated by exchange with feedwater and then by steam.

Conversion of the Nantes-Cheviré Power Station to Natural Gas Firing. T. Mabilleau, M. Delorme and R. Liebray. *Techn. Mod.* 1960, **52** (May), 264–9 (in French).

The modifications necessary for firing natural gas in boilers previously fired by coal and oil are described, especially with regard to the automatic controls for firing each fuel alone or in any combination.

Portishead "B" Power Station. Anon. *Petrol. Times* 1960, 61 (June 17), 423.

Boilers 8–12 in this station were supplied with retractable corner burners and despite high turbulence of the flame no impingement of it on the wall has occurred. The air to the burner is subdivided into primary, secondary and tertiary air to obtain optimum atomization and complete

burning out of the 6000 sec. Redwood No. 1 oil with an S content of 4–4.7%. No acid corrosion or smoke emission has occurred, the average efficiency has been 85.5 per cent and the availability 96 per cent.

The St. Andra II Steam Power Station, Austria. Anon. *Ö.Z.E.* 1960, **13** (April), 102–184 (in German).

The issue is devoted to articles dealing with the station, which has a 330 t/h, 207 atm. (gage), 530 C Benson boiler, with reheat to 530 C, and a 125 MVA hydrogen-cooled turbo-alternator. Cost was approximately £42/kw.

From *C.E.G.B. Digest* 1960, **12** (July), 1720.

How We Modernized Our Plant and Saved Money. M. Buhner. *Pwr. Engng.* 1960, **64** (June), 74–5.

At the Fox River Paper Corp. it was found possible to install new plant and operate it at a much lower cost than estimated by consultants. The new boiler is rated at 40,000 lb/hr and fitted with a Vibra-Grate stoker including automatic combustion controls and a pneumatic ash handling system; no new buildings or foundation work was required. The new plant is operated by four shift men and one utility man on the day-shift, i.e., not more than would have been required by an oil-fired boiler.

Benson Boiler at Steelworks. Anon. *Elec. Times* 1960, **137** (June 16), 961–3.

The new plant recently completed at the Margam Steelworks consists of a three-pass semi-outdoor Benson boiler (240 klb/hr) and a 9.5 mw back-pressure turbogenerator. The steam is generated at 3300 psi and 1060 F and the turbine exhaust steam reheated to 836 F before being passed into the existing 625 psi mains. The main fuel is blast furnace gas with oil as standby. Combustion control is obtained by control of the F.D. fans as a function of the fuel supplied to the furnace.

Extensions to Power Plant at the Mersey Mill of the Bowater Paper Corp. Ltd. Anon. *Pwr. & Wrks. Engng.* 1960, **55** (June), 444–9.

The new extension comprises three spreader-stoker fired boilers each rated at 90 klb/hr at 925 psi and 910 F, easily convertible to oil firing. About 30 per cent of the coal is burned in suspension, the remainder on the forward moving grate; fly ash and grit from the superheater hopper and grit arrester are returned with part of the secondary air into the furnace. The 15 Mw turbine has extraction points at 75 and 20 [illegible]. The make-up water is treated [illegible] hydrogen-ion starvation, ba[illegible]

hange plant with caustic soda addi-on for pH adjustment and passed rough two evaporators. The con-nsate and make-up water are passed rough a deaerator to reduce the O_2 nte: 0.005 cc/l.

aterials and Manufacturing Processes

Comparative Method for Testing raphite for Nuclear Reactors. I. Zezerun. *Kernenergie* 1960, 3 une), 538–42 (in German).
A method worked out in Russia is scribed for assessing the suitability a graphite for use in reactors based a comparison of the weakening of e flux of thermal neutrons by the aphite under test and a standard aphite.

lationship between Thermal Prop-ies and Atomic Molecular Struc-e of Carbon in Homogenising aphitisation. V. I. Kasatockin, K. Zamoluev and A. T. Kaverov. rnenergie 1960, 3 (June), 570–2 German).
Results of Russian studies of specific at, thermal conductivity and x-ray termination of degree of graphitiza-n of petroleum coke under iso-rmal conditions are reported.

sorption Cross-Section of Graphite F. Nichols. *Nucl. Sci. Engng.* 0, 7 (May), 395–99.
Am n, French and British phites were tested and their absorp-n cross-section measured and com-ed with values obtained in their ntries of origin.

con Nitride. N. L. Parr. *Re-rch* 1960, 13 (July), 261–9.
ilicon nitride has excellent oxida-n resistance up to 1600 C, is ensionally stable, resistant against rmal shock and can be produced ply and cheaply. Its properties tabulated and discussed.

Note on the Relationship between emical Composition and Hot-cking in Mild and Alloy Steels. K. B. Marshall. *Brit. Weld. J.* 0, 7 (July), 451–3.
ertain elements (e.g., sulfur, phos-rus and silicon) present in the l are now recognized as primary k formers, while others depending their solubility in austenite and ite may increase or reduce the lency to hot-cracking.

ct of Elevated-Temperature Ex-ure on Heavy Section Pressure-sel Steels. A. W. Pense, J. H. ss and R. D. Stout. *Weld. J.*), une), 231s–5s.
udies on the embrittlement of on and alloy steels due to aging oom temperature and at 500 and F.

Effect of Chromium Depleted Surface on Corrosion Behavior of Type 430 Stainless Steel. R. V. Trax and J. C. Holzwarth. *Corrosion* 1960, 16 (June), 105–8.
Causes of depletion, its effect on corrosion behavior and means of alleviating depletion are considered.

Growth of Uranium Rods in Agressive Gas Media. I. V. Batenin, A. N. Rudenko and B. V. Sarov. *Kernenergie* 1960, 3 (June), 532–5 (in German).
Russian investigations into the growth of uranium in air, nitrogen and carbon monoxide as a function of temperature, gas pressure, rod diameter and previous state of oxidation of the rod surface are reported. A possible mechanism of this growth is proposed.

Modern Welding Methods Applied to Power Station Engineering. D. P. Tait. *Brit. Pwr. Engng.* 1960, 1 (July), 41–4.
Some of the latest developments in arc welding pressure vessels and pipes are described.

Ultrasonic Welding. B. E. Noltingk. *Weld. Met. Fabr.* 1960, 28 (July), 260–6.
Some recent British investigations in the field of ultrasonic welding, its advantages and difficulties experienced are reported. The various techniques developed for spot and seam welding are described and illustrated by examples. Thin materials, dissimilar metals or those of unequal thickness are particularly suited to ultrasonic welding.

Piping. T. W. Edwards. *Power* 1960, 104 (June), 51–66.
This survey deals with: (1) Materials (steel cast iron, wrought iron, copper alloys, copper tubing, others); (2) supports and fittings; (3) fluid losses; (4) ASA piping standards.

Instruments and Controls

Automatic Boiler Control. F. Marchand. *Tech. Mod.* 1960, 52 (May), 300–3 (in French).
Recent trends in French power station control equipment are discussed. The "synchrolisseur" has been developed, an electronic instrument, which is used to set servomotors in their correct position.

The Control of Sulzer Monotube Steam Generators with Reheating. M. Diethelm. *Sulzer Tech. Rev.* 1959, 41, No. 4, 3–9.
The English version of the paper previously abstracted (abstract 4371, 1959).

Control of Power Reactors—1. R. H.

Campbell. *Nucl. Pwr.* 1960, **5** (July), 68–72.

The problems to be considered in the design of controls for power reactors are set out.

Recording Electrical Resistance Corrosion Meters. E. C. Winegartner. *Corrosion* 1960, **16** (June), 99–103.

The design of the instrument, precautions to be taken and results obtained are described.

Radioactive Equipment for Direct Measurement of Coal-bunker and Reservoir Levels. V. G. Segalin, P. V. Lopotskii and S. I. Libson. *Elekt. Stantsii* 1960 (April), 20–30 (in Russian).

A radioactive source of what appears to be an alloy of cobalt, barium and nickel in the form of a vertical wire in a protective sheath and with radioactivity uniformly distributed along its length is located inside the bunker. The radiometric receiver is fixed on the outer wall or inside the bunker or reservoir. Formulas derived show that the intensity of radiation induced by the radiometric equipment is related only to the length of the radioactive wire not covered by coal, i.e., with the level of filling of the bunker or reservoir. The equipment can operate satisfactorily in very dusty and humid conditions, these factors having little effect upon the measurements.

From *C.E.G.B. abstract.*

Nuclear Energy

World Power Conference. Anon. *Nucl. Engng.* 1960, **5** (July), 317–9.

A digest of the papers dealing with all aspects of nuclear power presented to the Madrid meeting is given.

Present State of Projects for Nuclear Power Stations in the European Community. H. Schult. *B.W.K.* 1960, **12** (June), 252–4 (in German).

In the countries of the European community about 75 research and experimental reactors are in operation or under construction. A brief survey of research and power station reactors in France, Germany, Holland, Belgium, Italy and Gt. Britain is presented.

The Engineering Design of Power Reactors. N. J. Palladino and H. L. Davis. *Nucleonics* 1960, **18** (June), 85–110.

The subject is discussed under the headings: (1) Conceptual design; (2) steps in the design process; (3) reference design; (4) plant conceptual design; (5) design criteria and initial estimates; (6) catalogue of design criteria for power reactors; (7) parametric studies; (8) co-

...eral layout; (9) temperature flattening; (10) reference fuel design and development; (11) reactivity requirements and control rods design.

The ...ine Boiling Water Reactor. ... Smith. *Brit. Pwr. Engng.* 1960, 1 (July), 26–33.

The design worked out by the Nuclear Power Group for a 65,000 ton tanker with a 20,000 shp power unit is described. The reactor power is 60 Mw and it operates with a coolant at 1000 psi and an outlet temperature of 546 F, fuel pellets enriched by 2.5 per cent and a maximum temperature of 3992 F and a maximum can temperature of 572 F. The steam is passed directly to a hp and a l-p turbine in series.

The Brown Boveri-Krupp High-Temperature Gas-Cooled Reactor. R. Schulten and E. Jantsch. *Brown Boveri Rev.* 1960, 47 (Jan./Feb.), 3–96.

The prototype reactor with a net electrical output of 15 Mw is of the breeder type using in the second phase uranium-carbide and thorium-carbide graphite spheres freely heaped in the core. The coolant gas is He or He + Ne entering at 200 C and leaving at 850 C at a pressure of 10 kg/cm² generating steam at 505 C and 75 kg/cm² at a rate of 60t/h. The reactor, core, fuel elements, gas and ... n circuits, controls given.

Dragon Objective. Anon. *Nucl. Engng.* 1960, 5 (July), 300–1.

The objectives are steam conditions comparable to those in conventional power stations, compact core and low capital costs and exploitation of the thorium-U233 breeder cycle. The differences between this graphite moderated and helium-cooled reactor the Calder Hall AGR are set out.

Dragon General Description. Anon. *Nucl. Engng.* 1960, 5 (July), 302–5.

This includes: (1) Core; (2) control; (3) reactor vessel; (4) coolant; (5) charge machine; (6) fission product removal; (7) shielding and containment; (8) ventilation; (9) auxiliary buildings and supplies.

Dragon Control System. J. R. Dean. *Nucl. Engng.* 1960, 5 (July), 306–9.

Dragon Fuel Elements. E. Smith. *Nucl. Engng.* 1960, 5 (July), 310–3.

Dragon Graphite. R. A. U. Huddle, A. P. Arragon and M. S. T. Price. *Nucl. Engng.* 1960 5 (July),, 314–5.

Hydrogen as a Reactor Coolant. N... Array. *Nucl. Pwr.* 1960, 5 (July), ...–9.

The properties of hydrogen which fit it for its application and also its disadvantages are set out.

Combustion

DEVOTED TO THE ADVANCEMENT OF STEAM PLANT DESIGN AND OPERATION

volume 32 number 6 **December 1960**

Published monthly by COMBUSTION PUBLISHING COMPANY, INC., 200 Madison Ave., New York 16. A SUBSIDIARY OF COMBUSTION ENGINEERING, INC.

Charles McDonough, President

Arthur J. Santry, Jr., Vice-President

Lambert J. Gross, Treasurer

Thomas A. Ennis, Secretary

COMBUSTION is sent gratis to engineers in the U. S. A. in charge of steam plants from 20,000 lbs per hr capacity up; and to sulting engineers in this field. To others subscription rate, including postage, is $4 in the United States, $5.50 in Canada, and $8 in Latin America and other countries. Single copies: Domestic, 40 cents, Foreign, 60 cents plus postage.

Publication Office, Easton, Pa. Issued the middle of the month of publication.

Accepted as controlled circulation publication at Easton, Pa.

COMBUSTION publishes its annual index in the June issue and is indexed regularly by Engineering Index, Inc. and also in the Applied Science & Technology Index.

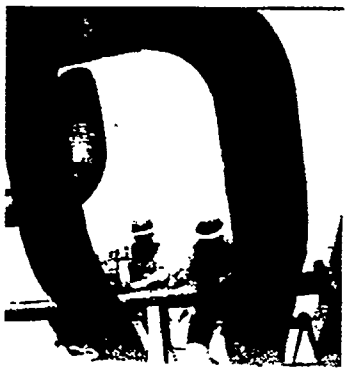
The magazine is now reproduced and distributed to libraries on microfilm by University Microfilms of Ann Arbor, Michigan.

Printed in U. S. A.

BPA

COVER PHOTO

Construction workers pause for that fleeting moment on a Fluor Corp. refinery installation



(from the Monthly Technical Bulletin, International Combustion, Ltd., London, W. C. 1)

Fuels: Sources, Properties and Preparation

Reactivity of Coke. K. Hedden. *BrennstChemie* 1960, 41 (July), 193–203 (in German).

The reactivity is determined by passing CO_2 at constant velocity through the furnace in which it reacts with the coke at a temperature kept constant at ±1 C. From the velocity of formation of CO the velocity constant defining the reactivity can be determined. Differences in reactivity of cokes and changes in the reactivity during burning are discussed. In a series of tests the relationship between reactivity and production conditions of the coke could be clarified.

The Transport of Solids in Pipe Lines in Collieries. M. Coeuillet. *Tech. Mod.* 1960, 52 (June), 312–8 (in French).

Examples of hydraulic and pneumatic transport of solids, such as sand, cr nd rock, are described and the ad tages and disadvantages discussed.

Sampling of "Difficult" Coals: Trials of an Automatic Sampler. A. J. Norman. *J. Inst. Fuel* 1960, 33 (Aug.), 402–5.

The sources of size segregation in loading and unloading coal wagons and the difficulties experienced in obtaining representative samples for ash analyses are discussed. The American sampling device for installation at the tipler is described and results are tabulated. It is concluded that although there may exist a bias in favor of the lower specific-gravity particles in the larger size fractions this sampler is preferred to other methods for taking samples from wagons.

Heat: Cycles and Transmission

Radiant Heat-Transfer Analysis of a Furnace or Other Combustion Enclosure. J. T. Bevans. *ASME Preprint* No. 60-HT-12 1960 (Aug.), 7 pp.

An analysis more complete than that of Lobo and Evans but less difficult and time consuming that that of Hottel or Oppenheim is presented.

E Transfer to Water in Turbulent Flow in Internally Heated Annuli.- Pt. 1: Stationary Flow; Pt. 2. Pulsating Flow. Z. Rotem and I. Shai. *ASME Preprint* No. 60-HT-20/21 1960 (Aug.), 4 and 5 pp.

The results of experimental investigations of local heat transfer and friction in turbulent stationary and pulsating flow of water through a circular concentric annular duct are presented.

The Effect of Density Variation on Heat Transfer in the Critical Region. Y.-Y. Hsu and J. M. Smith. *ASME Preprint* No. 60-HT-8 1960 (Aug.), 6 pp.

A method has been developed for predicting the influence of density variations on transfer of momentum and heat in the critical region. The results show that in heating the velocity and temperature profiles are flattened and the heat transfer coefficient at a given Reynolds number is increased. Investigations of the effect of natural convection showed that

this also flattens the velocity [illegible] and increases the heat-transfer efficient.

Steam Generation and Power Production

Determination of the Viscosity of Steam at Supercritical Pressures. E. Ljelland-Fosterud. *J. Mech. Engng. Sci.* 1959, 1 (June), 30–8.

The viscosity of steam has been measured at pressures of 200 to 1000 atü and temperatures of 370 to 540 C. The apparatus used is described and the results are tabulated.

An Equation of State for Liquid Water Valid up to 300 C and 1200 atü. R. Plank. *B.W.K.* 1960, 12 (July), 302–4 (in German).

The new semi-empirical equation has been deduced from the tables for the specific volume of water published by the Moskow Institute of Energy.

Energy Diagrams for Water and Steam. Z. Rant. *B.W.K.* 1960, 12 (July), 297–301 (in German).

Exergy diagrams show much better than energy diagrams where the losses in the steam power process occur and where the greatest scope for improvements still exists. The new diagrams in combinations with the earlier ones for air and flue gases are used to show the energy and exergy flow in two examples, one a steam generator and the other a power station.

Photo-Elastic Exploration of the Stresses in a Design for a Full-Bore Closure for a Reactor Pressure Vessel. C. Snell and H. T. Jessop. *J. Mech. Engng. Sci.* 1959, 1 (Sept.), 144–50.

The Turbo-Furnace. J. D. Williams. *J. Inst. Fuel* 1960, 33 (July), 328–36.

This boiler was first developed for slag-tap firing of low-grade coal and is characterized by the opposed, downwardly inclined burners in the front and rear wall. Despite the absence of soot blowers the furnace has remained clean. One of the largest built is rated at 1550 klb/h at 1925 psi and 1005 F with a water-cooled furnace floor lined with castable refractory. Other boilers have been designed for gas and oil firing, and one rated at 800 klb/h at 1600 psi and 1005/1005 F for oil firing is to be installed at Bankside "B" power station.

Towards Cheaper Steam. [illegible] *Pwr. & Works Engng.* 1960, 55 (July), 499–502.

At the N.C.B.'s Central Engineering Establishment at Bretby a [illegible] house has been erected to find the way of burning low-grade coal without smoke emission in shell boilers. The fuel used is ve[illegible]

...washed slack which is condi-...with water on a conveyor belt ...delivered to bunkers with a glass-...bottom; the chutes to the ...ppers are also glass-lined to ...hold-ups. A baffle is in-...ed ...e furnace flue behind the ...ge ... event dust accumulation. ...induced draught fans have shunt-...e scroll vortex grit arrestors with ...ndary centrifugal collectors to ...imize grit emission.

Packaged Boiler and Its Applica-... D. F. Brice. *Brit. Pwr. Engng.* ..., 1 (Aug.), 37–40.
...review of packaged, oil-fired, fire-...water-tube and monotube ...ers, their ratings and applications.

...t it Takes in Piping for a Super-...cal Unit. C. A. Dauber. *Pwr. ...ng.* 1960, 64 (July), 51–3.
...rief information is given of ma-...ils and sizes used for various pipe-...s and valves at Avon No. 8 unit of Cleveland Electric Illuminating ...pany's supercritical monotube ...er at 3500 psi and 1100/1050 F.

...l Fuel Firing

A. Standards for Pulverized Fuel ...ems. Anon. *Combustion* 1960, July), 26–36.
...complete reprint of the latest ...rican Standards Association Code ...7- ...59 for the installation and ...ation of pulverized fuel systems. ...ontains the following chapters: ...ntroduction; (2) General require-...ts; (3) Installation of pulverized systems; (4) Lighting and operat-...pulverized fuel systems; (5) Fire ...ention and fire protection.

...bustion Research and Fuel ...cy; A New Look in Combustion ...earch. M. W. Thring. *J. Inst.* 1960, 33 (Aug.), 406–9.
...brief outline is given of the fields ...hich research into the combustion ...oal, oil and gas appears most ...ful.

... Patterns in Three-Dimensional ...es. A Background for Furnace ...gn. N. P. Bacon, J. H. Chesters ...I. M. Halliday. *J. Iron & Steel* 1960, 195 (July), 286–92.
...udies of flow patterns in cubes, ...res, cones, cylinders and other ...-dimensional shapes are de-...ed and the behavior of enclosed free jets compared. Flow in the ...can be taken as the prototype for ...urnaces, that in the sphere and ...sphere for gas holders during ...g ... for ignition hoods, that in ...or. ... a burner quarl, that in the ...der for Lancashire boiler, flame ...els and rotary kilns.

Combustion

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volume 32 number 7 **January 1961**

Published monthly by COMBUSTION PUBLISHING COMPANY, INC., 200 Madison Ave., New York 16. A SUBSIDIARY OF COMBUSTION ENGINEERING, INC.

Charles McDonough, President

Arthur J. Santry, Jr., Vice-President

Lambert J. Gross, Treasurer

Thomas A. Ennis, Secretary

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Publication Office, Easton, Pa. Issued the middle of the month of publication.

Accepted as controlled circulation publication at Easton, Pa.

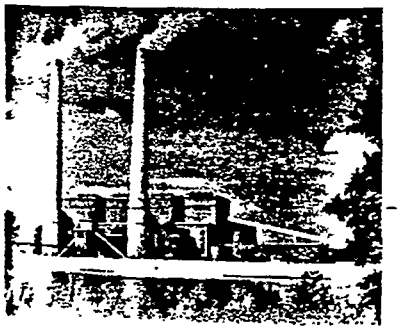
COMBUSTION publishes its annual index in the June issue and is indexed regularly by Engineering Index, Inc. and also in the Applied Science & Technology Index.

The magazine is now reproduced and distributed to libraries on microfilm by University Microfilms of Ann Arbor, Michigan.

Printed in U. S. A.

COVER PHOTO

Attractive view of the Porcheville power plant of the Electricite de France on the Seine River, near Paris



Abstracts from the Technical Press—Abroad and Domestic

(Taken from the Monthly Technical Bulletin, International Combustion, Ltd., London, W. C. 1)

Furnace Research and Advancement

Flow Experiments on Models of Boiler Furnaces. F. N. Scheubel. *B.W.K.* 1960, 12 (Aug.), 347–50 (in German).

The problems encountered in the investigations of flow problems in cold models, especially the development of similarity laws, are discussed. The most essential parameters are the Reynolds number and a "dust" parameter characterizing the relative movement of pulverized coal and gas. Experiments are in progress to obtain data of the turbulent mixing process between a dust-laden and a dust-free gas jet. Examples of model tests are presented.

The Factory Fabricated Coal Fired Boiler. L. F. Deming. *Amer. Pwr. Conf.* 1960 (Mar.), 24 pp.

The development of and test results obtained on two boilers, one rated at 12,000 lb/hr, the other at 30,000, are reported. The first is provided with a longitudinal drum, spreader stoker with vibrating grate and cinder reinjection and operated satisfactorily from 4,000 to 14,000 lb/hr with an efficiency of 85.31 at 12,999 lb/hr, but cinder reinjection was unsatisfactory and smoke density high. The other boiler is of the transverse drum type, has a spreader stoker with oscillating grate and was tested with a wide variety of coals up to outputs of 53,568 lb/hr, efficiencies varied with coal and load between 80.63 and 84.85.

Research on Pulverized-Fuel Flames by the International Flame Research Foundation: 1. Summary of Work Carried Out by G. G. Thurlow; 2. Cold Aerodynamic Trials on a Fifth-Scale Model of the Ijmuiden Pulverized-Fuel Furnace by G. Tissandier; 3. The First Performance Trial and First Combustion Mechanism Trial with Pulverized Coal by E. H. Hubbard; 4. Microscopic Examination of Samples taken from a Pulverized-Fuel Flame by B. Alpern, P. Courbon, J. Plateau and G. Tissandier. *J. Inst. Fuel* 1960, 33 (Aug.), 366–402.

The first article presents a description of the plant, test procedures used, history of the tests, input variables, results obtained to date and practical application. The second article deals with analytic and experimental investigation of the problem of pressure, velocity and concentration profiles in an enclosed jet system. The third paper details the results of the first test series and discusses the effect of the different variables on flame radiation, temperature and heat transfer and the combustion mechanism. The fourth article describes the examination by the electron and light microscopes of particles taken at various stages from the flame and draws some conclusions on the combustion process derived from it.

Investigations of a Pulverized Coal Flame in a Model. H. Effenberger. *B.W.K.* 1960, 12 (Aug.), 351–5 (in German).

Dried and pulverized brown coal was injected from below into a cylindrical vertical furnace and particle size and air ratio varied. Temperature, gas composition and particle size were measured over the furnace length. The results suggest that all the oxygen required for combustion should be added in front of or at the burner mouth.

Remarks on Research Work on Pulverized Coal Flames. R. H. Essenhigh. *B.W.K.* 1960, 12 (Aug.), 356–8 (in German).

A very brief outline is given of the work on pulverized coal flames carried out in Sheffield, preliminary results obtained and future research envisaged.

Water-Side Corrosion and Water Treatment

Corrosion in Circulating Water Systems. C. O. Smith. *Brit. Pwr. Engng.* 1960, 1 (Aug.), 61–4.

Occurrence and protective measures are discussed.

Interference of Organic Contaminants with Ion Exchange Processes—Occurrence, Prevention and Cost. H. E. Bacon and W. J. Lewis. *Combustion* 1960, 32 (July), 37–41.

The nature of organic fouling of anion resins is discussed and the various methods for preventing losses listed. It is generally necessary to apply more than one and it is impossible to predict which may be successful in a given case.

Corrosion of Heat-Resisting Alloys in the Presence of Fuel-Oil Ash. Pt. 1. Council of Brit. Manuf. of Petrol Equipment's Corrosion I Ctte. *Brit. Petrol Equip. News* 1959, 7, No. 4 (Autumn), 54–69.

The effect of various amounts of V and Na and their ratios on the corrosion resistance of ferritic and austenitic steels containing different percentages of Cr, Ni and Fe have been studied. Specimens were exposed to flue gases at Bankside and Haifa power stations and those of the boilers of S. S. Nestor. The ferritic steel (26 per cent Cr) was most resistant to deposits, austenitic steel with low Ni content more resistant to deposits of low V:Na ratio and steels of high Ni content more resistant to deposits of high V:Na ratio. The corrosion mechanism due to the deposits is discussed.

Corrosion by Vanadium-Pentoxide Sodium Sulphate Mixtures in Laboratory Tests: Correlation with Corrosion by Oil Ash in Field Tests. Pt. 2. H. Lewis. *Brit. Petrol Equip. News* 1959/60, **7**, No. 5 (Winter), 48–55.

The laboratory tests on the same steels were carried out with synthetic oil ash and various mixture ratios of sodium sulfate and vanadium pentoxide at temperatures of 650 to 850 C. The results largely confirmed the field tests.

Fire-Side Corrosion in Oil-Fired Boilers. L. K. Rendle, R. D. Wilsdon and G. Whittingham. *Corr. Prev. and Contr.* 1960, **7** (Aug.), 42–5

The second part describes the result of metallographic examination of heat-resistant alloys and presents tables of data on fuel oils, deposit and corrosion rates for low vanadium fuel oils, loss in weight and analysis of scales produced of heat resistant alloys and effect of dolomite injection on corrosion of Swedish superheater steels when firing high vanadium fuel oils.

Flue Gas, Ash and Dust

The Reinjection of Flyash into a Pulverized Coal Fired Boiler. G. Massip. *Chal. et Ind.* 1960, **41** (June), 161–72 (in French).

The installation of a reinjection system for fly ash from the dust collector hoppers and beneath the air preheater in a boiler rated at 92 t/hr at 80 atü and 570 C with roof burners is described. A considerable reduction of combustibles in the fly ash has been obtained and thus the thermal efficiency has been increased.

Intermittent Release of Smoke from Chimneys. J. S. Turner. *J. Mech. Engng. Sci.* 1960, **2** (June), 97–100.

Theoretical and experimental studies indicate that a considerable increase in height may be obtained by the smoke if it is ejected in discrete puffs at high velocity. Numerical values for final height, size of chimney, optimum storage and release times are presented.

Industrial Gas Cleaning. N. Pilpel. *Brit. Chem. Engng.* 1960, **5** (Aug.), 542–50.

A review of: (1) Filtration; (2) Electrostatic precipitation; (3) Inertial separation; (4) Washing and wet scrubbing; (5) Agglomeration; (6) Choice of plant.

New Advances in Fly-Ash Control. H. B. Alford. *Combustion* 1960, **32** (July), 45–9.

Due to the improved combustion conditions in modern boilers the ash has a high resistivity and a low SO_3 content so that its precipitation has become difficult. A new "finned" plate has been developed to increase collecting efficiency. Improved rapper controls are described which reduce re-entrainment of collected ash. Automatic controls allow operating the precipitator at optimum efficiency for a given ash; high resistivity ash requires fewer sparks at greater intensity.

Power Generation and Power Plant

Sites for Coal-fired Power Stations. Anon. *Electricity* 1960, **13** (July/Aug.), 204.

Owing to the scaling down of the nuclear power program and forecasts of higher loads for 1965/1966 coal-fired stations will have to be built. Consent is sought for two 2000 mw stations at West Burton and Holme Pierrepoint and a 1400 mw station at Tilbury. Further stations are likely to be constructed in the West Riding of Yorkshire.

Bandour Power Station. Anon. *Electricity* 1960, **13** (July/Aug.), 217.

The first section of this station consists of a monotube boiler rated at 750 klb/hr at 2432 psi and 1112/1067 F and a 115 mw turbogenerator. The thermal efficiency of the boiler is 93.1 per cent and the nett heat rate 7591 Btu/kwh at M.C.R.

Supercritical Plant at Drakelow "C". Anon. *Electr. Rev.* 1960, **167** (Aug. 19), 296–8.

Two 375 mw units have been ordered for installation at Drakelow "C" station by 1965. The boilers, one of Benson and the other of Sulzer design, will provide 2500 klb/hr of steam at 3650 psi and 1110 F with single reheat to 1055 F. One of the turbines will have one h.p., one i.p. and two l.p. cylinders with a double-flow exhausting into twin condensers, the other quadruple flow l.p. cylinders arranged in double-flow l.p. casings; both are in-line tandem-compound machines running at 3000 rpm with 8 stages of feedwater preheating to 505 F. The generators have hydrogen-cooled (45 psi) rotors and water-cooled stators and a M.C.R. of 375 mw at 0.85 p.f. generating at 19 kv.

The Use of Milled Peat in Large Boilers for the Generation of Electricity. J. F. Cullen. *J. Inst. Fuel* 1960, **33** (July), 317–28.

The experience gained in firing pulverized milled peat in three boilers of German make is described. The first boiler has roof firing and Kramer beater mills, the others corner firing, one H.G.S., the other Keller mills. Auxiliary oil burners are installed to stabilize combustion. The peat with a moisture content of 40–65 per cent is dried in the mill by hot flue gas taken from low down in the furnace to which cold flue gas, hot or cold air are admixed. Slagging difficulties at low moisture content and furnace pulsations at high moisture content were encountered and the countermeasures are discussed. Backfiring in the burners, breakages of the mill hammers, and fouling of the cold-end of the heaters are commented upon. Various modifications of the boilers and mills were introduced. The efficiency of the first boiler gave a thermal efficiency of 81.3 per cent at M.C.R. with peat of 54.9 per cent moisture and C.V. of 1780 kcal/kg.

Geothermal Power Plant. *Power* 1960, 104 (July), 80–2.

... boreholes at Geysers, Calif., produce 283,000 lb/hr of steam which is passed at 115 psi to a turbine driving a ... mw generator. If experience is favorable a second turbine is to be installed.

New Use for Coal. T. S. Spicer. *Coal Utilis.* 1960, 14 (July), 12–5.

Pittsburgh has erected a new plant for the drying and burning of sewage sludge. The sludge is heated in tanks for five days at a temperature of 85 F by steam generated in two spreader stoker fired boilers (each rated at 40,000 lb/hr, 125 psi, 400 F); the sludge floats to the top and leaves a clean effluent. The warm odorous air from the tanks is used as combustion air to destroy the smell. The sludge with 18–20 per cent solids content is pumped to feed tanks, mixed with dry sludge in a mixer and dried in dual-cage mills by hot gases at 1000–1300 F. The dry sludge is then burned in an incinerator assisted by firing of pulverized coal, the hot combustion gases are used to dry the sludge and are returned also to destroy their smell. Fly ash from the incinerator is separated in a cyclone, reinjected and removed in the molten state.

... Slag Tap Boiler Performance Associated with Power Plant. Fly Ash Disposal. H. M. Rayner and L. P. Copian. *Amer. Pwr. Conf.* 1960 (Mar.), 30 pp.

Western Electric Co. installed a Turbo Furnace boiler rated at 250 klb/hr at 900 psi and 835 F with slag tap to convert the ash of this and three other, dry-bottom furnace boilers into slag. The boiler is able to operate from 65,000 to 250,000 lb/hr with molten slag removal. The results of tests with no reinjection and with reinjection from one, two and three boilers are tabulated and discussed. Curves of dust loading before and after the collector are presented.

Dungeness Nuclear Power Station. Anon. *Nucl. Pwr.* 1960, 5 (Aug.), 66.

The sixth nuclear power station to be built at Dungeness will have an output of 550 mw produced in two reactors with a thermal output of 840 mw each at an efficiency of 32.9 per cent. The CO_2 inlet temperature is 250 C the outlet temperature 410 C. Steam is produced at 1410 psi and 392 C and at 550 psi and 391 C with a feedwater temperature of 180 C. ... are 3876 fuel channels with 7 ... ents each per reactor. The steam ... to 4 main turbogenerators, ... 142.5 mw output.

(Drawn from the Monthly Technical Bulletin, International Combustion, Ltd., London, W. C. 1)

Fuels: Sources, Properties and Preparation

Coal: A Colloid and a Chemical. The Eighth Coal Science Lecture. Sir Eric Rideal. *B.C.U.R.A. Quart. Gaz.* 1959, No. 39, 1–11.

The evidence produced by many investigators of the colloid nature of coal is discussed and possibilities discussed of using coal as a chemical raw material.

Pyrolysis of Coal and Shale. M. Gomez and C. H. Prien. *Ind. Engng Chem.* 1960, 52 (Aug.), 717–23.

The annual review of the literature published in 1959.

Laboratory Investigations into the Behavior of Salt Coal Ash in Steam Generators. Pt. II. K. Wickert. *Energie* 1960, 12 (Aug.), 328–35 (in German).

The second part deals with: (1) Experiments on the melting and adhesion behavior of this ash; (2) Influence of SO_3 on the melting behavior; (3) Reaction of the ash with SO_2 and SO_3; (4) Formation of $Na_2S_2O_7$; (5) Heating surface fouling; (6) SO_2 oxidation of SO_3; (7) Solidification of the ash and the influence of sulfides on the solidification; (8) Combustion experiments with salt coals.

The Production of Improved Metallurgical Coke. The Use of Fluidized Bed Char as a Blend Component. P. L. Waters and W. R. Hesp. *C.S.I.R.O. Coal Res. Sect.* T.C. 41 1960 (Mar.), 8 pp.

The results of earlier investigations are analyzed with regard to the factors influencing coke quality (oven temperature, charge density, blending) and coke strength (shatter strength, abrasion hardness, particle size of inert material, other factors). It is shown that the coking behavior of blends of high-volatile coals with chars or coke fines can be predicted from the bulk density, amount of inert material added and V.M. content of the inert material.

The Suitability of Home-produced and Foreign Fuels for the Operation of Slagging Furnaces. Pt. III: Brown Coals. T. Geissler. *Energie* 1960, 12 (Aug.), 336–48 (in German).

The third part discussing brown coals with: (1) Economic limits; (2) Range of proximate analyses of German and foreign brown coals; (3) Factors influencing the use of brown coals in slagging furnaces; (4) Chemical composition of the ash of brown coals found in various countries; (5) Slagging and melting character of the ashes; (6) Establishment of characteristic coefficients analogous to those for bituminous coals for the rapid assessment of the suitability of a brown coal for use in slagging furnaces; (7) Boilers with slagging furnaces for brown coal. It is concluded that slagging furnaces for brown coal should be used only if the problem of fly ash removal makes this imperative.

Gasification of Brown Coal with Hydrogen in a Continuous Fluidized-bed Reactor. T. J. Birch, K. R. Hall and R. W. Urie. *J. Inst. Fuel* 1960, 33 (Sept.), 422–35.

Studies of the continuous gasification of Australian brown coal with hydrogen in reactor with bed of [illegible] diam and 3-ft depth are repo[illegible] The variables were temperature, pressure, hydrogen partial pres[illegible] coal feed rate and gas composition. Two well defined stages were observed which are set out in detail. A practical process for producing a gas of high methane content is described.

Mechanical Handling

Pressure Drop in Pneumatic Transport. W. Konrath. *Fördern und Heben* 1960, 10 (Aug.), 609–13 (in German).

A review of various investigations followed by equations and graphs for the calculation of the pressure drop in horizontal and vertical pipe lines and a diversity of materials.

Investigations of the Transport Process in Vertical Screw Conveyors. A. Vierling and G. L. Sinha. *Fördern und Heben* 1960, 10 (Aug.), 587–92 (in German).

A theoretical and experimental study of the transport of a single particle and of bulk material has been carried out; the theoretical and experimental results show good agreement. The equations permit calculation of transport velocity, degree of filling and the volume moved when screw dimensions, friction coefficients and angle of repose are given.

Heat: Cycles and Transmission

The Theory of Radiant Heat Exchange in Unidimensional Systems. V. N. Adrianov. *Teploenergetika* 1960 (June), 63–66 (in Russian).

Solutions are given of some problems regarding the theory of radiant heat exchange in symmetrical systems under conditions of local radiant equilibrium on intermediate bodies.

C.E.G.B. abstract

Heat Transfer in Flowing Media in a Horizontal Tube with Natural Convection. B. Metais. *Chem. Ing. Tech.* 1960, 32 (Aug), 535–19 (in German).

In the theory of convective heat transfer the influence of the relationship between temperature and substance parameters (viscosity, density) or the heat transfer coefficient in the transition zone between laminar and turbulent flow has not yet been clarified. A semi-empirical equation has been developed for heat transfer in horizontal tube and experimental results of measurements of heat transfer coefficients of water on heating and cooling in a horizontal dom[illegible] have shown good agreement

Insulation. Some Basic ...tions. J. W. Dawson. ...c. *Engng* 1960, 41 (Sept.), ...

...Conduction and Its Special ...on to Thermal Insulation. ...ttle. *Chem. Proc. Engng* ..., (Sept.), 397–405, 423.

...id Fuel Firing

...easurement of Pulverized Coal ...ow in Pipe Lines. E. Hübel. *Mitt. V.G.B.* No. 67 1960 (Aug.), 230–42 ...a German).

The difficulty of uniform distribu...n of pulverized coal from a mill rough branch ducts to several ...rners led to the initiation of these ...easurements. The first part deals th the difficulties of accurately ...easuring particle size distribution d density over the cross-section of a ...ct and presents the results obtained th three different instruments. The ...plication of such measurements in actual case and the improvements tained by the modifications carried t are described in the second part.

...id and Gaseous Fuel Firing

...Pressure Burners for Steam Gen...tors. Pt. II. G. Weber. *Mitt. V.G.B.* No. 67 1960 (Aug.), 248–61 (G... n).

The second part describes in detail ypical plant: (1) Design; (2) Day ...k; (3) Pumps; (4) Preheater; Automatic shutdown; (6) Air ...nission; (7) Control of oil and air; Combustion chamber; (9) Instal...on; (10) Start-up.

...ary-Cup Oil Burners. H. A. ...etham. *Pwr Wrks Engng* 1960, (Sept.), 651–5.

The Hamworthy rotary-cup oil ...ner, its application to shell-type ...ers and oil and air metering equip...nt are described.

...ter-Side Corrosion and Water ...atment

...ign Features of Large-scale ...ter-treatment Plants for Power ...ions with High Condensate Loss. A. ... Krupchitskii. *Teploenergetika* ... (June), 58–62 (in Russian).

...roblems in the selection of efficient ...ngements of large-scale water-...tment plants for power stations ...high condensate loss are outlined. ...tions arrived at regarding layout ...r ...anization of storage ar...em...s for these plants are dis...ed.

C.E.G.B. abstract

Development of Water Treatment Plant with Cation and Chemical Demineralizing Combined with the Use of Magnesia for Silica Removal. I. M. Sokolov. *Teploenergetika* 1959 (July), 59–65. *D.S.I.R. Transl.* RTS 1516.

Russian projects for feed water treatment plants are described and their economics discussed.

Continuous Quality Control of Boiler Feed Water and Condensate. F. K. Evzerova. *Teploenergetika* 1959 (July), 65–9. *D.S.I.R. Transl.* RTS 1517.

A salt concentrator providing a concentration factor of 18–20 with a basic rate of flow of 25 kg/h for the control of condensate, superheated and saturated steam is described.

Technology of Thermal Deaeration. H. Laban. *Mitt. V.G.B.* No. 67 1960 (Aug.), 261–5 (in German).

The various types of deaerators are described and their merits discussed.

Studies on Humic Acids in Ion-Exchange Plants. H. Kurapkat. *Mitt. V.G.B.* No. 67 1960 (Aug.), 242–7 (in German).

Premature exhaustion of a weakly basic anion exchanger led to a study of its causes and the rôle played by humic acids contained in the raw water. New specifications for the determination of humic acids have been drawn up and recommendations made which anion exchanger material to use for different humic acid contents of the raw water.

Gas-Side Corrosion and Deposits

Report on the Use of Dolomite as a Fuel Additive at the Emilia Power Station. F. Cremonesi, G. Maranzana and P. Sturla. *Termotecnica* 1960, 4 (June). 275–80 (in Italian).

Information is given on the deposits and corrosion arising in the 500 klb/h 1500 psig 970 F boiler of the Emilia power station, Italy. The boiler is equipped for oil-, p.f.- or natural-gas-firing and the results quoted relate to the use of Bunker "C" oil. The use of other additives is touched upon.

From C.E.G.B. Digest 1960, 12 (Aug. 13), 2155.

Operating Experience with Dust-collectors at Reduced Gas Temperatures. M. S. Samokhin and I. L. Tarnavskii. *Teploenergetika* 1960 (June), 45–7 (in Russian).

Results obtained from testing dust-collector comprising a cyclone collector and an electrostatic precipitator in series at reduced gas temperatures are given. Recommendations are made for ensuring high-efficiency performance. *C.E.G.B. abstract*

Power Generation and Power Plant

Mobile Thermal Power Stations. B. Kretzschmar. *B.W.K.* 1960, **12** (Sept.), 390–7 (in German).

Mobile power stations up to 10 Mw output are used at large building sites, in emergencies, and during maintenance or repair work in power stations. They may consist of a steam generator and turbogenerator plant, gas turbine or diesel plant installed on specially designed railway cars or lorries or in ships. German, Czech, Spanish, Russian and American examples of the various types are described.

Hyperbolic Cooling Tower. T. W. Edwards. *Power* 1960, **104** (Sept.), 67–72.

The first American natural draught hyperbolical cooling tower (320 ft high, 245-ft diam at bottom) is under construction at Big Sandy power station, Kentucky, to serve a 265 Mw unit.

New Desuperheater Controls Steam Temperature to Fuel Oil Heater. T. J. Feneis. *Pwr Engng* 1960, **64** (Aug.), 82–3.

At the Burlington station of Public Service Electric and Gas Co. residual fuel oil has to be preheated from 223 to 335 F and the steam available for oil heating has to be reduced in pressure from 1200 psi and temperature from 950. Pressure reduction to 650 psi is carried out in a single pressure reducing and flow control valve, temperature reduction in a variable orifice desuperheater containing a spring-loaded ball and cooling water admission at the orifice seat; pressure drop at all flows is constant at 3–4 psi.

Plant Design Considerations Utilizing Largest U. S. Raw-Lignite-Fired Boiler. T. Y. Mullen. *Combustion* 1960, **32** (Aug.), 49–53.

At the Hoot Lake station a 53.5 Mw unit has been installed. The boiler is rated at 400 klb/h at 1500 psi and 1000/1000 F fired by raw lignite pulverized in three bowl mills each of 32,700 lb/h capacity (plus one reserve), and injected through 16 tilting corner burners. The lignite analyzes 36.97 per cent moisture, 27.9 per cent V.M., 29 per cent fixed C, 6.13 per cent ash, 0.72 S, and 6900 Btu/lb. Because of the clogging tendencies of the ash, the spacing of the superheater elements is wider than usual and horizontal surfaces have been eliminated as far as possible. The dust collector is sectionalized to maintain high gas velocities at low loads, the air preheater has a cold air bypass and steam preheater. The ash removal system is of the pneumatic type.

The Invisible Stack. Anon. *Combustion* 1960, **32** (Aug.), 57–9.

At the Seward station a chimney 214 ft height has been provided wi a stainless steel nozzle to increase t flue gas exit velocity from 30 to 1 ft/s and thus reduce air pollution ne the station. The design and constru tion of the venturi nozzle are c scribed.

The Biggest Pressure Vessel Test Far. Anon. *Engineering* 1960, 1 (Sept. 16), 388–9.

The procedure adopted for testi the pressure vessel at Berkeley nucle power station is described. The te proved entirely successful and t vessel has been passed for operating 137.5 psi and 340 C. In a simil way the spherical pressure vessel Bradwell power station has been teste with equally satisfactory results.

Materials and Manufacturing Process

High Temperature Materials. G. F Ramsden. *Mach. Lloyd* (Europ Edit.) 1960, **32** (Sept. 17), 29–31.

A general review of steels, ceramic and cermets and their limits of appli cability, advantages and disadvan tages. It is concluded that graphit could find wider application with th improvement of its oxidation resist ance.

Graphite. K. F. Anderson, F. K Harp and S. Shapiro. *Chem. Proc Engng* 1960, **41** (Sept.), 409–15.

The properties of graphite for use in the construction of chemical plant are set out and examples of applica tion given.

Graphite for Heat Exchangers. A. Hilliard. *Chem. Proc. Engng* 1960, **41** (Sept.), 416–8.

The French Polybloc system of unit blocks of graphite for the construction of heat exchangers is described.

Effect of Elevated-Temperature Exposure on Heavy-Section Pressure-Vessel Steels. A. W. Pense, J. H. Gross and R. D. Stout. *Welding Res.* 1960, **25** (June), 231–5.

Previous Pressure Vessel Research Committee investigations have indicated the suitability of high-strength steels for pressure-vessel applications in conventional thicknesses and also in heavy sections, particularly if the heavy sections are spray-quenched and stress-relieved. However, concern has been expressed regarding the effect of extended exposure in elevated temperatures on the mechanical properties of heavy-section pressure-vessel steels in applications such as fossil and nuclear and chemical plants. The present investigation deals with the effect of exposure at room temperature, 500, and 700 F for times

on the tensile properties and ch ductility of simulated spray- d and normalized carbon and heavy-section pressure-vessel

.E.G.B. Digest 1960, 12 2254.

ntribution to the Thermal Shock havior of Steels and High-Temper- re Resistant Materials. F. Eich- ru. *Stahl u. Eisen* 1960, 80 (Sept. 5), 1275–83 (in German).

A method for rapid thermal cycling f tube samples (medium-frequency eating, cold water cooling) is de- ribed to study the development of acks due to repeated thermal shocks various steels and Cr–Ni alloys. ne ferritic, one low-alloy, one aus- nitic and four Cr–Ni (Co) alloys ere tested of which Nimonic 95 gave outstanding performance. The sults are presented in tables and aphs and illustrated by photomicro- aphs.

gma Phase in Austenitic Stainless eel. R. F. Hills and D. R. Harries. *em. Proc. Engng* 1960, 41 (Sept.), 1–6.

In the application of stainless steel fuel can material the occurrence of e sigma phase and its effect on the operties of the steel may be detri- ental. The literature of the subject revie- d.

Look at Caustic Stress Corrosion. C. Wheeler and E. Howells. *wer* 1960, 104 (Sept.), 86–7.

The causes of chloride-free stress rrosion of stainless steel are dis- ssed and means for preventing acking described.

eam Pipe Sizing. E. Ingham. *am Engr* 1960, 29 (Sept.), 412–4.

The equation for calculating the e of a pipe and the pressure drop for essures up to 250 psi are developed. commended flow velocities for sat- ated steam are 100–133 ft/sec and superheated steam 133–200 ft/sec.

eating Cast Iron Melts by Ultra- nics. A. Kolorz. *Giesserei* 1960, (Aug. 25), 447–51 (in German).

Cast irons of different composition re treated for various periods by rasonics before pouring. Tensile ength, Brinell hardness and bend- strength were not different from se of untreated cast irons.

drogen in Welding. P. G. Bastien. *d. Weld. J.* 1960, 7 (Sept.), 546–57.

The Houdremont Lecture 1959 to mm n IX of the International titu. of Welding in which were cussed: (1) Effects of hydrogen in ught, cast or welded steel; sources this gas in the metal; (2) Basic

characteristics of hydrogen embrittlement; (3) Tentative explanation of the mechanism of this phenomenon (4) Consequences in the field of welding.

Aluminum Welding and Manipulation—Swedish Methods. U. Alfredson. *Nucl. Engng* 1960, **5** (Sept.) 405–8.

The fabrication and welding of Al tanks, pipes and heat exchangers for nuclear reactors are described. Both tungsten and metal arc inert-gas shielded welding are used, the former for the root and the latter for the subsequent passes.

Argon Arc Welding (WIG Method) at Low Cost. Anon. *Schweissteck* 1960, **10** (Sept.), 338–40 (in German).

A new nozzle has been designed which can carry up to 200 amp without water cooling. A further simplification has been obtained by omitting the control instrument. Despite this, good results have been achieved in welding alloy steels, copper and brass.

Fundamental Studies of Ultrasonic Welding. N. E. Weare, J. N. Antonevich and R. E. Monroe. *Weld. J.* 1960, **39** 331s–41s.

The bending mechanism, effect of welding variables and of material factors have been studied experimentally. The factors controlling the strength of ultrasonic welds are set out.

Instruments and Controls

Limits of Control Possibilities of Large Boilers. P. Profos. *Mitt. V.G.B.* No. 67 1960 (Aug), 211–21 (in German).

After briefly discussing the quantities to be controlled, the meaning of quality of control is explained and the limits of different arrangements set out. Continuous developments in the field of control design and application are widening these limits, the positive and negative effects of these developments are discussed and an attempt is made to draw a balance between these. It is concluded that economics determine in the last resort the extent to which refinements can be applied.

Automation in Thermal Power Stations. E. P. Stefani. *Teploenergetika* 1960 (June), 3–7 (in Russian).

Results of automation of thermal power stations are briefly reported. The need to calculate the dynamic characteristics of generating units in the process of their design is discussed and the application of control computers in thermal P/S engineering is examined. *C.E.G.B.*

...ation for Large Thermal Power ... D. I. Rabkina. *Teploenergetika* 1960 (June), 7–12 (in Russian).

...sideration of the amount of ...tion, remote regulation and ...; followed by discussion of ...nation circuits and systems, the ... concepts of power-station automation and organization of the design of automatic equipment for power stations. *C.E.G.B. abstract*

... Analytic Supervision of the Water-Steam Circuit in High-Pressure Power Stations by Automatic Instruments. H. Fuhrmann. *Mitt V.G.B.* No. 67 1960 (Aug.), 269–75 (in German).

Instruments for the automatic analysis of the boiler water (silicic acid, phosphate, conductivity), steam (salts and other solids) and condensate (hardness, salt, oxygen) and complete control stations are described.

...gress in Process Instrumentation. ... *Ind. Chem.* 1960, 36 (Sept.), ...

This review deals, in part, with recent developments in the measurement of fluid flow, especially the ultrasonic flow-meter.

... Electronic Automatic Regulators. ... Mironov. *Teploenergetika* 1960 (June), 20–7 (in Russian).

...ro' ...ns connected with the development of electronic regulators for automatic control of thermal processes are reviewed.

C.E.G.B. abstract

...lear Energy

... Economic Prospects of Nuclear Power in New States. J. A. Jukes. ... 1960 (Sept.), 13–20.

An attempt is made at assessing the conditions under which the provision of nuclear power in New States may be economically justified.

... Relative Advantages of Advanced Gas Cooled Reactors and Magnox Reactors. P. D. Murphy. *Brit. Pwr Eng* 1960, 1 (Sept.), 61–4.

The capital and fuel costs for both types are estimated and compared. The development of new fuel elements of the Magnox type should bring the expected cost down to that of the advanced gas cooled type it will be difficult to decide which one will be the more economical in operation.

...earch Reactor Fault Analysis. J. ... Moore. *Nucl. Engng* 1960, 5 (...) ...5–90.

The ...em adopted at Harwell for analyzing the main features of faults occurring during the operation of research reactors is described.

Abstracts from the Technical Press—Abroad and Domestic

(Drawn from the Monthly Technical Bulletin, International Combustion, Ltd., London, W. C. 1)

...Sources, Properties and ...paration

...l Derivatives. Anon. *Coke and ...* 1960, 22 (*Oct.*), 421–5, 448.

...he "Wilson" report of the Com...tee on Coal Derivatives" (Cmd. ...0) is analysed in detail and ...usses the following sections: (1) ...l carbonization and the gas in...try; (2) developments in com...e gasification; (3) industrial gas; ... synthesis of oil from coal; (5) ... as a chemical raw material; (6) ...eral conclusions.

...vimetric and Volumetric Measure...nts During the Degasification of ...ls. H. Luther, O. Abel, A. Kett ... K. C. Traenckner. *Brennstmie* 1960, 41 (Sept.), 257–63 ... German).

...he investigations into degasifica... of coals and their softening and ...r mutual relationship were carried ...by measurements of the degasifica... rate as a function of mechanical ...k density, particle size distribu...), physical (pressure, rate of ...ting and chemical (preoxidation, ...n gases) factors. Discrete ranges ...decomposition were found which ...w the presence of chemical groups ...h certain dissociation energies; ... analysis of the decomposition ...ducts confirmed this. The prop...es of coking coals depending ...nly on the extent of release of ...id products between 350 and ...C and of methane between 450 ...500 C.

...hanical Handling

...ding Coal and Dirt at Lea Hall ... Anon. *Engineering* 1960, 190 ...t. 23), 420–1.

...he power station under construc... near Lea Hall Colliery with a ...l capacity of 600 Mw is exclusively ...plied by conveyor direct from the ...ery which sorts and washes coal ... dirt from its own production and ...t several other mines in the ...ict. The coal and dirt handling, ...ng and washing plant is described.

...dling Lump Coal on Belts. D. C. ...s. *Mechanisation* 1960, 24 (Sept.)

...n installation able to transport up ...2,C... per shift of large coal ... a mine to the wagon loading ...t is described. Ropeside frame ...conveyors were chosen because ...can easily be extended or contracted and the cushioning effect when transporting large lumps.

Automatic Coal Transfer from Wagon to Ship. Anon. *Engineering* 1960, 190 (Oct. 7), 485.

Two identical plants have been installed at Immingham for the unloading of wagons into ships. Each can handle 55 wagons of 10 to 24.5 ton capacity and consists of a combination of wagon haulage and tippling plant connected by a belt conveyor to a loading tower with adjustable boom for discharge into the ship's hold. The installations operate automatically and each requires only 2 men for supervision.

The Transport of Pulverised Coal by Carrier Gas in Pipe Lines and its Influence on the Control of the Combustion Conditions. A. Schneider. *Energie* 1960, 12 (Sept.), 378–88 (in German).

Starting from the movement of a single particle and a particle mixture the flow in a pipe upwards or downwards, horizontally and in bends has been studied and equations for calculating the transport time have been deduced. Recommendations are made with regard to the planning and design of pipe lines and, especially of the bends, to reduce the total transport time. The influence of the transport time on the control of the combustion conditions is discussed and illustrated by an example.

Steam Generation and Power Production

Tests on the Thermal Conductivity of Water Vapor. H. B. Vargaftik and A. A. Tarzimanov. *Teploenergetika* 1960, 7 (July), 12–16 (in Russian).

The results are given of tests on the thermal conductivity of water vapour in the temperature range of 600F to 1040F and pressures from 70 psig to 7100 psig. *C.E.G.B. abstract.*

Design and Construction of Pressure Vessels. J. J. Haftke. *Chem. Proc. Engng* 1960, 41 (Oct.), 437–44.

The factors to be considered in designing a pressure vessel for a nuclear reactor are discussed: (1) fatigue; (2) excessive deformation; (3) corrosion; (4) brittle fracture; (5) creep rupture. Also discussed are accuracy limitations, economy, speed of construction, radiation effects and constructional considerations.

Design of Reinforced Cylinder for Nuclear Reactor Pressure Vessel. R. W. Lakin and S. S. Gill. *Engineer* 1960, 210 (Sept. 23), 495–9.

The reinforcement consists of layers of thin plate around the main cylinder, the joints being welded. This permits the use of higher pressures and greater heat production without proportionate increase in costs. The design is described and results of tests on two 1/10th models presented.

Hydrodynamics of Forced Circulation Boilers. A. A. Davidov and B. I. Sheinin. *Teploenergetika* 1959 (Nov.), 53–7. D.S.I.R. *Transl. RTS* 1584.

Data on the resistance of tubes in the water and steam circuit, pulsation in tubes, differences of temperature between tubes and header, distribution of the steam-water mixture and its stratification is forced circulation boilers.

Boiler Design for Low Grade Coal in Power Plants. B. Limpouch. *Technical Digest* (Czech) 1960, 2 (Mar.), 43–6.

Czechoslovakia's extensive experience in the field of steam-boilers for high-moisture fuels and ash contents of up to 60 per cent is illustrated with the numerous design examples described. Lignites and brown coals as well as high-ash black coals are

burnt successfully. Good results have been obtained with stoker-fired and particularly with pulverized-fuel fired boilers. Both dry-bottom and slag-tap boilers are used and boilers fitted with double-pass combustion chamber developed in Czechoslovakia have proved most successful and versatile as regards both fuel composition and ash properties.

From C.E.G.B. Digest 1960, 12 (Sept. 24), 2573.

Furnaces and Combustion

Control of Reaction Rate in Dust Flames. J. M. Beer and R. H. Essenhigh. *Nature* 1960, **187** (Sept. 24), 1106–7.

Recent investigations on pulverized anthracite flames tend to show that a chemical rate control is important in the combustion process and the previous theory of diffusional control is not valid.

Water-Side Corrosion and Water Treatment

Water-treatment with Hydrazine for Protecting Boiler Metal against Corrosion. P. A. Akolzin and N. M. Mikailova. *Teploenergetika* 1960, **7** (July), 59–64 (*in Russian*).

The results are described of an investigation on the development of the use of hydrazine in the treatment of boiler water to protect boiler metal against corrosion.

C.E.G.B. abstract.

Laboratory Investigation of Water-Side Scale and Corrosion in the Presence of High Process-Side Temperatures. H. Kerst. *Corrosion* 1960, 16 (Oct.), 131–7.

The tests were carried out with 130 F water and 350–395 F hotside temperature to investigate corrosion and calcium phosphate scale deposition. Use of polyphosphates at residual levels high enough to give corrosion protection produces calcium phosphate scale. Chromates reduce the amount of this scale and also carbonate scale.

Gas-Side Corrosion and Deposits

Some Properties of Ash Deposits Accumulated on the Screen Tubes of Boiler Furnaces. A. M. Gurvich and R. S. Prasolov. *Teploenergetika* 1960, 7 (July), 80–6 (*in Russian*).

Measurements were made on the thickness of the layer and weight of ash deposits on boiler screen tubes. The growth of deposits over time and their effect of heat transfer in the furnace were determined. It was found that in some definite cases the thermal conductivity of the initial layer of deposit may be lower than that of air. *C.E.G.B. abstract.*

Linden Combats Boiler Tube Corrosion with $Mg(OH)_2$. R. A. Baker *Pwr Engng* 1960, **64** (Sept.), 58–9.

The oil used at this power station contains between 100 and 500 ppm vanadium, on average 350–400 ppm and this in conjunction with sodium and sulfur caused severe, very sticky and corrosive deposits in the boilers. After tests it was decided to use magnesium hydroxide in preference to the oxide which tends to take up moisture and clog pipelines and nozzles. The $Mg(OH)_2$ is injected into the furnace just above the burners at a ratio of 2 parts to 1 part vanadium. The magnesium is ground to 90 per cent through 325 mesh and maximum consumption is 160 lb/h per furnace. The deposits though increased in amount are now dry and fluffy and easily removed by soot blowing. Corrosion of the air heater has not been reduced and they are washed every 3 months.

Corrosion of Steel in Hot Gases. H. Keller. *Chem. Ing. Tech.* 1960, **33** (Sept.), 582–4 (*in German*).

Corrosion of ferritic steels by sulfur and vanadium pentoxide is discussed and results of tests of the corrosion resistance of various ferritic chromium steels presented. It is shown that in many cases these steels are superior to austenitic steels though their heat resistance is lower.

Flue Gas, Ash and Dust

Recommendations on Heights for New Industrial Chimneys. G. Nonhebel. *J. Inst. Fuel* 1960, **33** (Oct.) 479–511.

It is recommended that: (1) Chimneys for large plants be so high that the calculated 3 min-max concentration of SO_2 at ground level does not exceed 40 pphm (by vol) in areas of heavy industry or high density of population and 50 pphm in other areas and the maximum rate of deposit of grit and dust not exceeding 1000g/100 m² month with a wind direction constant within an octant; (2) A sliding scale of chimney heights from 60 to 120 ft for boiler plants from 5000 to 33,000 lb/h. Rate of dust deposition will generally control the chimney height and not the SO_2 concentration. It is important that particles larger than 76 μ should not be emitted from chimneys. Recommendations are also made on the design of chimneys (combination of flue gases in one or two chimneys, avoidance of down draught and wash). The first appendix gives the methods of calculating

and the second appendix with mula for threshold visibility of y plume.

Selection of Optimum Tempera- Boiler Flue Gases. M. A. ik h, G. A. Matveev and V. I. aev. *Teploenergetika* 1960, 7 y), 27–32 (*in Russian*).

he optimum temperatures of flue es are determined from the hnical and economic aspects, for h-capacity boilers operating on als of different prices.

C.E.G.B. abstract.

X-ray Study of Pulverized Fuel h. H. S. Simons and J. W. Jeffrey. *pl. Chem. J.* 1960, 10 (Aug.), 328–

Pulverized fuel ash has been sub- ted to X-ray examination and emical analysis and the main neralogical and physical character- ics have been determined. It is own that the ash is a very com- x material in which the overall emical composition varies from rticle to particle. It is tentatively ncluded that there is a positive rrelation between pozzolanic tivity and glass content. The types combination of iron present in the have been determined and the ect of hydration examined.

From C.E.G.B. Digest 1960, 12 ept , 2577.

ot Recovery Plant

ite Heat Exchangers. Flow aracteristics. E. L. Watson, A. A. cKillop, W. L. Dunkle and R. L. ry. *Ind. Engng Chem.* 1960, 52 pt.), 733–40.

A study of velocity patterns, resi- ce times and pressure drop has n carried out to assist in design and The results are presented in phs.

ite. Heat Exchangers. Heat nsfer. A. A. McKillop and W. L. nkley. *Ind. Engng Chem.* 1960, (Sept.), 740–4.

A theoretical and experimental dy showing that turbulence pro- tors and flexible plate arrangements ult in high rates of heat transfer d low pressure drop.

wer Generation and Power Plant

Look at Big-Power Cycles for 40 cent Thermal Efficiency or Better. H. Knowlton. *Steam Engr.* 1960, (Oct.), 16–21.

Vari- s ways are considered in ich thermal efficiency of power eration could be increased. Im- vement in the steam cycle, ap- ation of the binary cycle, super- ion of the gas turbine cycle

over the steam cycle, gas turbine cycles alone and fuel cells are discussed. Which of these would constitute the best approach to high efficiencies is left open.

Off-Load Efficiency for Boilers. Gas-Tight Sealing of Plant Provides Many Economies. P. E. Jents. *Fuel Effic.* 1960, **8** (Oct.), 59–60.

Tight sealing off of a boiler plant during longer shutdown periods or during low-load operation together with intermittent firing greatly increases the efficiency and reduces smut or smoke emission. This also reduces the danger of corrosion.

Steam for Japan's Chiba Power Station.z J. Grindrod. *Steam Engineer* 1960, **30** (Oct.), 22-3.

This station contains two 125 and two 175 Mw units with a total consumption of coal of 1,650,000 t. No. 1 boiler by C.E. is rated at 960 klb/h at 1825 psi and 1005/1005 F; No. 2 boiler is a Japanese copy of No. 1 but for a pressure of 1880 psi; No. 3 boiler by Babcock and Wilcox is rated at 1300 klb/h at 2467 psi and 1060/1010 F; No. 4 boiler is identical with No. 3 but made by Babcock Hitachi.

The Elektrim (Warsaw) 360 Mw Steam Power Station: First (220 Mw) Stage. H. Scheidt. *Siemens Zeits.* 1960, **34** (July), 410–421 (*in German*).

The station, one of the most economical in Poland, has four 55 Mw sets in the first stage of construction and two 70 Mw reheat sets in the second, with natural-circulation and Benson boilers respectively; these will be pf fired.

From C.E.G.B. Digest 1960, **12** (Sept. 24), 2563.

Kincardine Power Station. Anon. *Elect. Times* 1960, **138** (Oct. 13), 565–7.

Kincardine power station, officially opened on Oct. 12, 1960, now has three 120 Mw sets in operation and two 200 Mw sets under construction to provide a total capacity of 700 Mw. The three boilers in operation (1 by International Combustion, 2 by John Brown Land Boilers Ltd) are each rated at 860 klb/h and 1010/1005 F. The first boiler is provided with 5 roller-type pulverizers (1 reserve) and four tilting burners in each corner, spray-type desuperheater for the superheated steam and burner tilt control for the reheated steam. The second and third boilers are each provided with four high-speed attrition pulverizers (1 reserve), 16 burners in the front wall, spray desuperheaters for the superheated steam and control of gas flow over

reheater and primary super- for the control of the reheated

Steam Power Station, Belgium. arbev and F. Bachmayer. *Sulzer* F 960, 42 No. 1, 13–21.

is power station contains two 60 nits each served by a Sulzer otube boiler rated at 408 klb/h, 0 psi and 1015/1015 F. The re- ing of the steam is based on the lux system and the reheated m temperature is held constant n to 30 per cent of full load. er thermal efficiency on nett C.V. ne fuel is 90.3 per cent at 20 Mw load) and 92 per cent at full load; all net thermal efficiency of the on is over 37 per cent.

La Spezia Thermal Power Station Edisonvolta. Anon. *Quaderni* , **16** (July 16), 553–61 (in Italian). ne projected station will have one Mw unit which will be the largest installed or being installed on ontinent. Steam will be generated e boiler, designed by Combustion neering, at 2520 psig, 1050 F, reheat to 1000 F. The 3000 Tosi-Westinghouse turbine will two 170 MVA hydrogen-cooled nators manufactured by Marelli r Westinghouse licence. *om C.E.G.B. Digest* 1960, **12** 24\ 2561.

itz s Turbine Power Station peration. Anon. *Energie* 1960, ept.), 377 (in German). is power station contains 2 gas nes each generating 25 Mw ovide peak load in the morning evening and in emergencies. part of the gas turbine drives the ompressor, the other the lp ressor and generator. The ther- fficiency is 25.7 per cent.

len Nuclear Power Station. us Authors. *Nucl. Engng* 1960,), 434–41.

Outline design; (2) design ophy by V. D. Nixon; (3) aspects by V. D. Nixon; (4) ower operation.

Savannah. Various Authors. *Engng* 1960, **5** (Oct.), 447–9.

General description; (2) con- od operation; (3) refueling by D. McDaniels.

e Atomic Electric. Various rs. *Nucl. Engng* 1960, **5** (Oct.),

General description by J. N. rick; (2) reactor vessel by P. B. initial core by A. G. ; (control rod drive mecha- by T. F. Widmer; (5) reactor l system by C. F. Obermesser; l handling by H. A. Smith.

Abstracts from the Technical Press—Abroad and Domestic

(Drawn from the monthly Technical Bulletin, International Combustion, Ltd., London, W. C. 1)

Fuels: Sources, Properties and Preparation

A Correlation between Helium Density and Hydrogen Content of Coals. M. Mentser and S. Ergun. *Fuel* 1960, 39 (Nov.), 509–10.

Further investigations have confirmed that there is a linear relationship between the specific volume of coal and their atom per cent of hydrogen with natural graphite having zero hydrogen content. Both hydrogen content and specific volume can thus be used to establish the degree of coalification of high rank coals.

The Composition of the True Combustible Coal Substance. H. Romovackova and F. Kessler. *Erdöl und Kohle* 1960, 13 (Sept.), 639–46 (in German).

The different methods of conversion of coal to dry, ash-free substance are critically discussed. Studies of the changes of oxygen, carbon and hydrogen as a function of ash content are reported. It is concluded that it is impossible to carry out the conversion of the content of the individual elements of the same sample in two fractions of different ash content by a linear equation.

New Calorific Value Formulae for Bituminous Coal. W. Gumz. *B.W.K.* 1960, 12 (Nov.), 484–5 (in German).

Three new quadratic equations are proposed for calculating the gross and net C.V. of a bituminous coal. In the first the C.V. is a function of carbon content, in the second a function of volatile matter content and in the third a function of both C and M.V. The equations are believed to be more accurate than any existing equation.

Coke Combustion and Coke Reactivity. M. F. R. Mulcahy, A. Cameron and W. O. Stacey. *C.S.I.R.O. Coal Res. Rej. M.* 163 1960 (July), 10 pp.

The influence of the porosity of a coke on its reactivity is discussed and experiments described in which the penetration of CO_2 into the pores was determined. It was found that this depends markedly on the reaction temperature. Preliminary results are presented.

Coal Storage. D. E. Shipley. *B.C.U.R.A. Mon. Bull.* 1959, 23 (Oct./Nov.), 433–46.

This review deals with oxidation of coal in storage piles, observations on stock piles, laboratory tests of coal properties before and after storage, methods of storage and protection of stocks.

Hydraulic Transport of Solids in Pipelines. A. Redeker. *Fördern u. Heben* 1960, 10 (Oct.), 755–9 (in German).

After a brief review of existing pipelines in Russia, U.S.A. and Europe the equations developed by various authors for calculating the friction coefficient, water velocity, power requirements and specific gravity of the mixture are discussed for vertical and horizontal transport. Recommended values are tabulated. Means for entraining the material into the transport medium are described with special reference to the lock invented by Zänsler which appears to be the most economic and simplest apparatus available at present.

Heat Transmission with Boiling. G. S. Emmerson. *Nucl. Engng.* 1960, 5 (Nov.), 493–500.

The various theories of boiling heat transfer are presented, especially the transfer from nucleate to film boiling and burn-out. The application of the theory to pressurised and boiling water reactors is discussed.

Transient Natural Convection from Vertical Elements. B. Gebhart. *ASME Preprint* No. 60-HT-33 1960 (Aug.), 13 pp.

Equations are derived which give an accurate description of natural convection transients for vertical elements with time dependent internal energy generation.

Steam Generation and Power Production

A Survey of P-V-T- Data for Water in the Critical Region. E. S. Nowak, R. J. Grosh and P. E. Lilley. *ASME Preprint* No. 60-HT-25 1960 (Aug.), 13 pp.

A review of data for water from 2700 to 4000 psia, spec. volume from 0.025 to 0.125 cu ft/lb and temperatures from 630 to 800 F. There is a lack of smoothed or computed values for the spec. volume of superheated vapor and it is therefore difficult to derive accurate values of density and coefficients of expansion and compressibility. Data for superheated steam differ greatly.

Smoothed Pressure-Volume-Temperature Data for Water in the Critical Region Derived from Experimental Measurements. E. S. Nowak, R. J. Grosh, and P. E. Lilley. *ASME Preprint* No. 60-HT-26 1960 (Aug.), 13 pp.

Data derived from American, Russian and Czech measurements by a graphical method are presented for pressures from 3000 to 4000 psia, spec. volume of 0.030 to 0.12 cu ft/lb and temperatures from 690 to 752 F.

The Equation of State of Heavy Water on the Basis of Experimental P-V-T Data. A. M. Mamedov. *Teploenergetika* 1960, 7 (Sept.), 71–5 (in Russian).

The equation of state of heavy water is considered for heavy water in the range from 480 F to 700 F and 570 psig to 14,200 psig.

C.E.G.B. abstract.

The Viscosity of Steam and Water at Moderate Pressures and Temperatures. J. R. Moszynski. *ASME. Preprint* No. 60-HT-29 1960 (Aug.), 12 pp.

The viscosity of water has been measured from 3 to 340 atü and 20 to 186 C, that of steam from 1 to 42 atü and 137.5 to 270 C.

New Tables for the Specific Volume of Water to 1200 ata and 300 C. G. Sarukhanian. *B.W.K.* 1960, 12 (Nov.), 492–8 (in German).

The tables based on latest international research are those originally published by M. P. Voukalovich, B. H. Drampoff, D. S. Rasskasoff and S. A. Remisoff in Teploenergetika 1960 (July) 4–12.

Development Trends in German Steam Generator Design. H. Seidl. *V.G.B.* No. 68 1960 (Oct.), 285–96 (in German).

After a review of developments between 1920 and 1950 with the rapid increase of boiler size, steam pressure and temperature, introduction of pulverized fuel firing, of the forced-flow boiler and of slagging furnaces, boilers designed in recent years, all of forced-flow design, are described. A special feature is their prefabrication in the workshop; the advantages of this are outlined. The largest boilers installed at present for are 150 mw units, but those for 250 or 300 mw and larger are under consideration. The problem in Germany is the ability of operating during the night at 20–30 per cent of full load and for this reason two boilers to one turbine are often preferred. The application of temperatures above 100 F depends on technical developments and economics; only a few plants with steam temperatures of 100 F and above are

operating. It appears possible that boilers for 1000 mw, 7000 psi and 1300 F with multiple reheat and incorporating a gas turbine cycle might be developed.

Development Trends in English Steam Generator Design since 1950. K. R. Lenel. *Mitt. V.G.B.* No. 68 1960 (Oct.), 297–310 (in German).

The position of the electricity supply industry at the time of nationalisation is outlined and the reasons for the rapid increase of unit and power station size in the years 1950–1960 presented. Designs of boilers from 180 to 3750 klb/h, mills, burners, casings and ash handling plant are described. The introduction of forced-flow boilers, especially those operating at supercritical pressure, is discussed. Future developments are difficult to forecast in view of the uncertain trends of nuclear power generation.

Development Trends in the Design of Steam Generator Plants of the French Public Energy Supply. Y. Teste. *Mitt. V.G.B.* No. 68 1960 (Oct.), 310–21 (in German).

The position of public steam power stations, hydro-electric generation and power plants of the coal mining, iron and steel and other works supplying the public network is outlined. Examples of standardised boilers rated at 800–885 klb/hr, 1800 psi and 1004/1004 F for 125 mw units and those rated at 1550–1700 klb/h, 2760 psi and 1050/1050 F for 250 mw units are described. The fuel is mostly coal, but oil and natural gas are increasingly used. Details of designs of controls, air preheaters (tubular), finned tubes for superheaters and reheaters prefabrication and multi-tube heat exchangers for nuclear reactors are presented.

Development of the Benson Boiler in Germany. R. Mutke. *Heat Engng.* 1960, 35 (Sept./Oct.), 168–73.

Examples of Benson boilers designed by VKW from its first inception to the present time are presented.

The TPP-110, a New High-output Boiler. V. S. Patychenko, I. N. Goldenfarb and L. A. Ostrovskii. *Energomashinostroenie* 1960, 6 (Aug.), 1–11 (in Russian).

Full details are given of the boiler which has an output of 935 t/h at 3750 psig and 1080 F. The plant is built up as a series of self-contained units of exceptional size.
C.E.B.G. Digest 1960, 12 (Dec. 3), 3169.

Boiler Blowdown. W. F. Gerrard. *Pwr. Wrks. Engng.* 1960, 55 (Nov.), 870–6.

The reasons for the necessity of blowing down boilers are explained. The various methods used for this and the determination of the amount to be blown down are described and illustrated by an example.

Liquid and Gaseous Fuel Firing

The Economic Combustion of Sulfur Containing Fuel Oil, a Means of Avoiding Dew Point Difficulties in Boiler Operation. F. Glaubitz. *Mitt. V.G.B.* No. 68 1960 (Oct.), 338–43 (in German).

Severe difficulties in the operation of boilers fired by heavy fuel oil with high S content could be overcome by redesign of the burners which resulted in rapid ignition and complete combustion with minimum excess air. Part of the air is introduced into the burner as core air, the larger part at high velocity parallel to the oil jet and without swirl to prevent the air from flowing away from the flame. The CO_2 content of the flue gas averages 15.3 per cent and the O_2 content 0.2–0.4 per cent. It has not been found necessary to use the soot blowers and steel shot cleaners; all heating surfaces including the tubular air preheater have remained clean.

Water-Side Corrosion and Water Treatment

Present-Day Feed-Water Treatment for High-Pressure Boilers. P. Hamer. *Proc. Inst. Mech. Engrs.* 1960, 174 No. 1, 69–94.

The quality of feedwater required by industrial boilers operating at 1000–2000 psi is discussed and present treatment methods described. The control of steam purity, concentration of salts and silica in the boiler is dealt with. Corrosion in high-pressure boilers and preventative measures are discussed, especially for boilers standing during erection and normal operation.

Possibilities of Application of Filter Aids in Water Treatment. H. Hannig. *Mitt. V.G.B.* No. 68 1960, (Oct.), 332–8 (in German).

The various filter aids, filter installations and their operation are discussed. Specially developed plants for mechanical filtration and removal of iron from water, removal of oil from condensate, reduction of organic substances from water by filter aids are described. Control of the filtrate is obtained by measuring the turbidity with an instrument based on the Tyndall effect.

Corrosion of Boiler Tubes Subjected to Temperature Changes. D. Ya. Kagan and L. S. Zhuravlev. *Teploenergetika* 1960 (Feb.), 60–7, *D.S.I.R. Transl.* RTS 1602.

Corrosion of tubes in the transition

zone from water to steam in Sulzer monotube boilers was found to be due to the destruction of the oxide film by sharp variations of wall temperatures during phase changes. Similar o[b]servations were made in Russian forc[e]d flow boilers.

Gas-Side Corrosion and Deposits

An Aspect of the Corrosion of Mild Steel by Combustion Gases. T. K. Ross, A. J. Macnab and B. E. Leyland. *J. Inst. Fuel* 1960, 33 (Nov.), 540–2.

The corrosion of mild steel by SO_2 in a reducing atmosphere above dew point with pure N_2 and added H_2 and O_2 has been studied. The scaling rates are expressed as a function of sulfur concentration and temperature.

Electro Precipitators: Practical Design Aspects. J. E. Sayers. *J. Inst. Fuel* 1960, 33 (Nov.), 542–50.

Precipitator performance factor, factors outside and under designer's control and designs for power stations and steel works are considered.

Considerations on the Usefulness of Application of Electrostatic Precipitators and Mechanical Fly Ash Separators Upstream or Downstream for the Cleaning of Flue Gases. R. F. Heinrich. *Mitt. V.G.B.* No. 68 1960, (Oct.), 322–32 (in German).

The changes in the composition of the fly ash over the years is traced and its effect on the separation efficiency of electrostatic precipitators based on studies carried out by Simon-Carves Ltd. described. Improvement in the separation efficiency by the installation of cyclone separators upstream or downstream of the precipitator is discussed; the decision which combination to employ will depend on the properties of the fly ash and local conditions. In many cases especially in new plants, better results will be obtained by using a multi-stage precipitator than a simple precipitator and cyclone combination.

Note: Experience with Shot-cleaning Equipment for Air Preheaters. A. C. Kjaer. *Inst. Fuel* 1960, 33 (Nov.), 553–4. Attempts were made in stoker-fired boilers with additional oil firing to overcome tubular air preheater clogging by either steam soot blowing or shot cleaning. The former increased dust emission and was abandoned, the latter with 3 × 2 h operation in each kept the heater clean when firing up to 10 per cent of oil on a Btu basis, but above this the shot became covered with sulfurous soot.

Note: Experience in the Cleaning of Economizers on Power Station Boilers by the Shot-cleaning Method. W. Board and J. P. Holmes. *J.*

Inst. Fuel 1960, **33** (Nov.), 554–8.

The shot-cleaning system and full automatic control gear at Battersea power station are described. It is estimated that the regular on-load cleaning of the economizer will lead to a fuel saving of 1.1 per cent.

Further Corrosion Tests on Materials in Regenerative Air Preheaters. J. F. Barkley, H. Karlsson and C. F. Stark. *U. S. Bureau of Mines.* Report No. 5471, 1959, 28 pp.

Field tests were made on the rate of corrosion of 30 materials used in air preheaters under regular operating conditions, and the buildup of deposits was observed. Twenty-three materials were tested with coal as the fuel on an underfeed stoker and seven with oil, including a short period with pulverized coal as fuel. The plant equipment is described, and pertinent plant operating data are tabulated.

From C.E.B.G. Digest 1960, **12** (Nov. 19), 3156.

Power Generation and Power Plant

Central Station Design Survey. Anon. *Power* 1960, **104** (Oct.), 161–72.

The annual review of units planned, under construction and starting operation. It is now predicted that capacity will grow at a rate of 5 per cent annually.

Industrial Plant Design Survey. Anon. *Power* 1960, **104** (Oct.), 89–108.

The annual review covers electrical systems, steam conditions, fuels and firing appliances, boiler and turbine sizes, controls, subdivided into plants over and below 150 psi. Combination gas and oil firing is still preferred, whilst coal firing by underfeed and spreader stoker declines. More small than larger boiler sizes are being installed and electric combustion controls are on the increase.

The Supercritical Power Station Unit Asserts Itself. K. Schröder. *B.W.K.* 1960, **12** (Nov.), 499–500 (in German).

A brief illustrated description of the unit in Breed power station originally rated at 450 mw and now uprated to 475 mw is given. The net heat rate is 8500 Btu/kwh, the thermal efficiency 40 per cent and the volume 12 cu ft³/kw. The orders for supercritical pressure units at Drakelow 'C' and Russian intentions of installing 28 300 mw units at 3356 psi and 1076/1050 F are discussed and American, British and German units in operation or on order tabulated giving output, pressure, temperature, turbine output and boiler suppliers.

Aberthaw Power Station. W. Wilde. *Proc. Sth Wales Inst. Engrs.* 1960, 75 (Oct.), 117–32.

The Aberthaw power station is designed for a capacity of 600 mw consisting of six 100 mw turbogenerator unit The single drum, natural circulation 755 klb/hr boilers are rated at 600 psig and 985 F reheat. The circulating water system, p.f. firing system, dust and ash handling plants, turbines, generators, feed water system, and electrical plant are described. The economy in space and cost effected by building larger units is indicated by tabular data and graphs. *From C.E.B.G. Digest* 1960, 12 Nov. 19), 3026.

Lorneuburg Power Station. Anon. *Engineer* 1960, 210 (Nov. 11), 815–6.

This power station on the banks of the Danube in Austria contains two 5 mw double-shaft gas turbines, red by natural gas; two waste-heat oilers fired by hot exhaust gases and additionally by oil or gas each supply 10 klb/h at 213 psi and 842 F to a ommon 25 mw turbogenerator. here is further a Benson boiler rated 530 klb/h at 1877 psi and 995/ 36 F to supply a 77 mw turbogen- ator; this boiler is also oil or gas ed.

Coal-Fired Thermal-Storage Boiler-ouse Anon. *Pwr. Wrks- Engng.* 960 (Nov.), 880–9.

At the British Oil and Cake Mills td.'s Olympia mills the highly fluctating steam demand is met by four- avelling grate stoker fired shell-type ilers each rated at 17,000 lb/h at 5 psi and 530 F, the water space ing large enough to allow a fall or e in the water level of 2–3 ft. The ntrols keep the pressure within ±1 i. Sootblowers are installed in the rnace, in front of the smoke box d behind the bridge wall of the oker. The flue gas are cleaned by a ction type grit arrestor and a secdary collector. The boiler ash is moved by ash extractor under each oker into a hydraulic system. The ilers are continuously blown down o a flash tank, the steam being used heat the feed water and condition e coal. The water is treated by culation, settling and filtration lowed by an ion starvation, base exange plant.

velopments in the U.S.S.R. Anon. *eld. Met. Fabr.* 1960, 28 (Nov.), 7–64.

Impressions of the welding art as cticed today in Russia are given ov a visit of a team of British erts. Of special interest have been progress in electroslag welding d automatic submerged arc welding.

Abstracts from the Technical Press—Abroad and Domestic

(Drawn from the Monthly Technical Bulletin, International Combustion, Ltd., London, W. C. 1)

ower Generation and Power lant

ligh Efficiency Boiler Plant at a evon Pottery Works. Anon. *Steam ngr.* 1960, **30** (Nov.). 47–52.

Candy and Co. Ltd. have installed a entrax boiler for providing 25001 b/hr f steam at 100 psi which is provided ith a Riley (IC) Type HL (high- w-off) burner which consists of a mall burner for lighting off and low oad and a large recirculating burner or full load. The oil (950 sec) is reheated to 220 F before being admitted to the burners which operate t a pressure of 300 psi. The oil eetering and control installation is lso described. The thermal efciency of the boiler is up to 85 per ent.

5 Mw Gas Turbine Alternator for eak Power. Anon. *Elect. Times* 960, **138** (Nov. 17), 255.

A 15 Mw gas turbine set is to be nstalled at Hams Hall for operation n the autumn of 1962. Fuel con- um n is estimated to be 0.752 lb/ wh.

merica's H.T.G.C.R. Anon. *Nucl. Energy* 1960, (Nov.), 539–41.

The reactor under construction at each Bottom and to be completed in 963 will have a thermal output of 115 Mw and an electrical output of 40 Mw nd produce 336 klb/hr of steam at 450 psi and 1000 F. The fuel is nriched uranium and thorium carbide ixed homogeneously with graphite n graphite sleeves. Coolant is helium at 20 at. pressure with an inlet emperature of 660 F and an outlet emperature of 1380 F. The overall et thermal efficiency is 34.8 per cent.

Materials and Manufacturing Processes

Cracking in Welded Joints of Austentic Steel in C.E.G.B. Power Stations. F. E. Asbury, B. Mitchell and L. H. Toft. *Brit. Weld. J.* 1960, **7** (Nov.), 567–78.

Examination of cracks in the heat-affected zones of welds of 18 per cent Cr–12 per cent Nb steel showed these to be in a hardened condition due to stra g and hardening by precipitation . niobium carbide leading to a reduction in ductility, particularly at low rates of straining.

The Heat-Affected Zone of Arc-Welded Iron. E. F. Nippes, W. F. Savage and W. A. Owczarski. *Weld. J.* 1960, **39** (Nov.), 465s–72s.

Based on the results of an investigation into the changes of microstructure and physical properties it is recommended to avoid fusion of the base metal because of the resulting embrittlement. Braze welding or arc welding with electrodes with melting points around 2000 F is suggested.

Particularities of Austenitic Transformation and Formulation of "Cold" Cracks in Fusion Welding. N. N. Rykaline and M. K. Chorchorov. *Soudage* 1960, **14** (Sept./Oct.), 335–47 (in French).

The structural changes in base and weld metal have been studied as a function of heating and cooling rates. Welding processes and conditions excluding any possible formation of "cold" cracks are indicated.

Creep in Steel. Technological Aspects of the Subject. J. D. Murray. *Iron and Coal Tr. Rev.* 1960, **181** (Nov. 4), 1007–13.

A review of recent investigations into the effect of various alloys on the creep resistance of steel.

Heat-resistance of Austenite Alloys Under Non-Stationary Test Conditions. L. B. Getsov and M. G. Taubina. *Teploenergetika* 1960, **7** (Sept.) 40–44 (in Russian).

The paper discusses the fatigue strength of two types of austenitic steel and two nickel-base alloys subjected to cyclic changes of temperature and stress up to 1550 F and 59500 psi. *C.E.G.B. abstract.*

Designing Very High-Pressure Steam Piping for Strength. A. V. Ratner and M. Ya Aristov. *Teploenergetika* 1960, **7** (Sept.) 44–9 (In Russian).

A description is given of an experimental determination of the compensating forces and bending moments in steam piping for steam up to 980 F and 3380 psig. Suggestions are made for a more accurate method of designing steam pipes for strength.

C.E.G.B. abstract.

High-Temperature Steel Welding Problems. Pt. II. E. Kauhausen, P. Kaesmacher and S. Sadowski. *Werkst und Betr.* 1960, **93** (Oct.), 238–43 (in English).

The second part deals with: (1) Fields of application and properties of austenitic steels; (2) Additional all-austenitic welding materials; (3) Formation and cause of cracks; (4) Welding; (5) Welded joints between ferritic and austenitic steels.

Welding of Nickel-Chromium-Iron Alloy for Nuclear Power Stations. C. E. Witherell. *Weld. J.* 1960, **39** (Nov.), 473s–8s.

For the welding of 15 per cent Cr–7 per cent Fe nickel alloy a new nickel-chromium-iron alloy electrode and inert-gas filler wire have been developed which produce crack-free and porosity-free welds in all positions. The electrode can be used also for welding the alloy to carbon and stainless steel.

Shop Fabrication for Hinkley Point. Anon. *Weld. Met. Fabr.* 1960, **28** (Nov.), 424–33.

The fabrication and welding of the pressure vessels, heat exchangers and diagrid are described including: (1) Inspection of plate material; (2) Pressing of plates; (3) Welding; (4) Fabrication of steam raising units; (5) Inspection; (6) Stress relief; (7) Fabrication of diagrid.

Shop Fabrication at Hinkley Point. Anon. *Weld. Met. Fabr.* 1960, 28 (Nov.), 434–47.

A detailed description of the assembly and welding of prefabricated parts of the pressure vessels and heat exchangers, inspection methods used and final installation is presented.

Instruments and Controls

Automation—Boiler Operation. G. W. Kessler. *Mech. Engng.* 1960, 82 (Nov.) 68–71.

Although it is known what is required of complete automatic control of boilers it is considered that computers presently available are not yet reliable enough and also very expensive to install and maintain. Computer programming, methods of automation, boiler design for automation and simulation of boiler automation are discussed.

Automation—Economic Justification. W. T. Hess. *Mech. Engng.* 1960, 82 (Nov.), 74–5.

Complete automation would increase safety and reliability, full and maintenance economy.

Flame Monitoring—Important Key to Unit Automation. Anon. *Power* 1960, 104 (Oct.), 151–4.

One of the most important items to be monitored in a power plant for reasons of safety of operation is flame failure. Various types of flame sensors are described. Equally important are flue gas and combustibles analysers to obtain early warning of the formation of an explosive mixture in the furnace. A combination of flame failure and flue gas analyser appears necessary for automatic control.

Pressure and Velocity Measurements on a Double-Venturi and a Standard-Venturi Orifice. W. Kühnel. *Energie* 1960, 12 (Oct.), 446–9 (in German).

The results of pressure and velocity measurements on a double and a standard venturi orifice and the influence of a length of pipe upstream are reproduced in curves. Simultaneously, the point of maximum negative pressure was located in both orifices.

Measurement of Flow Coefficients and Pressure Drop in Double-Venturi Orifices. R. Speer. *Energie* 1960, 12 (Oct.), 449–52 (in German).

Flow coefficients and pressure drop were measured in 5 double venturi orifices with opening ratios of largest to smallest diameter of 0.1, 0.255, 0.35, 0.475 and 0.6. The flow coefficients of the new orifices are 10–15 per cent lower than those of the original double venturi and it is thus

ossible to use larger opening ratios nd lower pressure drops. After a mall initial decrease of the coefficient nis remains constant over a large ange of Re numbers.

'he d Image Microscope. R. L. ;regory. *Research* 1960, 13 (Nov.), 22–7.

The general principles and design f the solid image microscope are de-cribed and possible applications dis-ussed.

luclear Energy

)ynamic Programming and Nuclear :eactor System Design. N. Kallay. *'ucl. Sci. Engng.* 1960, 8 (Oct.), 15–25.

Applications of dynamic program-ıing techniques to nuclear reactor ptimization problems are considered.

ome Aspects of Fluid Fuel Reactor)evelopment. A. M. Weinberg. *'ucl. Sci. Engng.* 1960, 8 (Oct.), 346–0.

A detailed review of the merits and isadvantages of fluid fueled reac-ors and the need for further experi-ıents to assess their value as breed-rs.

)ower Reactors—The Next Ten 'ears. F. K. Pittman and C. M. ;taebler. *Mech. Engng.* 1960, 82 Nc 76–9.

The development of nuclear reac-ors for power stations as seen by the '. S. Atomic Energy Commission is iscussed. The various types of re-ctors and their probable applicability re described.

;tructural Materials for Nuclear Re-.ctors. J. L. Bernard. *Tech. Mod.* 960, 52 (Oct.), 467–75 (in French).

The structural materials considered re those employed for the core, pipe-ines, heat exchangers, supports and truts and fuel element cans. The ntrinsic quality required for each ap-)lication (nuclear, mechanical), and he extrinsic quality (corrosion re-istance) and effects of irradiation are liscussed and French can design, velding of beryllium and zirconium .nd the production of fuel element lusters described.

)esign and Testing of Large Gas)ucts. A. T. Bowden and J. C.)rumm. *Proc. Inst. Mech. Engrs.* 960, 174, No. 3, 119–57.

The problems encountered in de-igning and testing large gas ducts for ıuclear reactors are outlined. The nos' economic way of meeting the ıee : high flexibility and low flow)ressure loss is discussed and the ;olution, a combination of tied expan-ıion bellows and cascaded corners, lescribed.

Fuel Element Shapes. Anon. *Elect. Times* 1960, **138** (Nov. 17), 769–70.

A summary is given of a paper by H. H. Gott, J. Brown and J. P. Bond presented to a symposium organized by the Inst. of Mech. Engineers in which the influence of heat transfer on the performance of gas-cooled power reactors was reviewed. Existing designs of fuel element cans for optimum transfer of heat from the core to the gaseous coolant were described and new designs outlined.

CANDU Fueling Costs—Breaking the 1-Million Kwhr Barrier. A. J. Mooradian and J. A. L. Robertson. *Nucleonics* 1960, **18** (Oct.), 60–6.

The design developments of the fuel elements for the NPD and CANDU reactors are described and the efforts made to reduce fabrication and operating costs are presented.

On-Power Refueling. J. S. Foster, W. M. Brown and H. E. Tilbe. *Nucleonics* 1960, **18** (Oct.), 66–8.

The refueling scheme and machines developed for the NPD and CANDU reactors are described.

Grinding, Screening and Filtering

A Study of the Size Reduction Mechanism of Swing Hammer Mills. T. G. Callcott. *J. Inst. Fuel* 1960, **33** (Nov.), 529–39.

From the evidence provided by high speed cinema photographs and other tests it is concluded that the hammers break the coal in a mild way and that near the gap between hammer tip and breaker bar the size reduction mechanism is a form of localized closed-circuit grinding.

Ni-Hard Grinding Balls Far Outlive Steel. R. H. T. Dixon. *Engineering* 1960, **190** (Nov. 4), 589–9.

Comparative tests of steel balls and those made of Ni-Hard (white cast iron with 4 per cent Ni and 2 per cent Cr, tempered for 4 h at 450 C and 4 h at 275 C) showed the latter to have a vastly superior life. It is claimed that Ni-Hard balls last more than 14 times longer than steel balls.

Analysis and Testing, Research

Code Testing of Large Boilers—Input—Output or Heat-Loss Method? J. A. Bostic and W. F. Long. *Combustion* 1960, **33** (Oct.), 34–7.

The two methods are compared and a new test code proposed. The new equations for calculating the efficiency by either method according to the new code are given. It is concluded that ash pit and radiation and convection losses should be more closely studied to arrive at more accurate figures.

Comparative Dew Point Measurements. H. Rögener. *Mitt. V.G.B.* No. 68, 1960 (Oct.), 343–7 (in German).

The measurements were carried out with 5 different instruments (2 of BCU design) in the flue gas duct of an oil fired boiler. Maximum difference of dew point temperatures was 5 F. None of the instruments is sufficiently accurate for present-day requirements and advice for their improvement is given. Improvements in measuring technique are also discussed.

Fractional Thermogravimetric Analysis. P. L. Waters. *Anal. Chem.* 1960, 32 (June), 852–8.

This method gives a continuous record of the tar and liquor, CO_2 and H_2S, heavier gaseous hydrocarbons and noncondensable gases evolved during carbonization. In a modified form the carbon and hydrogen evolving in volatile form can be determined and it is thus possible to calculate the average density of the gases evolved during decomposition.

Application of the Thermogravimetric Balance to Studies of the Pyrolysis of Solid Materials. P. L. Waters. *C.S.I.R.O. Coal Res.* Ref. T.C. 34, 1960 (July), 19 pp.

The method itself and its application to the determination of the rate of evolution and chemical composition of tar, liquor and gases evolved from coal on pyrolysis are described. The application to materials other than coal is discussed.

Steam Sampling in Russia. J. Jackson. *Engineering* 1960, 190 (Nov. 4), 627.

Russian methods are described and compared with American tests. The same conclusions are reached in both countries with regard to the best sampling point, i.e., where the steam leaves the drum.

Non-Destructive Testing in Power Plant Inspection. P. W. Sherwood. *Combustion* 1960, 33 (Oct.), 44–8.

It is shown that many of these methods can be successfully used in insp on work and would permit finding faults not detectable by previous methods. The practical application of these methods is outlined.

Combustion

DEVOTED TO THE ADVANCEMENT OF STEAM PLANT DESIGN AND OPERATION

volume 33 number 1 **July 1961**

olished monthly by COMBUSTION PUB- HING COMPANY, INC., 200 Madison e., New York 16. A SUBSIDIARY OF OMBUSTION ENGINEERING, INC.

ories McDonough, President

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OMBUSTION is sent gratis to engineers in U. S. A. in charge of steam plants from 000 lbs per hr capacity up; and to sulting engineers in this field. To others subscription rate, including postage, is in the United States, $5.50 in Canada, $8 n America and other countries. gle co.. Domestic, 40 cents, Foreign, cents plus postage. Copyright 1961 by bustion Publishing Company, Inc. Pub- ion Office, Easton, Pa. Issued the middle e month of publication.

epted as controlled circulation publication aston, Pa.

MBUSTION publishes its annual index in June issue and is indexed regularly by neering Index, Inc. and also in the ied Science & Technology Index.

magazine is now reproduced and dis- ted to libraries on microfilm by University ofilms of Ann Arbor, Michigan.

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COVER PHOTO

Striking night view of the Roy S. Nelson Station, Gulf States Utilities Co.

(Photo courtesy of Allis-Chalmers Electrical Review)

...m the Monthly Technical Bulletin, International Combustion, Ltd., London, W. C. 1)

...ces, Properties and

...al and Chemical Properties ... Structural Components of ... Coal. XI. X-ray Dif... Macerals and Maceral ... Kröger and G. Mues. *... Chemie* 1961, 42 (Feb.) 33–40 (*In German*).

...evaluation of the diffraction ... given new insight into the ... romatic lamellae, the per... distribution and proportion of ... macerals. The examina... the cokes has shown the rela... between temperature of coking ... and growth of the lamellae.

... Nitrogen in Coals. J. D. Brooks ... Smith. *C.S.I.R.O. Reprint* 1961, ...

A major proportion of the nitrogen in ... range of coals occurred in ... basic primary, secondary ... amine groups. These ... cyclic structures.

Mechanical Handling

... Protection Equipment for ... Handling System. H. W. Buus. *... Engng* 1961, 65 (Feb.) 72–4.

Equipment for removing tramp iron from ... conveyor belts prior to ... crushers or pulverisers is described ... the best way of installation dis... Charts for the selection of ... rectangular suspended magnets and ... permanent magnetic pulleys are pro...

... Generation and Power ...

... in Steam Cycles. B. Wood. *... Mech. Engrs* 1960, 174 No. ...

... of present knowledge of ... properties of wet steam and the ... and damage caused by it in ... water-steam cycle.

... Contributions from Nuclear ... to Engineering Practice. I. ... *J. Brit. Nucl. Energy Conf.* 1961, 6 (Jan.) 27–35.

... and design improvements ... pressure vessels made of steel and ... concrete are discussed. ... designs are outlined.

... Reinforced and Layer Built ... Vessels. P. J. Palmer. *... Weld J.* 1961, 8 (Feb.) 51–7.

... reinforced vessels the ... constructed from thin plates and carry only hoop load, in layer built vessels the bands are jointed by circumferential welds and carry longitudinal loads. The theories relating to these vessels and their merits are discussed. Design formulae are presented.

Lobed Pressure Vessels. J. P. Duncan and N. W. Murray. *Engineer* 1961, 211 (Feb. 3) 169–72.

A new form of pressure vessel is proposed consisting of a special frame, cage or three-dimensional structure from whose members spring three-dimensional membranes or domes. Experiments on models are described and the results of stress investigations presented.

Welded Boilers and Pressure Vessels. Anon. *Engineer* 1961, 211 (Jan. 27) 122–5.

Lengthy abstracts are given of two papers: 1. A Comparison of United States, Eureopean and British Commonwealth Codes for the Construction of Welded Boilers and Pressure Vessels by J. F. Lancaster; 2. Pressure Vessel Design Requirements in the Near Future by W. B. Carlson.

New Design of Tower Boilers. O. von Swietochowski. *Energie und Technik* 1961, 13 (Feb.) 59–61 (*In German*).

A single-pass tower design was chosen for a Benson boiler rated at 50 t/h at 127 atü and 500 C and pressurized cylindrical furance with a single burner in the centre of its floor because of the very restricted space available at a chemical factory. The steel chimney is placed on top of the boiler. The furance walls consist of helically wound evaporating tubes; at the top end of the furnace a square pass follows containing the final evaporator, superheater, economiser and tubular air preheater. The controls including starting are completely automatic. The heating surfaces are lined on the outside by a thin layer of chamotte and this surrounded by a leak-proof casing to avoid acid corrosion; escape of flue gases is prevented by air under pressure flowing between the inner and outer casing. A similar natural circulation boiler is under construction.

Design of Heat-Exchangers for Nuclear Plants. B. F. Ridal and J. H. Wilson. *Chem. Proc. Engng* 1961, 42 (Feb.) 55–8.

The difficulties involved in calculating the heat transfer surfaces required in steam raising plant for nuclear power stations by the exchange of heat by forced convection from hot gas to water and steam are discussed and some equations found useful in this respect are given.

Calculation of the Water Circulation in Natural Circulation Boilers. H. Sebulke. *Techn. Überw.* 1961, 2 (Feb.) 51–4 (*In German*).

A simplified method of calculating the circulation is presented in which a circulation diagram is used to determine the pressure difference at the inlet and outlet of the riser tubes as a function of the water velocity and heat uptake. From these values the water volume and conditions can be easily computed.

Preservice Cleaning of Power Plants. B. Tuck. *Brit. Pwr Engng* 1961, 2 (Feb.) 62–4.

The main reasons for preservice cleaning of boilers are the removal of welding slag, mill scale, silica, oil and grease and other foreign matter. The methods using 5 per cent hydrochloric acid suitably inhibited, sulphuric and/or citric acid and that developed by Siemens-Schuckertwerke in Germany are briefly outlined. Such cleaning has been carried out in the once-through boiler at Margam steel works and recently in a 120 Mw boiler at Rugeley station where the economizer, boiler, superheaters and reheaters, all feed water and steam lines, low and high pressure feed heaters, deaerator and tank and the condenser were included.

Refractory Performance in Oil-Fired Boilers. D. P. Peplow. *Brit. Pwr Engng* 1961, 2 (Feb.) 31–6.

Experience with various refractories in false bottoms and ignition belts of boilers at Marchwood and Poole stations has shown that those with high alumina content and high refractoriness have performed best, have a good spalling resistance and are least affected by oil ash. Hand ramming is preferred to gunning by giving a denser structure.

Flameless Combustion. Anon. *Chem. Proc.* 1961, 7 (Mar.) 18–9.

In this process for dealing with the waste liquor of pulp and paper mills a heated mixture of liquor and water is oxidized by compressed air at low temperatures (260–315 C) and pressures of 1400–1500 psi and the resulting steam and hot gases are passed to a turbine, whilst the liquid residue is fed to separators and heat exchangers to generate additional steam and hot water. The efficiency is stated to be up to 95 per cent.

Water-Side Corrosion and Water Treatment

The Development of Boiler Feed-Water Treatment—1. A. G. D. Emerson and F. R. Jarrett. *Steam Engineer* 1961, 30 (Feb.) 147–51.

An historical review outlining the reasons for water treatment and a description of the troubles experienced in the past, methods of treatment and testing and control.

Phosphate Water-Conditioning. Anon. *Pwr Wrks Engng* 1961, 56 (Feb.) 108–110.

A brief account of its advantages, methods of application, precautions, threshold treatment.

Corrosion Prevention by Water Treatment. Anon. *Fuel Efficiency* 1961, 9 (Feb.) 38.

Prevention of corrosion of evaporators, condensate lines and heat exchangers can be obtained by adding Hagafilm, an octade cyclamine to hot water at rates varying from 3.5 to 10 ppm. This agent has a dispersing action on iron oxide deposits and thus increases heat transfer; it also promotes dropwise condensation and keeps surfaces clean.

What Causes Corrosion in the Condenser Steam Space. R. A. Wilson. *Pwr Engng* 1961, 65 (Feb.) 57–9.

Ammonia is regarded as the main contributor to stress corrosion of Admiralty, aluminium, brass and copper alloys when oxygen, moisture and stress are present. Since these can never be entirely excluded the use of stainless tubes in condensers is advocated.

Gas-Side Corrosion and Deposits

Acid Deposition in Oil-Fired Boilers: Comparative Trials of Additives and Testing Techniques. P. A. Alexander, R. S. Fielder, P. J. Jackson, E. Raask and T. B. Williams. *J. Inst. Fuel* 1961, 34 (Feb.) 53–72.

The results of extensive tests with various additives at Bromborough and without additives at Ince power station are reported and discussed. It is concluded that: 1. Short-term methods of tests should include measurements of acid deposition rate and determination of sulfur oxides; 2. Excess air to be a minimum to suppress SO_3 formation; 3. Magnesium carbonate and zinc both to be considered in future trials and feeders made more reliable; 4. Injection of p.f. ash is effective only at SO_3 concentrations below 10 ppm; 5. Research into the relation of SO_3 formation and S content of the fuel to be instituted; 6. Research on the rôle of economizer and air heater deposits on the oxidation of SO_2 to be carried out.

Reactions of Magnesium with Inorganic Constituents of Heavy Fuel Oil and Characteristics of Compounds Formed. W. D. Niles and H. E. Sanders. *A.S.M.E. Preprint* No. 60-WA-278 1960, (Dec.) 8 pp.

After checking the literature on the sodium-vanadium-sulfur system the magnesium-vanadium-sulfur system was investigated and the compounds formed analyzed. Predictions of the compounds likely to be formed under operating conditions were made and checked against actual deposits in boiler and gas turbines. The influence of the SO_3 partial pressure and temperature on the type of compound formed is stressed.

Control of Sulfur Corrosion in Boilers. H. N. Wigan. *Fuel Effic.* 1961, 12 (Jan.) 50–2, 54.

After discussing the causes and measures of prevention of high and low temperature corrosion and deposit formation in small and medium sized oil and coal fired boilers the mode of action of Desulforol in admixture to fuel oil (1:1000) is explained. It affects the internal cohesion of the oil and thus improves atomization and combustion, retards oxidation of SO_2 to SO_3, neutralizes sulfuric acid vapor, reduces deposit formation and makes any deposits easily removable and also removes any scale already formed.

Mechanical Dust Collectors of Low and Medium Efficiency. R. Jackson. *B.C.U.R.A. Monthly Bull.* 1960, 24 (Aug./Sept.) 397–427.

The design, mode of action and efficiency of the following are reviewed: 1. Louvered dust arrestors; 2. Scroll type collectors; 3. Fan collectors; 4. Low loss swirl collectors.

Power Generation and Power Plant

The Electric Power Industry of China. Yu. M. Avsenel. *NLL Transl. Bull.* 1961, 3 (Mar.) 173–8.

Generation of electric power in China has increased by 963 per cent between 1949 and 1959 and some details are given of new installations, new transmission lines and future installations.

New South Wales Develops Coal-field Power Stations. Anon. *Elec. J.* 1961, 166 (Jan. 13) 110–1.

Brief details are given of future extensions to the Wangi, Tallawarra, Wallerawang and Vales Point steam power stations in New South Wales. The Wangi station has a present capacity of 270 Mw; this is to be increased to 330 Mw. The 120 Mw Tarrawarra station is to be increased to 320 Mw. The 120 Mw Wallerawang station is to be increased to 240 Mw by 1962. The first set of the Va-

Point station is to be commissioned in 1963 and the station will have an ultimate capacity of 1000 Mw.
From C.E.G.B. Digest 1961, **13** (Feb. 18) 457.

Fuel and Energy Required for Steelmaking by the VLN Converter Process. G. G. Fletcher and R. A. Pullen. *J. Inst. Fuel* 1961, **34** (Feb.) 46–52.

A detailed analysis of the various fuels or power required in the VLN (very low nitrogen) steel process is presented.

The Breen Plant Story. P. Sporn and S. N. Fiala. *Elect. Wrld* 1961, **155** (Jan. 16) 47–9.

New Boiler Concepts Meet High Expectations. G. W. Bice, P. H. Koch and E. M. Griffin. *Elect. Wrld* 1961, **155** (Jan. 16) 50–3.

The design of the supercritical boiler for Breed station rated at 3250 klb/h at 3500 psi and 1050/1050/1050 F is described and the reasons for various modifications outlined. The boiler is fired by eight 10 ft dia. cyclone furnaces in the front and rear wall and recirculated gas is introduced at the top of the lower furnace. This is followed by the upper furnace, convection section with the secondary superheater, primary superheater, reheaters and economizer in vertical arrangement. Three regenerative air preheaters are installed on top of the convection section. The boiler is of the outdoor type and pressure-fired. Details are also given of furnace design, membrane furnace wall design, start-up by-pass system and steam temperature control.

Heat Cycle Refinements Yield 8376 Btu Heat Rate at 480 Mw. T. T. Frankenberg and J. A. Tillinghast. *Elect. Wrld* 1961, **155** (Jan. 16) 58–61.

The various factors which have contributed to the exceptionally low heat rate are detailed.

Station Controls are Closely Coordinated. A. S. Grimes and W. S. Morgan. *Elect. Wrld* 1961, **155** (Jan. 16) 62–4.

The control system for the boiler and turbogenerator is outlined. The central control room contains also the controls for a substation, switchyard and coal handling plant and an analogue computer for calculating and monitoring thermal performance.

Clean-Up System Prevents Feedwater Contamination. E. B. Morris and A. G. Lloyd. *Elect. Wrld* 1961, **155** (Jan. 16) 65–7.

The cleaning of the boiler prior to start-up was carried out by using 3 per cent citric acid for the reheaters, alkaline phosphate solution followed by 5 per cent hydrochloric acid for the condenser and feedwater cycle and 3 per cent citric acid for the steam generator. The feedwater make-up and condensate treatment plant is described and feedwater specifications tabulated.

Piping Design Integrates Factors of Size, Stress and Material. G. E. Lien and A. J. Breugelmans. *Elect. Wrld* 1961, **155** (Jan. 16) 68–70.

Details of piping layout planning, stress calculations and materials used for main and reheated steam lines, feedwater, by-pass system and condensate are presented.

Semi-Outdoor Structure Houses 500 Mw Compactly. H. A. Kammer and E. A. Kammer. *Elect. Wrld* 1961, **155** (Jan. 16) 75–8.

By placing the boiler and bunkers outdoors and a semi-outdoor type of superstructure for the other plant the enclosed part is only 13.3 ft³/kw. The chimney has a height of 597 ft from base to top. Also described are: 1. Coal supply and handling arrangements; 2. Coal sampling and storage; 3. Cooling water supply.

Utilization of Blast Furance Gas in the Boilers of the Farciennes Power Station. J. Godfroid. *Votre Electr.* 1961, **31** (Nov.) 13–30 (*In French*).

The boilers are rated at 72–90 t/h at 75 atü and 500 C and are fired by a mixture of coal and blast furance gas, the ratio depending on the availability of the gas. The gas burner used in this installation, the automatic controls and safety measures are described. The efficiency of the boiler is 88.7 per cent on coal and 85.1 per cent on a gas-coal mixture.

The Colliery Steam Power Station of Farciennes to the East of Charleroi. J. Godfroit. *Votre Electr.* 1960, **31** (Nov.) 31–8 (*In French*).

For the utilization of the low-grade coal produced in the coal treatment plant, such as dust of high ash content, middlings and slurries the Farcienne power station has been built by a group of collieries. It contains at present a boiler rated at 290/350 t/h, 150 atü and 540/540 C and a 100/110 Mw turbogenerator. The boiler is provided with burners for pulverized coal and blast furance gas.

The Paradise Steam Plant of the TVA. J. C. Voorhees. *Civ. Engng* 1961, **56** (Feb.) 192–3.

The construction has started of this power station which will contain the largest units ordered so far. It will consist of 2 units each.

Abstracts from the Technical Press—Abroad and Domestic

(Drawn from the Monthly Technical Bulletin, International Combustion, Ltd., London, W. C. 1)

Fuels: Sources, Properties and Preparation

Getting the Best out of Coal. Anon. *Steam Engr.* 1960, 30 (Dec.), 75–80.

The papers presented at the Conference of the Combustion Engineering Conference at Harrogate, November 8 and 9, 1960 and the discussions are reviewed. These included: (1) Choosing the right coal by A. H. Slade: (2) Sampling of coal by R. C. Tomlinson; (3) Operating and Maintaining the Plant by F. L. Griffiths; (4) Choosing Plant, one by J. E. H. Moore and one by R. A. Kirby; (5) New Developments by G. G. Thurlow.

Coal to Make 750,000 kw. D. H. Gregg. *Pwr. Engng.* 1960, 64 (Nov.) 2–3.

The coal handling plant at the Thos. H. Allen power station on the bank of the Mississippi consists of twin unloading towers with a capacity of 1500 t/h each, a hopper of 900 t capacity, dual belts to the transfer tower, a traveling conveyor for stacking out two reclaiming hoppers and conveyors to the crusher house equipped with two crushers of 1200 t/h total capacity and two conveyors for filling the bunkers on opposite sides of the boilers (opposed cyclone fired). The control room is installed in the transfer tower containing a mimic bus and lights and bunker level indicators.

Coal Sampler Gets to Bottom of Heap. Anon. *Elect. Wrld.* 1960, 154 (Nov. 7), 57.

The sampler for taking representative samples from a loaded wagon consists of a hollow tube pneumatically driven to a predetermined depth when two hinged leaves close. After withdrawal of the tube the hinged leaves open, the sample is inspected visually and then sent to the laboratory.

Steam Generation and Power Production

Hydraulic Instability in a Natural Circulation Loop with Net Steam Generation at 1000 Psia. S. Levy and S. Beckjord. *ASME Preprint* No. HT-27 1960 (Aug.), 20 pp.

The causes of instability and the nature of the oscillations were studied. It is not yet possible to obtain a complete understanding of the phenomena from the test data.

Natural-Circulation Tests with Water at 800 to 2000 psia under Nonboiling, Local Boiling and Bulk Boiling Conditions. O. J. Mendler, A. S. Rathbun, N. E. Van Huff and A. Weiss. *ASME Preprint* No. 60-HT-36 1960 (Aug.), 17 pp.

Natural and forced circulation test data for a closed loop system are presented. No differences in results were found for forced and natural circulation. Flow fluctuations during natural circulation were observed before burnout heat flux was reached causing premature burnout in some cases.

A Variable Density Single-Fluid Model for Two-Phase Flow with Particular Reference to Steam-Water Flow S. G. Bankoff. *J. Heat Transf.* 1960. 82 (Nov.), 265–72.

Two equations have been derived making possible the prediction of the mean void fraction and frictional pressure drop for the flow of a steam-water mixture of known quality at a given pressure.

Influence of Different Fuels on Boiler Design. O. Engler. *Energie* 1960. 12 (Nov.), 482–6 (in German).

The following are illustrated and briefly described: (1) Benson boiler rated at 1100 klb/h at 2418 psi and 985/985 F, for brown coal with 15 per cent sand, roof fired, with horizontal low-level convection pass containing pendant superheater, reheater and economiser, followed by horizontal air preheater and precipitator; (2) New mixing burner with tangential coal and air inlets resulting in complete combustion with only traces of CO in the furnace: (3) Boiler with slag-tap furnace and opposed burners, tangent tubes with attached insulation and boiler casing; (4) Russian boiler insulation and casing attached to tube panels before erection; (5) Boilers with circular grate or inclined (Möring) stoker for coke firing; (6) Boiler for gas and oil firing with spring-steel band air preheater behind Ljungstrom preheater permitting cooling of flue gas below few point without corrosion; (7) Boiler for oil and sulphite lye: (8) Boiler with Martin stoker for refuse burning and slag-tap furnace for coal: (9) Boilers for blast furnace gas and oil or coal.

Oil Fired Corner-Tube Boilers. H. Oestreich. *Energie* 1960, 12 (Nov.), 494–8 (in German).

Examples of oil fired corner-tube boilers with and without superheater and of different size are illustrated. Burners may be installed in the roof, front wall or bottom of the furnace. The difficulties of designing boilers for alternative firing of coal and oil are discussed.

Superheater Supports Made of 40-60 Nickel Chromium Alloy Withstood Corrosion from Marine Fuel Oil Ash for Over 7000 h. Anon. *Chem. Proc.* 1960, 6 (Dec.), 6–7.

Superheater supports of 25 per cent Cr-12 per cent Ni iron base alloy had an effective life of 3000–4000 h while those made of a 60 per cent Cr-40 per cent Ni alloy showed little wastage after 7000 h and have a service life expectancy of 17,000 h.

New Chemical Cleaning Concepts and Possible Applications for the Future. C. M. Louks. *ASME Preprint* No. 60-WA-259 1960 (Dec.), 4 pp.

Chemical cleaning methods of boilers at present in use are discussed and possible new methods eliminating time-consuming processes and permitting cleaning of superheaters, reheaters and steam lines by non-condensed or vapor phases are indicated.

Chemical Cleaning with Citric Acid Solutions. W. E. Bell. *ASME Preprint* No. 60-WA-257 1960 (Dec.), 3 pp.

The removal of deposits such as scales and oxides by ammoniated 3 per cent citric acid solutions (pH 3–3.5) instead of citric acid is discussed; by using the ammoniated solution no ferrous acid citrate precipitation occurs as it does with citric acid.

Solid Fuel Firing

Progress in the Design of Mechanical Stokers. J. P .Lauder. *Engng. Boil. Ho. Rev.* 1960, **75** (Dec.), 399–404.

Recent improvements on mechanical stokers are described. In double-flue boilers with low-ram stoker a supplementary gear box has been added to one of the feeders which in conjunction with variable throw crank magnifies or reduces the movement of the other, or two motors are used to drive the feed mechanism and grate bars independently; grate bars are now made of chromium steel to B.S.S. 1648–1950 Grade "C"; a new side sealing plate prevents accumulation of clinker; a new ram with increased travel improves feeding of wet and small coal from the vertical-wall hopper; a newly designed screw-feeder for moving coal from the ground to bunker or hopper is described. For chain-grate stokers two methods of ensuring high-pressure combustion air being admitted at the front and low-pressure air at the rear by the "dual-zone" or "contraflow" stoker are outlined. A new control is applied to underfeed stokers to prevent smoke emission on starting and stopping; the air fan continues running for a while after the coal supply has been stopped and is started before feeding in green coal.

Liquid and Gaseous Fuel Firing

Influence of Combustion Conditions on the Dew Point of Flue Gases of Oil Fired Boilers. K. Cleve. *Energie* 1960, 12 (Nov.), 486–90 (in German).

Based on laboratory and field tests on boilers of different size and type of burners the relationships between dew point and excess air, load, primary air admission and uniform flow of oil to the burners are discussed. It is concluded that the minimum flue gas temperature is 250 F without additives but should preferably be 280–300 F. Minimum excess air and maximum CO_2 content of about 15 per cent should be aimed at.

New Insight into the Combustion of Sulphur Containing Fuel Oil. W. Hoffmann. *Energie* 1960, 12 (Nov.), 491–4 (in German).

Recent investigations by the aut and others lead to these conclusio (1) The SO_3 content of the flue does not depend on the S content the oil, it depends on combusti conditions and all factors influenc combustion; coarse atomization wi good mixing of air produces less S than fine atomization with bad mi ing; (2) The term sulfuric acid de point should be replaced by beg ning sulfuric acid deposition; (Corrosiveness depends on the amou of sulfuric acid formed during combu tion; no relationship exists betwe sulfuric acid content of the flue g and S content of the oil; (4) Chimne emission of smut and smoke is problem of burner and furnace desig

Furnaces and Combustion

The Influence of Volatile Matter the Combustion of Pulverized Coa J. F. Mullen and G. Gould. *ASM Preprint* No. 60-FU-3 1960 (Oct 4 pp.

The evolution, composition a ignition limits of volatile matter coals are considered in general a their effect on the combustion of p verized coals of different V.M. conte in particular. The appearance of fi tails, blow back, pulsating burners a high carbon losses is discussed as function of the release and ignition volatile matter and combustion co ditions.

The Cyclone Furnace. A. G. Rober *B.C.U.R.A. Monthly Bull.* 1960, (Apr./May), Pt. II, 205–54.

This review deals with: (1) Ma types of cyclone furnaces used f firing boilers: (2) Size of cyclone fu naces and cyclone-fired boilers; Commercial developments; (4) Co preparation and feeding; (5) R moval and disposal of slag; du emission; (6) Suitability of coals; Use of fuels other than coal; Power requirements for cyclone-fir boilers; (9) Maintenance and avai bility; (10) Safety; (11) Combu tion control; (12) Corrosion, erosi and deposition; (13) Cyclone fu naces for gas turbine cycles; (1 Other designs and applications of t cyclone furnace; (15) Combustio heat transfer and pressure drop in t cyclone furnace; (16) The prese position of cyclone firing.

Ten Years of Operating Experien of Opposed Burner Slag-tap Furnace K. Nuber. *Energie* 1960, 12 (Nov 479–82 (in German).

Experience has shown that boilers with this type of slagging f nace corrosion, erosion or deposit f mation has rarely occurred, especia since the introduction of a mix

ɔurner which has proved equally ɯitable for low and high volatile 5–50 per cent) coals. Soot blowers ɹnd steel shot cleaners were not re- ɥuired and have often been removed. ᑭartial load down to 30 per cent can ɛ ca ʅ with liquid slag removal. ɹsh r. ..tion is deliberately limited ɔ 50–65 per cent, the remaining fly ɹsh being used to keep the boiler ɔlean.

/ater-Side Corrosion and /ater Treatment

ıternal Corrosion of Power Station oilers. E. C. Potter. *Br. Pwr. ngng.* 1960, **1** (Dec.), 31–3.

A general survey of causes of corro- ɔn such as caustic cracking and ːygen pitting, failure of protective m and contributory factors, of ethods of detection of corrosion and eans to ensure freedom from corro- ɔn.

venty-First Annual Water Confer- ıce. Anon. *Combustion* 1960, **32** ɩov.), 46–50.

Brief abstracts of papers and dis- ssions on different aspects of feed ıter and condensate treatment and emical cleaning of boilers and nu- ·ar plants are presented.

ːe Conditioning and Control of ed Water in the High Pressure wer ˜tations of Electricité de ancı .. Rath. *Chal. et Ind.* 1960. (Nov.), 309–17 (in French).

The amounts of trisodium phos- ate and morpholine added to the ler feed water for boilers operating different pressures are tabulated ɩ compared with American and tish practice. Automatic control the feed water is supplemented by ular manual control.

ɜ Control and Measurement of drazine in Thermal Power Stations. Massart and L. Missa. *Centre ge d'Etude et de Doc. des Eaux ɩl,* Trim. 1960. III 162–70 (in nch).

ˋhe paper deals with the deteriora- ı of hydrazine, effect of the nature the salts in the water, the part ·ed by oxygen in air, prevention deterioration and dissociation of razine in a boiler, with reference ːhe results, given in the form of ɔhs, of observations on these mat- carried out at Awirs power sta- , Belgium. *C.E.G.B. Digest* 1961. .Jan. 21), 189.

·-Side Corrosion and Deposits

ct mmonia Injection on Cor- ɔn in Air Preheaters. R. Kato B. E. Paris. *ASME Preprint* No. VA-255 1960, (Dec.), 7 pp.

The first trials with ammonia injection into the flue gas of a pulverized coal fired boiler (320 klb/h, 840 psi, 850 F) at B.E. Morrow station are reported. The gas inlet and exit temperatures are 420 and 310 F, those of the air 105 and 280 F. The coal has an S content of 3.9–4.2 per cent. A constant temperature corrosion probe was used. By the use of ammonia at the rate of 0.06 per cent by weight of fuel corrosion at metal temperatures between 150 and 420 F was eliminated, but not below 150 F.

Flue Gas, Ash and Dust

Pulverized-Fuel Ash as a Structural Material. A. E. Williams. *Engng. Boil. Ho. Rev.* 1960, **75** (Dec.), 407–9.

Some examples of the use of fly ash replacing sand in concrete structures, in road construction, dams and building foundations are described.

Measures for the Reduction of Dust Emission in an Older Industrial Power Station. F. Bellendorf. *Energie* 1960, **12** (Nov.), 499–502 (in German).

In a power station built in 1938/41 containing 10 boilers generating a total of 1800 klb/h at 1850 psi and 932 F originally equipped with dry bottom but later converted to slag-tap furnaces the chimney (150 ft height) emitted excessive amounts of dust. Experiments were made with the installation of multi-cyclone separators before and behind the existing electrostatic precipitator. Although the tests showed that in this particular case the installation of the separator behind the precipitator gave better results and was easier to adopt because of the general layout of the plant it is concluded that this need not always be the case; only if the dust is very fine does this arrangement appear to be more successful.

Heat Recovery Plant

Thin Tube Plates for H.P. Heat Exchangers. Pt. I and II. D. E. Hartley. *Nucl. Engng.* 1960, **5** (Dec.), 557–60, 1961, **6** (Jan.), 8–11.

Although theoretical predictions would allow thin tube plates to be used it has been found in experimental investigations that it is in fact possible to do so without exceeding stress limits. Experimental evidence is presented which shows that thin tube plates are in fact stronger than predicted by theory.

Shell-and-Tube Heat Exchangers: Effect of By-Pass and Clearance Streams on the Main Stream Temperature. B. E. Short. *ASME Preprint* No. 60-HT-16 1960 (Aug.), 8 pp.

By-pass is the space between tubes and the shell and clearance space between the baffles and shell. The mixing of the stream flowing through these spaces with the main stream and the resultant temperatures of the mixed and the main stream are considered in their effect on heat transfer coefficient and pressure drop.

Performance of Stainless-Steel Condenser Tubes. R. H. Pell. *ASME Preprint* No. 60-WA-217 1960 (Dec.), 9 pp.

The excellent operating experience is described. Advantages are better heat transfer than expected, high corrosion and fouling resistance, tendency to self-cleaning and scouring, reduced erosion and wear.

Power Generation and Power Plant

Critical and Supercritical Steam Pressures. P. B. Silk. *Pwr. and Wrld. Engng.* 1960, **55** (Dec.), 939–42.

Subcritical, critical and supercritical steam cycles with and without reheat are compared and the gain in thermal efficiency, especially in large units, shown.

More Economical New Power Stations. K. Schröder. *Elektwirt* 1960, **59** (No. 20), 786–91 (in German).

Present preferred unit size is 100–250 mw with steam at 2400–2700 psi and 986–1050 F. Possibilities of reducing overall generating costs are discussed under: (1) Reduced specific heat consumption; (2) Decreased specific construction costs; (3) Savings in operational costs; (4) Favorable purchases of fuel. It is suggested that installation of supercritical pressure units would materially improve specific heat consumption and allow larger units to be constructed. Reduced capital costs would result from outdoor installation. It is not believed that increased automatic control would lead to a reduction of personnel.

A Decade of Electric Utility Fuel Experience. M. E. Robinson and W. J. Kurtz. *ASME Preprint No.* 60-FU-1 1960 (Oct.), 13 pp.

Statistical data are provided on the consumption and efficiency of consumption of coal, oil and gas in the various regions of the U.S.A. between 1949 and 1958. It is shown that the efficiency of burning coal expressed by Btu/kwh has increased more rapidly than that of oil and gas.

6th Steam Station Design Survey. L. A. Allen. *Elect. Wrld.* 1960, **154** (Nov. 21), 73–92.

Details of 72 new plants are tabulated. The trend is towards increase in size, temperature and pressure

Increased automatic control by computer is noted. As regards boilers divided furnaces are increasing, twin furnaces decreasing, pressurized firing of coal fired plants is increasing and also gas recirculation for superheat ntrol. No supercritical pressure c is planned.

System Expansion Fuel Costs Versus Capital. W. J. Fahrner and C. M. Heidel. *ASME Preprint* No. 60-WA-156 1960 (Dec.), 5 pp.

The procedure instituted by Detroit Edison Co. for making decisions on uture plant installation is based on a computer-type programme providing short-range and long-range system plans.

Thermal Stress Protection in Starting and Loading Boiler-Turbine-Generator Combinations. R. H. Reisinger and C. B. Scharp. *ASME Preprint* No. 60-PWR-3 1960 (Sept.), 8 pp.

Procedures developed for starting boiler-turbine units from cold and hot have been worked out to avoid thermal shock cracking.

Heat and Power Economy in Denmark. H. Reimer. *Energie* 1960, 12 Nov.), 459–72 (in German).

Denmark has 6 heat-power stations supplying electric energy to the towns and surrounding districts and heat hot-water) to consumers in the ow 60 stations supply heat only o t neighborhoods. Condensing power stations work in close collaboration with the 6 heat-power stations. These 6 stations, pipe lines, cost division between heat and power, house connections and costing methods for eat are described.

Energy Economy in Iron and Steel Works. R. Simon. *Energie* 1960, 12 Nov.), 472–8 (in German).

The development of energy-consumption in different types of iron and steel works is traced, supply of energy and from the works and losses, supply of blast furnace and coke-oven as to various consumers is discussed nd generation and consumption of electric power and preheated air described. Waste heat utilization, especially generation of steam has increased considerably in recent years.

entilation of Eddystone Station—An pproach to Ventilation of Modern team-Electric Generating Stations. J. Kowalski. *ASME Preprint* No. -WA-44 1960 (Dec.), 8 pp.

is suggested that ventilation of a oiler room should result in a heat ss of 1 per cent of coal burned with a m ture rise of 20–25 F and a turne om 0.9 per cent of generator ame plate rating with a rise of 15–20

Abstracts from the Technical Press—Abroad and Domestic

(Drawn from the Monthly Technical Bulletin, International Combustion, Ltd., London, W. C. 1)

Fuels: Sources, Properties and Preparation

Methane from Coal. F. J. Dent. *B.C.U.R.A. Quart. Gaz.* 1960, No. 42, 1–14.

The Ninth Coal Science Lecture in which the development of processes of complete gasification and the production of a gas of town gas quality was reviewed.

The Physical and Chemical Properties of Bituminous Coal Macerals. XII. Small Angle X-ray Scattering of the Macerals and their Cokes. C. Kröger and G. Mues. *Brennst-Chemie* 1961, **42** (Mar.), 77–83 (in German).

The inner surface of macerals and their cokes determined by X-ray scattering has been compared with that by the heat of wetting method; they are in good agreement.

Reducing Coal Degradation in Bunkers. Anon. *Iron and Coal Tr. Rev.* 1961, **182** (Apr. 21), 860–1.

An anti-breakage trunking forming a slot or rectangular channel down one side of the bunker is used to guide coal from the top to the outlet without pressure from the weight of the coal in the bunker causing degradation. The installation is specially recommended where a spiral chute is used for feeding the coal.

Steam Generation and Power Production

Acoustic Attenuation and Relaxation Phenomena in Steam at High Temperature and Pressure. D. D. Eden, R. B. Lindsay and H. Zink. *J. Engng. for Power* 1961, **83** (Jan.), 137–44.

Preliminary investigations were made with a fixed-path acoustic interferometer and steam of up to 450 C and 100 atm but the work done so far does not suggest a relaxation process which would have a significant bearing on high speed flow properties of steam.

Large Strains of Drum Heads Studied with Silicone Rubber Models. H. Fessler and J. J. Foreman. *J. Mech. Engng. Sci.* 1961, 3 (Mar.) 42–9.

The model experiments have shown that the effect of large strains on the bending moments in a drum head can be calculated if the relation between increase in head height and pressure has been determined and the bending moments for one pressure are known.

Efficiency of Coal-Fired Industrial Boilers. D. C. Gunn. *Engineering* 1961, **191** (Apr. 14), 534–5.

The tests were carried out on a vertical boiler rated at 4950 lb/hr and a horizontal boiler rated at 7000–9000 lb/hr and efficiencies with oil firing and coal firing (on a chain-grate stoker) compared. In the vertical boiler oil firing gave an efficiency of about 82 per cent, the best coal only 1.9 per cent less, in the horizontal boiler oil firing produced an efficiency of 84.9 per cent over a wide range of load whilst the best coal only 1 per cent less but over a much narrower range of load. This shows that with good coal almost the same high efficiency can be obtained as with oil if a modern appliance is used.

Thoughts on the Development of German Boiler Design since 19[illegible]. E. Duis. *Elektwirtsch.* 1961, **60** (M[illegible] 21), 183–91 (in German).

After a survey of general design trends, especially toward the forced flow boiler with high subcritical or supercritical steam pressure and temperatures around 1100 F examples of recent boiler design for larger power stations are described. Most of these are Benson boilers with outputs of 400–500 tons/hr, 190–210 atü and 535–545 C and slagging furnaces.

Post-War Development in British Water-Tube Boiler Design—II. K. R. Lenel. *Steam Engr.* 1961, 30 (Apr.), 225–30.

The second part mainly describes boilers for 30 and 60 Mw units as built in large numbers in the early post-war years. The two boilers with slagging furnaces for Padiham power station each rated at 860 klb/hr, 1600 psi and 1010/1005 F and a boiler rated at 830 klb/hr, 1600 psi and 1060 F for a 100 Mw unit at Castle Donington power station are also mentioned.

Some Dual Circulation Boilers. R. H. Paddon Row. *J. Inst. Fuel* 1961, **34** (Apr.), 143–52.

The reasons for introducing the dual-circulation boiler, definition of dual circulation and designs of such boilers are presented.

The Ejection of Water from a Tube Beyond the Critical Point of Water. E. M. Shchukin. *Energomashinostroenie* 1960, **6** (Dec.), 19–22 (in Russian).

The hydrodynamic parameters of a forced flow water-tube boiler are discussed from the point of view of hydrodynamic stability; a method is given for determining the minimum loading of the boiler. Various assemblies of screen panels are considered; graphs are given.

U.K.A.E.A. abstract.

From *C.E.G.B. Digest* 1961, **13** (April 15), 1069.

Lagging the Open-Air Boiler. Anon. *Pwr. Wrks. Engng.* 1961, **56** (Apr.), 295–9.

A system of boiler lagging has been developed which allows for the expansion and contraction of the boiler itself as well as the outside cladding under the effect of sun or cold winds. Particular attention has been paid to electrical insulation between outside aluminum sheets and steel lagging and cleading pins to prevent corrosion.

Solid Fuel Firing

Prevention of Low-Load Smoke from Spreader Stokers. R. B. Engdahl

nd W. A. Erion. *Coal Utiliz.* 1961, 5 (Mar.), 15–16.

Smoke emission at low loads is aused by excessive cooling of the rnace and can be prevented by reucing overfire air in proportion to the el f ' and all leakage of air into ie ı ace. Dust emission at low ads can be prevented by increasing ie fuel bed thickness as load is deeased.

quid and Gaseous Fuel Firing

tomization of Liquid Fuels for Comstion. P. Eisenklam. *J. Inst. uel* 1961, 34 (Apr.), 130–43.

Recent research has indicated that ass transfer (evaporation) has a ntrolling influence on atomization d the factors influencing rate of aporation of drops and sprays are nsidered. The mechanism of disingration of a liquid drop and means obtaining clouds of finely divided ops are discussed. Data on permance criteria of atomizers such flow rate, drop size and spatial nfiguration of the spray are preted.

naces and Combustion

plication of Flow Research to Instrial Furnaces with Particular Emsis on Soaking Pits. H. Boe-ke. *J. Iron and Steel Inst.* 1961, (A' ', 283–95.

ser. research into flow in fures by means of models and its lication to the design of industrial naces are described.

estigation of a Two-Chamber Cyie Furnace with Intersecting Jets. P. Kovalev and A. S. Ippolitov. *rgomashinostroenie* 1960, 6 (Nov.), 19 (in Russian).

model is used for studying the cts of velocity and composition of pulverized fuel on the motion near burner. The system has two jets.

U.K.A.E.A. abstract.

rom *C.E.G.B. Digest* 1961, 13 ril 15), 1086.

er-Side Corrosion and Water tment

Development of Boiler Feed er Treatment—III. A. G. D. rson and F. R. Jarrett. *Steam* . 1961, 30 (Apr.), 234–6

is last part deals with methods ater treatment for high pressure rs by evaporation and ion exge, respectively. Waters of low nedium solids content are prefertreated by demineralization, 's high solids content by ora. . followed by polishing in ixed-bed demineralizer. Final ment with hydrazine and/or ammonia is usual to prevent corrosion by traces of dissolved oxygen.

Gas-Side Corrosion and Deposits

Slurry Spraying for the Control of Corrosion and Deposits in Oil-Fired Boilers. W. F. Cantieri and R. E. Chappel. *ASME Preprint* No. 60-WA-284 1960 (Dec.), 8 pp.

Reduction of high temperature corrosion and deposit formation of boilers fired by oil with high vanadium, sulfur and sodium content by additives mixed with the fuel or injected through the burners or ports not having proved successful the spraying of a slurry of additive and water through soot-blowers on to the superheater and reheater surfaces has been tried out and found to make the deposits sintered, spongy and porous. The deposits fell to the furnace floor in pebbles which did not fuse. Superheater and reheater tubes of the boilers on which this method was tried out first showed no signs of corrosion although some hangers and supports were attacked. Altogether more than 40 boilers of Florida Power and Light Co. are now so treated.

Flue Gas, Ash and Dust

Key Point Inspection, Electrical Indicators Save Time on Fly-Ash Precipitator Maintenance. R. W. Sickles. *Combustion* 1961, 32 (Mar.), 30–2.

It is suggested that maintenance of electrostatic precipitators is often either neglected or done unnecessarily and that it is sufficient to inspect a few important parts and consult electrical records before deciding on a complete overhaul.

Power Generation

Power Stations Sites in the West Riding. Anon. *Engineer* 1961, 211 (Apr. 14), 611.

Two sites each suitable for a 2000 Mw power station have been found, one next to the existing Ferrybridge power station and the other at Eggborough, both on the river Aire. The Yorkshire coal fields would be able to provide the 5×10^6 tons of coal for each station. A third site on the river Aire at Gowdall is being investigated and another on the river Don near the Thorpe Marsh power station now under construction.

U.S.S.R. Plans Superpressure Plant. Anon. *Power* 1961, 104 (Apr.), 153.

A power station containing four units is being planned each consisting of a boiler rated at 3800 klb/hr at 4300 psi and 1060 F with double reheat to 1050 F and 600 Mw cross-com-

pound turbogenerator. Fuel is lignite with a C.V. of 5300 Btu/lb, 35 per cent moisture and 16 per cent ash and annual consumption will be 12 million ton. The overall thermal efficiency will reach 40–43 per cent.

Power Plant Developments by the Victoria State Electricity Commission. Anon. *Engng. Boil. Ho. Rev.* 1961, **76** (Apr.), 104–13.

The state of Victoria, Australia, possesses one of the largest known deposits of brown coal, of which at least 17,500 million ton can be economically won in large-scale workings. This brown coal is used to produce gas and briquettes and as fuel in power stations. The plant installed at Yallourn "A," "B," "C," "D" and "E" stations, Morwell and Hazelwood stations is described. A 330 kv link exists between this generating system and the Snowy Mountains hydroelectric scheme for the exchange of power between Victoria and New South-Wales.

Fuel and Energy Required for Steelmaking in the Open-Hearth Furnace. R. Mayorcas and I. H. McGregor. *J. Inst. Fuel* 1961, **34** (Apr.), 153–6.

Materials, oxygen and heat balances for the o.-h. furnace operating with different proportions of scrap and hot metal and when using oxygen are presented. The influence of waste heat utilization for steam generation on fuel efficiency is discussed.

Adapting the Arrighi Power Station to Firing by Natural Gas from Lacq: Control and Regulation Equipment. Pt. II. P. Boulogne and R. Becquet. *Tech. Mod.* 1961, 53 (Mar.), 95–103 (in French).

The electrical controls for the regulation of gas preheat, fuel and air valves, and the burners and flame failure devices are detailed. The operation of the controls when firing coal and gas separately and simultaneously is explained.

Power and Heat for Finland. Anon. *K.S.G. Register* 1961, No. 5, 7–22 (in German).

The new Hanasaari power station near Helsinki in Finland is at present equipped with a 75 Mw A.E.G. turbogenerator supplied with steam by a K.S.G. boiler rated at 550 klb/hr at 1860 psi and 995/995 F. The boiler is designed for the separate or simultaneous firing of pulverized coal, heavy fuel oil and town gas and contains tilting corner burners consisting of 3 oil burners between 4 coal burners, each oil burner flanked by two gas burners. The convection pass is divided into two damper controlled passes, one containing the primary superheater, the other the primary reheater. The secondary superheater is composed of the tubes lining the furnace roof, upper front and side walls of the furnace and finally the radiant tube platen superheater. The secondary reheater lies in the gas path from the furnace exit to the convection pass. The air preheater is of 3-pass cast-iron Kablitz design with a steam heated preheater in front to raise the air entry temperature. Soot blowers are installed in the upper part of the furnace and convection pass which also contains a steel-shot cleaner. The electrostatic precipitator has a bypass for use when only oil is fired. The thermal efficiency is 90–91 per cent when coal fired and 92 per cent when oil fired. Brief details are also given of a traveling grate fired boiler rated at 364 klb/hr at 1963 psi and 975 F for a cellulose works, a vertical-cyclone fired boiler rated at 44 klb/hr at 600 psi and 797 F for a nitrogen works and a pulverized coal fired boiler rated at 243 klb/hr at 1430 psi and 986 F for a cement works.

The Power Station Mannheim A.G. W. Ellrich. *Energie* 1961, **13** (Mar.), 112–6 (in German).

Station I of the year 1923 has a total capacity of 12.5 Mw with steam parameters of 284 psi and 680 F, is still operational and serves as a reserve. It also contains the first high pressure boilers ever installed in a power station, two boilers each rated at 132 lb/hr at 1430 psi and 887 F erected in 1927 which are kept as reserves until a new boiler is commissioned in 1962. Station II contains two natural circulation, single pass boilers with slagging furnaces each rated at 440 klb/hr at 2490 psi and 986 F with double reheating of the steam by superheated steam to 968 F. The steam is supplied to a 43 Mw topping turbine and after reheating to two 41 Mw turbogenerators; these turbines each drive a 33 Mw three-phase (50 c/s) and a 15–18 Mw single-phase ($16^2/_3$ c/s) generator. Surplus steam from station I at 270 psi is expanded in a 67.5 Mw condensing turbogenerator installed in station II. The net heat rate of station II with double reheating is only 9000 Btu/kwhr. A new boiler rated at 1060 klb/hr at 2500 psi and 1004/968 F fired by 4 horizontal cyclones is under construction to supply a 40 Mw topping turbogenerator and a 67.5 Mw condensing turbogenerator for 3-phase (50 c/s) and a 40 Mw condensing turbogenerator for single-phase ($16^2/_3$ c/s) operation. It is intended to continue the use of station I for peak loads and as a reserve because of its exceptionally low generating costs.

Piratininga, the Largest Thermal Power Station in South America. Anon. *Electrique* 1961, 36 (Jan.), 8–12 (in German).

To the two 80 Mw sets of the P- -ilian station have been added two 1 Mw sets with two 1000 F, 1740 psig boilers. Heavy oil for firing is pumped from the Petrobras refinery through a 40 km heated pipeline over a difference in level of 1150 ft.

From *C.E.G.B. Digest* 1961, 13 (April 15), 1057.

The Rheinhafen Steam Power Station Karlsruhe of the Badenwerk A.G. W. Leitner. *Energie* 1961, 13 (Mar.), 108–11 (in German).

This power station contains at present 3 units with a total capacity of 230 Mw; its ultimate capacity is 500 Mw. The first unit of 64 Mw is supplied by a Benson boiler with steam at 1635 psi and 975 F, the second 66 Mw unit by a Benson boiler with steam at 1635 psi and 1004 F and the third 100 Mw unit by a Benson boiler rated at 665 klb/hr at 2575 psi and 995/995 F; this latter boiler is provided with an 18-cornered slagging combustion chamber and 3 burners each in 6 corners, a regenerative and a plate-type air preheater to obtain a flue gas exit temperature of 266 F. Availability of the boilers has been 97–99% and the overall average net heat rate 10,300–9,600 Btu/kwhr.

At .ated Plant Has One Operator. L. R. Eddins and J. L. Warmack. *Elect. Wrld.* 1961, 155 (Apr. 3), 49–51, 84.

Riverside station of the Gulf States Utilities Co. is now employed for peak load duty and the installation of automatic controls has enabled the reduction of personnel from 14 to 1 man. The equipment for automatic starting, including burner ignition, operation and shutdown and the operation performed by each part are described.

Coal Flow for Power Generation. F. D. Cooper. *Coal Utiliz.* 1961, 15 (Mar.), 18–9.

At the H. B. Robinson station of Carolina Power and Light Co. a 182 Mw turbogenerator has been installed erved by a twin-furnace, controlled irculation boiler rated at 1350 klb/hr t 1900 psi and 1005/1005 F equipped vith 5 bowl mills of 45,500 lb/hr apacity each supplying 40 tangential orner burners. Coal is stored in 5 ilos with stainless steel bottoms and eccentric conical connectors and assed to the Easy-Flo Bituminous oal Research units with eccentric utl) the mills. Moisture of the oal has been up to 9 per cent but no old up has been experienced. The ation is controlled by a monitor and

computer supplied by 300 scanning points.

Plans for 580-Mw Unit Announced. Anon. *Elec. Wrld.* 1961, **155** (Mar. 27), 48. A 580 Mw unit with steam at 3500 psi and 1000/1025/1050 F is to be installed in the Tanners Creek station of the Indiana and Michigan Electric Co. to give it a total capacity of 1105 Mw. The unit is to be ready for commissioning in 1964.

TVA 900-Mw Equipment Contracts Are Resolved. Anon. *Elect. Wrld.* 1961, **155** (Mar. 27), 76.

TVA have announced award of an order to CE for a boiler rated at 6100 klb/hr at 2400 psi and 1050 F (with an option for a second boiler) to supply a 900 Mw cross-compound turbogenerator of which two are on order. The actual site has not yet been decided upon but the first unit is scheduled to be commissioned in 1964.

Should You Refrigerate Condenser Circulating Water? M. Bjorndal and A. Furreboe. *Pwr. Engng.* 1961, **65** (Mar.) 58–9.

It is suggested that by using a closed condenser circulating water system with evaporation refrigeration added about 50 per cent savings in capital cost, 50 per cent in pumping power and 4–5 per cent increase in thermal efficiency can be obtained. Evaporation of the refrigerant could be by waste heat in the flue gas, bleed steam or live steam. Two schemes are illustrated.

Instruments and Controls

Automation—The Application of Computers to Automatic Boiler Operation. G. W. Kessler. *Steam Engr.* 1961, **30** (Apr.), 221–4.

A review of the advantages to be derived by computer control of boiler operation and the programming of a computer for this particular purpose.

Central Control Rooms: Ideas Differ. B. G. A. Skrotzki. *Power* 1961, **104** (Apr.), 61–5.

Present opinions on control room location, layout and equipment differ so widely that it is not possible to establish a clear trend.

400-Channel Digital Recorder. Anon. *Chem. Proc.* 1961, **7** (Apr.), 38–9.

This instrument has been installed at Geertruidenberg power station near Rotterdam to scan 350 temperatures from 20 to 700 C and 50 other instruments. The input signal is compared with a reference value and if outside set limits an alarm is given. At certain intervals or by push-button

command the printer records one complete scan of the 400 channels. A similar instrument is to be installed in a Polish power station.

Services at a Large Chemical Works. Anc *Pwr. Wrks. Engng.* 1961, 56 (Apr.), 310–7.

Continuous increase in demand for steam made the replacement of several older boilers at the Clayton Aniline Co. Ltd. works imperative. In a new boilerhouse three water-tube boilers each rated at 75/90 klb/hr at 625 psi and 800 F equipped with I.C.L. type L traveling grate were installed to supply two 5500 kw back-pressure (60 psi) turbogenerators. The exhaust steam is passed to the process mains, the high-pressure feed heater and after reduction to 15 psi, to the direct-contact feed heaters and deaerators.

Centrifugal Air Compressors Fill Needs of Large Central Generating Stations. M. Ragsdale. *Power* 1961, 104 (Apr.), 82–4.

The advantages of centrifugal air compressors for providing air for soot blowers, pneumatic instruments and controls and general services are outlined and a few recent installations in power stations described.

Nuclear Energy

Gas Cleaning in Nuclear Plants. H. U. Kohrt. *Chem. Ing. Tech.* 1961, 33 (Mar.), 135–8 (in German).

The various processes of cleaning gas containing radioactive solid or liquid particles are discussed with regard to their suitability and separation efficiency. Filters made of various materials, -2-stage electrostatic precipitators, drying processes, absorption or adsorption on activated carbon and molecular sieves and their application are described.

Pressurized Subcritical Facility. E. J. Hennelly. *Nucleonics* 1961, 19 (Mar.), 104–5.

To obtain higher moderator temperatures Savannah River Laboratory have installed a subcritical facility with self-pressurizing tank heated by steam coils to 215 C. Details of design and construction are given.

Ceramics-Thermal Conductivity. G. Arthur. *Nucl. Engng.* 1961, 6 (Apr.), 138–42.

The increasing importance of ceramics in the production of fuel elements, moderators and structural elements is discussed and their densities, melting points, thermal neutron cross sections and thermal conductivity values of interest in reactor technology tabulated. Ways of increasing the conductivity are described.

(Drawn from the Monthly Technical Bulletin, International Combustion, Ltd., London, W. C. 1)

Fuels: Sources, Properties and Preparation

Liberation of Pyrite from Steam Coals. R. A. Glen and R. D. Harris. *Amer. Power Conf. Paper* 1961, (Mar.), 26 pp.

Research into the possibilities of reducing the S content of coals of high S content has shown that the major portion of the pyrite exists as particles large enough to be separated after liberation. The major portion is associated with the mineral matter and can be separated by coarse pulverizing. The microscopic particles embedded in the coal substance tend to concentrate in the fine fractions below −200 mesh and further research is required into separating techniques for these small fractions.

The Oxidation of Bituminous Coals during Storage and its Prevention. W. Radmacher and A. Hoverath. *Brennst Chemie* 1961, **42** (Apr.), 97–108 (in German).

The investigations have shown that in the storage of: (1) large coals, the danger of autoignition is very small since the air passing through cools the coal below the ignition point; (2) small coals, autoignition may occur but rarely does the oxidation proceed to the point of ignition; boreholes to increase ventilation are recommended where the rise of temperature appears dangerous; (3) fine, uncompacted coals are most liable to autoignition but the maximum autoignition temperature can be forecast by measurement of gas composition and temperature; (4) fine, compacted coal is not liable to autoignition because of the lack of oxygen. Changes in the caking and coking properties of these coals can be slowed up by compaction.

Modern Ore and Coal Handling Installation in the Amsterdam West Harbour. W. Golawski. *Fördern und Heben* 1961, (*Special Hanover Fair Edition*), 183–91.

A split stockyard served by a conveyor bridge for stocking and a grab-equipped transporter for reclaiming has been added to the earlier installation. This permits the simultaneous loading and unloading of ocean-going ships and barges, railway wagons or lorries. A shuttle platform allows both transporters to work on one or the other side of the stockyard or separately. The stockyard area allows the storage of several million tons of ore and coal and can be further extended if required later on. The description includes the conveyor and transporter, transfer and return stations, hopper and tripper cars and the control system which requires only two operators.

Potomic Electric Spends $195 Million to Meet Rapid Rise in Power Demand. Anon. *Link-Belt News* 1961, **28** (Jan./Feb.), 1–3.

The coal handling at Dickerson power station containing two 185 MW units is described. It consists of a rotary car damper (1 car every 3 min.) discharging into a track hopper, two 54 in. conveyor belts to the crusher house (750 t/h capacity), the crusher house with a breaker reducing coal to minus $1^1/_2$ and a sampler, a 54 in. conveyor discharging either to the power plant conveyor or to a stocking out stationary boom conveyor.

Coal Handling Trials with Special-purpose Dozer Blades. Anon. *Mech. Handl.* 1961, **48** (May), 270–1.

Stocking out and reclaiming tests with a specially designed blade of U-shape were carried out at Brighton "B" power station and the results are tabulated.

Air Panels Keep $^1/_4$-in. × 0 Coal Moving in Bunker. R. J. Brandon. *Elect. Wrld.* 1961, **155** (Apr. 24), 78.

Inflatable neoprene panels have been installed in the bunkers of St. Clair Power plant to prevent sticking, hanging-up and arching of the coal and were found in excellent conditions after a whole year's service. Six panels are installed on the sloping sides of each bunker and operated sequentially and continuously as long as the drag feeder below the bunker is working.

Heat: Cycles and Transmission

Thermodynamics. J. M. Smith. *Ind. Engng. Chem.* 1961, **53** (Apr.), 315–8.

The annual review of literature published during 1960.

Effect of the Rate of Circulation on the Coefficient of Heat Emission on Boiling in Tubes. S. S. Kutateladze. *Energomashinostroenie* 1961, **7** (Jan.), 12–15 (in Russian).

A simple interpolated formula for calculating the joint effect of forced convection and the evaporation process on the intensity of heat emission is suggested. *C.E.G.B. abstract*

Steam Generation and Power Production

Phase Transition in the Supercritical Region and the Inversion Curve. D. D. Kalafati. *Teploenergetika* 1961, **8** (Jan.), 72–8 (in Russian).

The conditions of phase transition in the supercritical region are considered, the inversion curve of real gases and the line of maxima of the derivative are examined. The combined analysis of lines of phase transition and the inversion curve are discussed. Twenty references are given. *C.E.G.B. abstract*

Steam Generators. K. Cleve. *B.W.K.* 1961, **13** (Apr.), 163–4 (in German).

The largest boilers being built at present have a capacity of 500 t/h with steam temperatures rarely exceeding 535 C. Natural circulation boilers have design steam pressures up

to 190 atü, forced flow boilers up to 250 atü. Thermal efficiencies are around 92 per cent. Model tests are being used increasingly to determine the optimum design of boilers.

The Design of Steam Boilers with Stagewise Evaporation. J. Jackson. *Pwr. Engng.* 1961, 2 (May), 29–33.

This is a translation from the Russian of parts of a book entitled "Modern Boiler Units" giving the reasons for the introduction of this system of steam generation and some examples of recent developments.

A Pre-Engineered Standard Steam Generator Series. D. A. Cassino. *Heat Engng.* 1961, 36 (Jan./Feb.), 8–11.

Four standard series of water-tube boilers are described: (1) SC contains 12 sizes of liquid or gaseous fuel fired boilers up to 200 klb/h, 1500 psi and 900 F; (2) SD consists of 8 sizes up to 500 klb/h, 1500 psi and 950 F, also oil or gas fired; (3) SE of 10 sizes of pulverized coal-fired boilers up to 200 klb/h at 1500 psi and 900 F; (4) SF with 8 sizes up to 500 klb/h, 1500 psi and 950 F, also pulverized coal fired.

The Removal of Silicic Acid from New Boilers. T. Samuel. *Mitt. V.G.B.* No. 71 1961, (Apr.), 104–8 (in German).

Tests on a new experimental boiler of the Centre Belge d'Etude et Documentation des Eaux (CEBEDEAU) have shown alkaline treatment with various hydroxides and phosphates did not result in a rapid removal of SiO_2 but acid treatment was very effective. Thorough flushing of the boiler after acid treatment is imperative to remove any remaining traces of SiO_2. The SiO_2 content of boiler water is a function of pressure and heat release rate. The distribution coefficients of SiO_2 in the water and steam were 30–40 per cent lower than those in the published literature.

Solid Fuel Firing

Bituminous Coal Firing. A. Sifrin. *B.W.K.* 1961, 13 (Apr.), 165–6 (in German).

About 86 per cent of all boilers above 100 t/h ordered in Germany in 1960 had slagging furnaces, those above 400 t/h exclusively slagging furnaces. New burners have been developed with fewer but higher velocity secondary air jets to obtain better mixing and combustion, the velocity being kept constant at all loads. Burners are now also available for firing a wide variety of coals. About 16 per cent of all boilers ordered can be fired by coal and oil simultaneously or separately.

Brown Coal Firing. A. Frenzke. *B.W.K.* 1961, 13 (Apr.), 166–8 (in German).

Little change is reported in the design of boilers and burners, but in mills there is a trend toward those without classifiers and burning out grates under the furnace hoppers. A new beater mill with increased output and reduced wear by improvement of the axial suction design has been developed and proved highly successful.

Further Development of Burners for the Vertical Cyclone. H. Hülsmeyer. *Mitt. V.G.B.* No. 71 1961, (Apr.), 128–30 (in German).

The original burner design having proved unsatisfactory mainly because of the multiple subdivision of the secondary air and the resulting existence of points of excess and deficiency of air various changes of design were tried out. In the first, air ports with pivoted dampers were arranged at the side of each burner which was also provided with mantle air; the effect of the pivoted dampers was thus small. In the second, burners and secondary air ports were both arranged tangentially but the ignition delay caused considerable erosion of furnace tubes. In the third, the burners of the two mills were arranged not vertically as before but side by side and in the direction of a secant to the tangentially arranged secondary air ports so that the secondary air meets the coal about 1 m behind the exit. This has led to a uniform furnace atmosphere, a dew point of the flue gas of about 113 F, low load operation down to 35 per cent of full load, increased ash retention and reduced wear and warping of burners and air nozzles. The burning of coke with a temperature of 1,560–1,650 F had to be abandoned because of excessive tube erosion.

Liquid and Gaseous Fuel Firing

Oil Firing. T. Geissler. *B.W.K.* 1961, 13 (Apr.), 168–70 (in German).

Despite the introduction of a fuel oil tax in Germany in 1960 the consumption has increased by 30 per cent. Boilers fired with oil only rarely exceed 100 t/h but in many boilers oil firing has been added to support ignition of low grade fuels. Means against high-temperature corrosion by V_2O_5 have not been found but against low-temperature corrosion magnesite has proved superior to dolomite.

Furnaces and Combustion

Advances in Combustion. M. W. Thring. *Brit. Pwr. Engng.* 1961, 2 (May), 24–8.

After complaining about the un-

willingness of British industry to support research and exploit its findings and citing various examples (Benson and La Mont boilers, etc.). lines of development for coal burning in domestic, central-heating and small industrial appliances, kilns, pulverized coal fired furnaces and cyclone furnaces, oil and gas firing are outlined. Improvements in steel and iron making based on recent research are described. Possibilities of direct electricity generation are discussed.

Preventing Furnace Explosions. Pt. 3. W. L. Livingston and P. Gray. *Amer. Power Conf. Paper* 1961, (Mar.), 9 pp.

A practical protection philosophy is presented which describes and defines the unique service ideal flame detection can provide. The general application of presently available flame sensors and their relationship to this ideal is discussed.

Water-Side Corrosion and Water Treatment

New Clues in the Boiler Tube Pitting Puzzle. F. E. Clarke and A. J. Ristaino. *1st Internat. Congr. Met. Corros. Paper No. V*, London 1961, (Apr.), 129–33.

Remarkably similar boiler pits can result from entirely different corrosion mechanisms. Dissolved air pitting is confined primarily to heavily aerated condensing systems and idle boilers. High temperature chemical pitting that requires no free oxygen appears to predominate in steaming boilers. No known practicable chemical treatment will control corrosion adequately in a cold partially filled boiler. Alkaline phosphate solution localizes attack, the extent of damage increasing with increase in chloride ion content. Sodium sulfite treatment is better since it prevents pitting of submerged areas and yields sodium sulfate which tends to inhibit caustic attack under sludges. The effect of dissolved oxygen in steaming boilers probably is small, but has not yet been thoroughly assessed.
From C.E.G.B. Digest 1961, 13 (May 13), 1343.

Behavior of Stainless Steels and Other Engineering Alloys in Hot Ammonia Atmospheres. J. J. Moran, J. R. Mihalisin and E. N. Skinner. *Corrosion* 1961, 17 (Apr.), 115–9.

Nickel-base alloys were more resistant to nitrogen attack than alloy richer in iron and chromium.

Composition of Corrosion Products Formed on Metals in Steam Condensate. R. D. Eberhardt, E. W. Arneson and C. E. Imhoff. *Corrosion* 1961, 17 (Apr.), 95–6.

Admiralty metal, Muntz metal, aluminum 35 and zinc in condensate with a pH of 5.1 to 9.6 and temperatures of 100 and 212 F was studied. On steel and cast iron magnetite and basic ferric oxides formed, on Admiralty and Muntz metal cuprite at a pH of 6 or below, on zinc oxides over the whole pH range.

Corrosion of Metals by Weak Acids under Heat Transfer Conditions. N. D. Groves, C. M. Eisenbrown and L. R. Scharfstein. *Corrosion* 1961, 17 (Apr.), 97–100.

Various stainless steels, Inconel and Monel were exposed to acids differing in concentration at temperatures between 230 and 284 F. Carpenter No. 20-Cb and Hastelloy were most resistant, Monel's resistance decreased with increasing temperature.

Operational Experience with Hydrazine Hydrate in a Steam Power Station. G. Gutperle. *Mitt. V.G.B.* No. 71 1961, (Apr.), 136–7 (in German).

Since the introduction of hydrazine the contents of iron and copper in the condensate have been much reduced, corrosion on feed pumps and feed heaters has ceased, deposits on tubes and slurry in the drums do no longer occur so that it is not necessary to use blow-down. In consequence the make-up required has been reduced to 1 per cent. If the boilers are to be stopped for up to 30 h the N_2H_4 injection is increased to 0.7–0.8 mg/l, for longer periods to 10–15 mg/l with subsequent addition and circulation of the water to keep up a N_2H_4 excess. The savings have far exceeded the cost of the N_2H_4.

The Use of Condensed Phosphates as Protection against Corrosion and Scale Formation in Hot Water Pipelines. E. Herre. *Mitt. V.G.B.* No. 71 1961, (Apr.), 90–8 (in German).

Tests with a number of condensed phosphates have shown that disodium phosphate, tripolyphosphate, hexametaphosphate and their mixtures form a fast adhering, nonporous protective layer provided that the water temperature does not exceed 75 C (167 F), formation of air bubbles is avoided and the pipelines are not corroded already. The admixture of metasilicates is not recommended.

Gas-Side Corrosion and Deposits

How Coal Properties relate to Corrosion of High Temperature Boiler Surfaces. J. T. Reese, J. Jonakin and G. Koopman. *Amer. Power Conf. Paper* 1961, (Mar.), 5 pp.

Tests of five boilers of identical design and operating conditions with 5 different coals using corrosion probes have shown that water-soluble alkalis and their molar ratio are the only coal properties which appear to be critical factors in deposit-type corrosion.

Elevated Temperature Corrosion of Type 310 Stainless Steel by Vanadium Compounds. H. L. Logan. *Corrosion* 1961, 17 (Apr.), 109–11.

Catastrophic attack by a mixture of 67 wt. per cent V_2O_5 + 33 wt. per cent of $NaVO_3$ occurred at temperatures of 1900–2000 F if the steel had previously been oxidized and air and water vapor were present. An investigation of the slag suggests that nickel is selectively absorbed by the slag prior to the general attack.

Power Generation and Power Plant

District Heating and Heat Power Stations. F. H. Ebert. *B.W.K.* 1961, 13 (Apr.), 159–61 (in German).

Demand for supply of heat by district heating continues to increase in Germany and several new combined heat and power stations are commissioned, under construction or planned. In the Oberhausen heat power station a coal fired hot air turbine has been started up, near Hanover an extraction-condensing station is being built to supply heat to the whole inner part of the town, in Mannheim and network is being enlarged to supply more customers and in Munich a large plant is under construction to supply an industrial area, new suburb and hospitals containing natural gas fired turbines with heat exchangers and waste heat boilers. Near Cologne a plant for supplying heat to a new suburb is to be fired with pulverized coal supplied in tank wagons. In several towns refuse burning plants are being planned in conjunction with district heating.

Initial Operation of Avon No. 8. A Supercritical Plant. N. F. Gill and N. D. Flack. *Amer. Power Conf. Paper* 1961, (Mar.), 21 pp.

Performance availability, problems encountered and solved and findings during a complete overhaul are described. The economics of a supercritical unit are compared with that of a subcritical unit.

Supercritical Boiler Operating Experience at Avon No. 8. J. I. Argersinger and G. C. Smith. *Amer. Power Conf. Paper* 1961, (Mar.), 15 pp.

The description includes: (1) boiler design and operation; (2) boiler construction; (3) performance; (4) problems; (5) special components; (6) controls.

Generator Unit. C. C. Franck and J. A. Carlson. *Amer. Power Conf. Paper* 1961, (Mar.), 18 pp.

The design of this 250 Mw unit operating at 22 kv, 0.85 p.f. and 45 psi hydrogen pressure with internal cooling of the stator through vent tubes and the rotor through the conductors is described. The turbine control system, starting procedure and loading procedure are outlined. A few problems which occurred during operation are discussed.

The Water and Steam Circuits of the Reheat Boiler-Turbine Unit at the Drogenbos P/S., Belgium. M. Schouls and F. Decelle. *Votre Electricité* 1961, 32 (Feb.), 21–32 (in French).

Results are given of observations made during four years operation of the Babcock and Wilcox 210 t/h, 1500 p.s.i.g., 1000 F (reheat 985 F) p.f.f. boiler and the Brown Boveri 62 Mw reheat turbine. The method, developed over a number of years for low-pressure units, of feeding very pure untreated water without the addition of hydrazine or morpholine has been applied to the reheat unit. Make-up water is obtained from blow-down from the m.p. and h.p. sections. *C.E.G.B. Digest* 1961, 13 (May 27), 1505.

Ellund. Anon. *Elect. Rev.* 1961, 168 (May 5), 783–5.

This station recently commissioned officially contains 3 units of 60 Mw output and as an overall efficiency of 30.17 per cent and a cost of electricity sent out of 0.407 d/k wh. The boiler of one unit is of two-drum design with corner-fired furnace and tilting burners for superheat control, the boilers of the other two units have a single drum, burners in the front wall and superheat control by dampers regulating the flow of flue gas over the primary superheater. All three boilers are also provided with spray desuperheaters for final steam temperature control. Steam conditions at t.s.v. are 900 psi and 900 F. Furnace hopper and fly ash are removed hydraulically. Condenser cooling water is either provided by the river Calder or by 2 cooling towers. The turbines are of the 2-cylinder type, the generators hydrogen cooled at 15 psi.

Ground Broken for APS 350 MW Plant. Anon. *Elect. Wrld.* 1961, 155 (Apr. 10), 38.

The Four Corners plant of the Arizona Public Service Co. is located on a coal field in the Navajo reservation and will contain two units each of a boiler rated at 1270 klb/h at 1925 psi and 1005 F and a 175 Mw turbo

4200 t/day. An artificial lake of 1200 acre will supply condenser cooling water. The station is to be commissioned in 1963.

Expansion at Oak Creek. F. M. [illegible]rton. *Heat Engng.* 1961, **36** (Jan./[illegible]), 2–7.

Unit 5 of the Oak Creel station of Wisconsin Electric Power Co. is rated at 275 Mw and served by a boiler of 1780 klb/h output at 2425 psi and 1050/1000 F with feedwater at 488 F. The furnace is L-shaped with 16 intervane burners in the roof of the horizontal part of the L served by two ball mill pulverizers; the single furnace is divided into four cells by water-cooled division walls. The all-radiant reheater constitutes furnace side and rear walls, the radiant superheater part of the rear wall and the division walls, the convection superheater of the pendant type being installed in the transition pass, while the second pass contains boiler convection surfaces. The economizer, boiler and convection superheater are supported at the top and expand downwards, the waterwalls, radiant superheater and reheater are anchored at the bottom and expand upwards, being kept in tension by springs.

Materials and Manufacturing Processes

Choice of Materials for Service at [illegible] Pressures. A. V. Ratner and [illegible]. Leonova. *Teploenergetika* 1960, **7** (Dec.), 14–8 (in Russian).

The article is concerned with the choice of materials for the component parts of accessories for service at high pressures and super pressures, and subject to wear. The results are given of an investigation of materials provided with different forms of hardening (boriding, nitriding, sulphiding) and also metals built-up with hard alloys. The use of one or other form is recommended for accessory flaps and spindles. Ten references are given. (A.E.I. abstract).

From C.E.G.B. Digest 1961, **13** (May 13), 1340.

Stresses in Steam Lines for High Operating Conditions. D. P. Elizarov. *Teploenergetika* 1960, **7** (Dec.), 19–23 (in Russian).

A new method is presented for the experimental determination of mechanical stresses in the walls of steam piping of pearlitic steel during the warming up process and under service conditions, and also the distribution of the stresses set up in the line.

(*A.E.I. abstract*).

From C.E.G.B. Digest 1961, **13** (May [illegible]), 1338.

Abstracts from the Technical Press—Abroad and Domestic

(Drawn from the Monthly Technical Bulletin, International Combustion, Ltd., London, W. C. 1)

Mechanical Handling

Coming. The Automatic Coal Pile. L. E. Stewart. *Power* 1961, 105 (June), 93–5.

Automation of coal handling from the supply point to the boiler bunkers and/or stock pile is discussed and three plants with increasing order of automation described. At the River Rouge plant two operators are required, at Tait station one only and at Portland station the whole operation is automatic after the selection of the rate of feed for each bunker.

Coal—From Mine to Boiler. Handling and Receiving Facilities. A. S. Drummond. *Pwr. Engng.* 1961, 65 (May), 52–4.

The various facilities employed by the Detroit Edison Co. and their power consumption for the unloading of water-borne coal and from railway wagons are described.

Automatic Coal Sampler and Divider. O. Wirthwein. *Mitt. V.G.B.* No. 72 1961 (June), 200–4 (*in German*).

[illegible]e Lünen power station an automa[illegible] coal sampler has been developed consisting of a slotted case passing to and fro a falling stream of coal and a riffler for subdividing the sample. Extended tests have shown that the samples thus obtained are suitable for the accurate determination of the coal properties.

Investigations into the Transport Process on Vibrating Troughs. Pt. I. K. H. Wehmeier. *Fördern und Heben* 1961, 11 (May), 317–27 (*in German*).

This first part deals with the theoretical side of the problem, such as general considerations of the vertical and horizontal movement of the trough and the material to be transported, the transport speed and its graphical determination and the influence of changes of amplitude and frequency on the speed. The influence of the properties of the material being handled on the transport process is discussed.

Investigations into the Transport Process on Vibrating Conveyors. K. H. Wehmeier. *Fördern und Heben* 1961, 11 (June), 375–83 (*in German*).

This second part deals with the experimental investigations and their results and discusses the reasons for certain discrepancies between theory and experimental results.

Vibrating Conveyors in Coal Pulverizing Plants. J. Hengstebeck. *Mitt. V.G.B.* No. 72 1961 (June), 204–8 (*in German*).

At Hüls power station the coal is transported from the bunker outlet to the downcomers to the mill by horizontal tubular vibrating conveyors of 12.6 in. diam. Each mill has two feeder tubes which can be operated simultaneously or separately and at different feed rates. They contain instruments indicating stoppage of coal flow. The control of the feed rate of each tube is described in detail. The cost of this installation is much lower than that of belt conveyors and repairs and exchange of worn parts easily and quickly done, but they are easily clogged by wet coal, especially the polyester elbow between bunker outlet and tube. The life of the tubes is 8000–10,000 h.

Heat: Cycles and Transmission

A Review of Heat Transfer Literature 1960. Pt. 1. E. R. G. Eckert, T. F. Irvine, E. M. Sparrow and W. E. Ibele. *Mech. Engng.* 1961, 83 (July), 34–42.

The first part reviews literature dealing with conduction, channel flow, boundary layer flow, flow with separated regions, transfer mechanism and natural convection.

The Melchett Lecture for 1960. Radiative Transfer in Combustion Chambers. H. C. Hottel. *J. Inst. Fuel* 1961, 34 (June), 220–34.

A mathematical analysis of furnace gas radiation is presented. Both rigorous and simplified equations have been developed and their application is discussed. Using machine calculations the systems of simultaneous linear equations can be solved and the simplified equation tested against the rigorous treatment.

Thermal and Flow Investigations on Finned Tube Bundles in Cross Flow. Pt. II. Influence of Fin and Tube Arrangement. H. Brauer. *Chem. Ing. Tech.* 1961, 33 (May), 327–35 (June), 431–8 (*in German*).

Heat transfer on finned tubes is disturbed by unfavorable flow conditions in the corners between fin and tube. The influence of the number of tube rows on heat transfer and pressure drop was investigated; this showed that both decrease with increasing number of rows. The Re number of the flowing medium has a large effect only on the heat transfer coefficient.

Steam Generation and Power Production

Pressure Reduction of Water and Water-Steam Mixtures in Orifices. H. Friedrich and G. Vetter. *Energie* 1961, 13 (May), 201–7 (*in German*).

Tests on orifices of small diameter with subcooled and boiling water, water-steam mixtures and saturated steam are reported and compared with other published data. Formulas are developed for different conditions.

The Movement of an Individual Droplet during Atomization. H. Hauschildt. *Energie* 1961, 13 (May), 207–11 (*in German*).

The movement of an individual droplet has been studied for various Re numbers obtained in tests. It is shown that although the conditions in an atomized cloud are much more complicated some fundamental laws are equally valid for a single droplet and a cloud. The equations permit an investigation of the influence of initial velocity which is a function of the atomizing pressure, of the specific gravity and of the dynamic viscosity of the air on the movement of the droplet. An example is calculated.

Post-War Developments in British Water-Tube Boiler Design—V. K. R. Lenel. *Steam Engr.* 1961, 30 (July), 338–44.

The last part of this review surveys boiler auxiliaries such as drums and their internals, pulverizers, burners, superheaters, economizers, air preheaters and electrostatic precipitators.

The State of the Steam Generator Technique. Evaluation of the Boiler Index ot the V.G.B. Pt. 5. H. Richter. *Mitt. V.G.B.* No. 72 1961 (June), 211–4 (*in German*).

The changes in the boiler statistics between 1957 and 1961 are tabulated and discussed. Total output increased by 22 per cent; the number of new natural circulation boilers installed is higher than those of forced-flow boilers, but the latter have the higher overall output. The forced-flow boiler is predominant above 125 t/h output. Although pulverized coal fired boilers constitute 81 per cent of the total output increase, the number of oil-fired boilers has more than doubled and 243 boilers were provided with additional oil firing. The installation of slagging furnaces is increasing still.

Circulation in Water-tube Boilers. T. Widell. *Tekn. Tidskr.* 1961, 91 (Mar. 17), 253–6 (*in Swedish*).

A new method of calculating the water circulation in the two new boilers for the Stenungsund power station, Sweden, based on a "working pressure efficiency," is described. Comparison between calculated results and measuring results is made in a further article.

From C.E.G.B. Digest 1961, 13 (June 10), 1669.

Measurement of Water Circulation in a Boiler. R. Carlson, B. Cederberg and K. Ljunggren. *Tekn. Tidskr.* 1961, 91 (Mar. 17), 257–62 (*in Swedish*).

Measurements of water circulation in the boiler for a 150 Mw set in the Stenungsund P/S, Sweden, are discussed. The methods used included current meters with radioactive cobalt and injection measurements with radioactive ammonium bromide. The measured results are compared with calculated results.

From C.E.G.B. Digest 1961, 13 (June 10), 1670.

Flow Resistances in the Heated Evaporator of a Benson Boiler. O. Schwarz. *Mitt. V.G.B.* No. 72 1961 (June), 143–55 (*in German*).

Measurements were carried out on a Benson boiler of the Hamburg Electricity Works to obtain an insight into the influence of volume and heat content of the flowing medium on the pressure drop coefficient of heated evaporator tubes and to compare these with those of unheated tubes. The highest values occurred at the start of evaporation and low flow rates caused by the formation of steam bubbles on the tube wall. The results should be useful for the control of forced-flow boilers.

Dynamic Behavior of Forced-Flow Evaporator Systems. P. Profos. *Sulzer Tech. Rev.* 1960, No. 4, 5–12.

A combined graphical and mathematical method has been developed by which the transfer characteristics can be determined from the design data of the boiler.

Calculation of the Dynamic Behavior of Heat Exchangers with the Aid of Analogue Computers. L. Acklin and F. Läubli. *Sulzer Tech. Rev.* 1960, No. 4, 13–21.

The development of the method and its application to the control of a superheater are described.

Simple Method of Calculation for the Steam Temperature Control of Boilers. G. Klefenz. *Mitt. V.G.B.* No. 72 1961 (June), 191–200 (*in German*).

The dynamic behavior of the final superheater is considered and equations are developed for the determination of the maximum control deviation using only data available in the design stage. A practical example shows the application of the equations.

Load Dependent Influence on Heat Exchange in Boilers by Heat Recirculation. K. Becker. *Energie* 1961, 13 (May), 212–8 (*in German*).

Possibilities of keeping the temperature of the superheated steam constant at all loads by flue gas recirculation from the furnace to the convection pass and vice versa, recirculation of steam or air from heat exchanger exit to its entry, by-passing of steam, air or feed water and their effect on overall efficiency and total cost are discussed. The advantages and disadvantages of each system or combination are outlined and equations developed with which an estimate of the results of the application of the different means can be obtained. It is shown that their application has different effects in natural and assisted circulation boilers and in forced flow boilers.

Damage to High-temperature Superheaters. R. Lemaire. *Bull. d'Inf. des Cent. Elect.* 1961 (Apr.), 13–15 (*in French*).

A brief account is given of damage arising in the Combustion Engineering boiler at Harnes power station after 56,000–60,000 hours' operation. Cracks developed on the internal walls of superheater tubes near the spacer weld and spread lengthwise following the generatrices, and depthwise to become transverse, attaining a length of $1^1/_2$ inches. Micrographic examination revealed a wide area of ferrite grain enlargement caused by superficial decarburation, probably due to the high silicon content of the steel. *From C.E.G.B. Digest* 1961, 13 (July 22), 2131.

Thermal Insulation Guarantees for Boiler Insulations. W. F. Cammerer and J. Achtziger. *Mitt. V.G.B.* No. 72 1961 (June), 180–91 (*in German*).

Theoretical considerations and experimental temperature and heat flow measurements on a boiler insulation have shown the unsuitability of the previously used guarantee quantities, i.e., heat loss of housing and its surface temperature. The measurements confirmed that the heat conductance coefficient unequivocally characterizes the boiler insulation and this quantity is now specified as the value to be guaranteed in the new V.G.B. specifications for boiler insulations. Details of the temperature and heat flow measuring methods used and results obtained on a 100 t/h cycle fired boiler are given.

Larger Repairs on Boilers—Their Permissibility, Assessment and Testing. H. Höcker. *Tech. Überw.* 1961, 2 (July), 246–9 (*in German*).

Kinds of failure and their causes are related for vertical, fire-tube, smoke-tube and water-tube boilers. The points to be considered in permitting or refusing repairs, assessment and testing of repairs carried out are discussed.

Chemical Cleaning of Boilers, Steam Turbines, Nuclear Reactors etc. E. A. Ulrich. *Energie* 1961, 13 (May), 231–5 (*in German*).

Some practical advice is given on the chemical cleaning of shell-type, sectional and vertical water-tube boilers, superheaters, steam turbines and nuclear reactors. Examples of successful cleaning are cited.

Furnaces and Combustion

Radiating Capacity of Furnace Installations. A. M. Gurvich and V. V. Mitor. *Teploenergetika* 1960 (Nov.), 66–9. D.S.I.R. Transl. RTS 1830.

New calculations are developed for the radiation in boiler furnaces taking into account that the tubes are practically always covered by fine ash particles offering high resistance to the passage of heat and causing an "intrinsic" radiation. Calculations are carried out on a fuel-bed type furnace with heat receiving surfaces uniformly distributed over all the walls.

Predicted Burning Times of Solid Particles in an Idealized Dust Flame. R. H. Essenhigh. *J. Inst. Fuel* 1961, 34 (June), 239–44.

Burning times have been calculated on the separate assumptions of reaction control by a diffusion film (square law) and by surface chemical reaction (linear law). By combining both factors simultaneously the two solutions are found to be additive. The significance of the findings and their effect on calculating burning times are discussed.

Refractory Arches and Walls. W. J. C. Shears. *Pwr. and Wrks. Engng.* 1961, 56 (July), 563–71.

Examples of recent installations in boiler and other furnaces are described.

Water-Side Corrosion and Water Treatment

Considerations Regarding Demineralization and Flash Evaporation of High-Pressure Boiler Makeup Water. N. E. Gilwood and J. G. Mack. *Amer. Pwr. Conf. Paper* 1961 (Mar.).

Comparison of demineralization versus flash evaporation in large high-pressure steam-generating plants is made on grounds of (1) Water quality; (2) Reliability; (3) Economics; (4) Labor; (5) Maintenance; (6) Corrosion—to name but a few. Economic comparison showed equipment-cost advantage for demineralizer with waters having over 1300 ppm total electrolytes (as $CaCO_3$). Total annual cost advantage for demineralizer starts at about 500 ppm total electrolytes—both figures based on 20,000 lb/hr unit capacity. Demineralizer's additional advantage: improved heat rate and availability of high-quality water for plant startup.

From C.E.G.B. Digest 1961, 13 (July 8).

The Effect on Water and Steam Quality of Colloidally Dispersed Particles. H. Kurapkat and E. Walther. *Mitt. V.G.B.* No. 72 1961 (June), 163–70 (*in German*).

Heavy silica deposits in a topping turbine were traced to a breakdown of the demineralizer beds after heavy rainfall in the neighborhood and consequent increased turbidity of the river water used for feed water make-up. Adsorption flocculation proved successful in preventing breakdown of the demineralizer beds but difficult to operate under varying loads. A provisional system of filter aids proved equally successful without the attending difficulties and a full-scale plant has been ordered. Details are given of measurements of suspended iron oxides, behavior of silica, measuring and determination of colloids, supervision of adsorption plants and the effect of reduction of colloids on the water-steam circuit.

Experimental Investigations of a Few Problems Arising in Once-Through Forced-Circulation Steam Generators Operating at Supercritical Pressures. J. Kägi. *Sulzer Tech. Rev.* 1961, **43**, No. 1, 29–35.

Studies of salt deposition in tubes of supercritical pressure boilers at temperatures up to 1200 F are reported which gave some unexpected results. Salt deposition occurred although the salt concentration in the feed water was far below the maximum solubility level and the deposits remained stable only at certain temperatures. Lowering of the temperature caused existing deposits to vanish in a short time. Various alkalizing agents were tried of which only ammonia remained stable at 1200 F.

The Solubility of Silicic Acid in Steam. R. Feitsma. *Mitt. V.G.B.* No. 72 1961 (June), 170–6 (*in German*).

On the basis of equations and data published by various authors' new formulas for the distribution coefficient of silicic acid in water and saturated steam and its solubility in

and two diagrams constructed. Their validity will be checked experimentally.

The Examination of Oxide Scales on Iron-Chromium Alloys by X-ray Scanning Microanalysis. G. C. Wood and D. A. Melford. *J. Iron and Steel Inst.* 1961, **198** (June), 142–8.

Oxide scales on iron-chromium alloys in steam at 950–1000 C were examined by X-rays and two major scale layers were found, the outer one consisting of Wüstite and the inner one of a complex distribution of oxides of iron and chromium. Chromium depletion in the alloy next to the alloy/scale interface has been observed.

Flue Gas, Ash and Dust

Cold Corrosion in Oil-Fired Boilers. Various Authors. *Schweiz. Arch.* 1961, **27** (May), 180–220 (*in German*).

The papers presented at a Swiss Conference held at Zürich on September 16, 1960, are published as follows: (1) Physicochemical Considerations of the Gas-Side Corrosion in Boiler Operation, by A. Bukowiecki; (2) Prevention of Corrosion and Deposits in Boilers Fired by Fuel Oil of High S Content, by E. Zehnder; (3) Problems of Corrosion, Deposit Formation and Air Pollution in Oil-Fired Boilers, by J. Greenwood and G. R. Wade; (4) Design Measures for the Prevention of Low-Temperature Corrosion in Oil-Fired Boiler Plants, by G. Peter; (5) Discussion.

The Influence of Dolomite on Acid Dew Point and Low-Temperature Corrosion in Oil-Fired Boilers. H. Draaijer and H. J. Pel. *B.W.K.* 1961, **13** (June), 266–9 (*in German*).

Measurements on two oil-fired boilers of acid dew point by the Degussa dew point meter and economizer tube surface temperature by resistance thermometer with and without dolomite addition are reported. It is stressed that dolomite does not reduce the acid dew point but reduces corrosion on certain points but not throughout the boiler. Despite regular soot blowing with steam heavy deposits formed necessitating thorough cleaning after 1500 h. Reduction of corrosion by increasing the feed water inlet temperature is recommended so that the wall temperature of the economizer tubes is above the acid dew point.

Thermal Insulation for Steel Chimneys. J. D. Blakeley. *Pwr. Wrks. Engng.* 1961, **56** (July), 551–4.

Protection of steel chimneys against erosion and corrosion is discussed and the various methods in use compared. The recently developed use of an outer shield of bright aluminium sheet spaced away from the chimney proper appears to be the best solution in preventing corrosion and emission of sticky smut deposits.

Baghouse Cures Stack Effluent. C. O'Connor and G. Swinehart. *Pwr. Engng.* 1961, **65** (May), 58–9.

To meet air pollution regulations a baghouse filter plant was added to the Pasadena incinerator installation. The filter bags made of silicon treated fibreglass with a permeability of 81, filter velocity of 5 fpm, pressure drop of 3–5 in. w.g. and flue gas flow of 375 cfm reduce the dust content from 13.4 gr/ft³ to 0.031 gr/ft³, an efficiency of 99.77 per cent. The filtered flue gas contains 1.6 ppm SO_3, the unfiltered flue gas 27.3 ppm SO_3. Despite flue gas temperatures of up to 750 F no deterioration of the bag material has been observed.

Effect of Tube Spacing and Arrangement upon the Fouling Characteristics of Banks of Tubes. P. Profos and H. N. Sharan. *Sulzer Tech. Rev.* 1960, No. 4, 31–43.

Tests are described which enabled obtaining mathematical data relating to the effect of pipe geometry on the fouling of tube banks. In-line banks have a smaller relative fouling tendency than staggered spacings and generally give higher heat transfer coefficients.

Power Generation and Power Plant

Generating Plant Design. C. W. Priest. *Elect. Rev.* 1961, **168** (June 9), 1005–8.

A review of the increase in size of power stations, boilers and turbogenerators since 1920 to match the increase in the annual consumption of electricity per head of population of 90 kwhr in 1920 to 1900 kwhr in 1960. Increase in size beyond the 500 Mw single-line units just ordered for commissioning in 1965 is possible, especially if two-line sets were adopted, but an early decision is not expected.

Condensing Power Stations in Russia. B. v. Gersdorff. *Elektwirtsch.* 1961, **60** (June 20), 414–23 (*in German*).

A summary of recently published Russian literature on the planning of power stations for the period 1959/1965 is presented. Eight standardized power stations of 1200 Mw with 6 × 200 Mw units and 640 t/h boilers are being built, and 22 power stations of 2400 Mw output with 8 × 300 Mw and boilers of 950 t/h are to be built. Their main characteristic is the central pulverizing plant outside the actual power station and the use of intermediary bunkers between boilers

with a 2 h reserve. The mills are generally of the ball type and have capacities of 50 t/h. The steam parameters for the smaller stations are 140 atü, 570/565 C, those for the ... r stations 250 atü and 585/565 C. ... also planned to build 18 out-of-door stations of 600 Mw capacity with 4 × 150 Mw units and boilers rated at 500 t/h at 140 atü and 570/565 C.

Power Industry's Leaders Exchange Information at American Power Conference. Anon. *Pwr. Engng.* 1961, **65** (May), 45–8, 82, 84.

The papers presented at the 1961 American Power Conference are summarized: (1) Transmission, distribution; (2) Nuclear power development; (3) Central stations (Avon and Breed plants); (4) Paradise plant; (5) Combined cycle; (6) Binary cycle; (7) Boiler feed pumps; (8) Electrical apparatus; (9) Automation and control; (10) Fuels; (11) Water; (12) Industrial plants: (13) Flue gas sampling; (14) Peaking symposium; (15) Air pollution.

Study of Double Reheat. H. Beyerlein and H. Mitschel. *B.W.K.* 1961, **13** (July), 320–6 (*in German*).

Fifteen different variations of a 200 Mw unit with steam parameters, preheater stages and number of reheats as variables were compared with a basic u... employing steam at 2560 psi and ... /1005° F. The savings in fuel are in most variations negatived by increased capital costs and payment of interests on the excess capital used. A nomogram has been developed as a basis for diagrams by which the calculation of the optimum design for given local conditions is facilitated.

The Theory of Combined Steam and Gas Turbine Installations. C. Seippel and P. Bereuter. *Brown Boveri Rev.* 1960, **47** (Dec.), 783–99.

A comprehensive and unbiased survey of the combinations worth considering is presented and the basic thermodynamic relationships are derived. Thermal efficiency, capital costs, safety, ease of control, fuel properties, running hours are also considered. The economics of a typical example are investigated.

Practical Examples of Utilizing the Waste Heat of Gas Turbines in Combined Installations. W. P. Auer. *Brown Boveri Rev.* 1960, **47** (Dec.), 800–25.

Four stations, Korneuburg, Cornigliano steelworks, Dudelange steelw... and Vahr district-heating stati... with different combinations of gas and steam turbines are described. Results of acceptance tests are tabulated.

One Prime Contract-One 350-Mw Plant Installed. H. R. Drew. *Pwr. Engng.* 1961, **65** (May), 70–1.

The 350 Mw addition at the Handley station of Texas Electric Service Co. has been awarded under a turnkey contract to Westinghouse and will consist of a pressurized furnace outdoor boiler rated at 2486 klb/hr at 2465 psi and 1005/1005 F fired by natural gas or oil as standby with provision for conversion to solid fuel firing and an outdoor tandem compound four-flow turbo-generator with 7 extraction stages. The full capacity boiler feed pumps will be driven via a hydraulic coupling from the turbine end of the shaft. The net heat rate is expected to be 7892 Btu/kwh and the total costs less than $80/kw.

Ptolemais Greece's Largest Brown Coal Power Station. T. Geissler. *Energie* 1961, **13** (June), 254–62 (*in German*).

Ptolemais Power Station in Greece. C. Koch and W. Stamm. *Brown Boveri Rev.* 1960, **47** (Dec.), 826–44.

The former article deals mainly with the characteristics of the brown coals, the design of the boiler and its auxiliaries, the latter article mainly with the electrical installations. The boiler is rated at 625 klb/h at 1260 psi and 955 F with natural circulation and corner burners supplemented by oil burners for ignition and low load operation. The brown coal has a moisture content of up to 60 per cent, ash content of up to 24 per cent and a gross C.V. from 2000 to 2400 Btu/lb.

Otto de Lorenzi Accorded Honor

Otto de Lorenzi, formerly educational director of Combustion Engineering, Inc., was given the Percy Nicholls Award at the Solid Fuels Conference of the ASME at Birmingham, Ala., on October 5, 1961.

In granting the award Julian Tobey, consulting engineer, cited these commendable facts about Mr. de Lorenzi:

"His patient studies led to the development of a technique for producing colored motion pictures that permitted the recording of actual furnace operating conditions with various types of fuel burning equipment using many different fuels.

"His comprehensive and authoritative reference text, *Combustion Engineering*, served greatly in the dissemination of new techniques and practices in fuel burning throughout the world.

"Moreover, his manifold services to the engineering societies, his many papers and articles greatly enhanced the role of the societies and the technical press in furthering the overall knowledge of his fellow engineers."

Abstracts from the Technical Press—Abroad And Domestic

(Drawn from the Monthly Technical Bulletin, International Combustion, Ltd, London, W. C. 1)

Fuels: Sources, Properties and Preparation

The Physico-Chemical Behaviour of Bituminous Coal Structure Components. XIII. The Heat of Decomposition of Bituminous Coal Macerals of Different Rank. C. Kröger and J. J. Das. *Brennst Chemie* 1961, 42 (July), 223–30 (in German).

A newly developed high-temperature calorimeter is described and the results of measurements of heat of reaction of the various macerals as a function of rank and temperature presented. It is shown that the macerals can be distinguished by their heat of reaction. An equation for calculating the decomposition temperature has been deduced.

Integrated Coal-handling Scheme Replaces Obsolete Unit Plants at North Wilford Power Station. J. M. Beskine. *Mech. Handl.* 1961, **48** (Aug.), 423.

A detailed description is presented of the unified coal handling recently completed for supplying coal to the B, C, D and E stations and possibly further extensions. The main equipment comprises a traveling wing tripper, a traveling reclaiming crane and hopper, wagon tippler, interconnecting belt conveyors and bulldozers.

Coal Storage and Reclaim. A. S. Drummond. *Pwr. Engng.* 1961, **65** (June), 69–71.

The second part describes two kinds of stackers for very large coal storage plants, a traveling and a swiveling stacker, with bulldozers used for compacting the piles and reclaiming.

Gyroelevator. Anon. *Chem. Proc.* 1961, **7** (Aug.), 36–7.

This device has been developed for the feeding of fine slack coal from storage to the hopper of a chain-grate stoker and consists of a spiral elevator in a tube with one or two agitators with large diameter spirals to loosen the coal and feed it towards the intake of the spiral elevator.

Coal Pipeline. A. N. Sharp. *Coke and Gas* 1961, **23** (Aug.), 336–8.

A survey is presented of: (1) The development of coal transportation by pipeline in U.S.A., France and Russia; (2) Design calculations, specific gravity and solids content; (3) Pipe materials; (4) The possibility of constructing a network in Gt. Britain to supply coal to power stations from the Midland coal fields; (5) Economic factors.

Heat: Cycles and Transmission

A Review of Heat Transfer Literature 1960 Pt. 2. E. R. G. Eckert, T. F. Irvine, E. M. Sparrow and W. E. Ebele. *Mech. Engng.* 1961, **83** (Aug.), 50–7.

The second part reviews: (1) Convection from rotating surfaces; (2) Combined heat and mass transfer; (3) Change of phase; (4) Radiation; (5) Liquid metals; (6) Low-density heat transfer; (6) Measurement techniques; (7) Heat transfer applications; (8) Thermodynamic and transport properties.

Boiling Heat Transfer. H. K. K. Muthoo. *Chem. Proc. Engng.* 1961, **42** (Aug.), 348–50.

A generalized equation for boiling heat transfer has been developed. Agreement between theoretical and experimental data has been good.

Thermal Radiation Characteristics of Cylindrical Enclosures. E. M. Sparrow, L. A. Albers and E. R. G. Eckert. *A.S.M.E. Preprint* No. 61-SA-23 1961 (June), 7 pp.

Solutions of the radiant flux balance equations are presented for various length to diameter ratios of the cylinder and apparent emissivities. Local and overall heat loss have also been calculated.

Heat Transfer by Simultaneous Conduction and Radiation in an Absorbing Medium. R. Viskanta and R. J. Grosh. *A.S.M.E. Preprint* No. 61-SA-34 1961 (June) 10 pp.

The solution is presented of the problem of simultaneous heat transfer by conduction and radiation between two diffuse, non-black, infinite, isothermal, parallel plates separated by a space filled with a thermal radiation absorbing and emitting medium.

Forced Convection Heat Transfer from a Uniformly Heated Sphere. W. S. Brown, C. C. Pitts and G. Leppert. *A.S.M.E. Preprint* No. 61-SA-26 1961 (June) 8 pp.

An integral method of solution for the local heat transfer of a sphere with uniform heat flux has been developed and the results compared with measurements with water over a wide range of Re and Pr numbers: the agreement is good. From the experimental data average heat transfer coefficients were computed. The problem is of interest in the nuclear field where spherical fuel elements are to be cooled by a liquid or gaseous medium.

Steam Generation and Power Production

The Evaporation Process with Self-Circulation in the Vertical Tubes. E. Kirschbaum. *Chem. Ing. Tech.* 1961, **33** (July), 479–84 (in German).

In the lower part of a vertical evaporating tube steam bubbles are generated which are immediately condensed in the liquid core and thus influence the heat transfer in the whole tube. The tube wall and liquid temperatures were measured and pressures determined subsequently. Conclusions drawn on origin, disappearance or increase of these bubbles, and other movements of the liquid-steam mixture were confirmed by film and slow-motion pictures. It is shown that up to 80 per

cent of the total heat available is transferred from the tube to the water by the formation of bubbles and their subsequent condensation.

Pressure Vessels for Gas-cooled Graphite-moderated Reactors. M. J. Noone and R. F. Bishop. *J. Brit. Nucl. Energy Conf.* 1961, 6 (July), 253–65.

The design, fabrication and installation of steel pressure vessels for various reactors are described.

The New High-pressure Cyclone Boiler at Wilton. E. Holmes-Smith, J. Lister and P. V. Liddell. *J. Inst. Fuel* 1961, 34 (Aug.), 307–23.

The boiler is rated at 530 klb/h at 1700 psi and 1065 F and provided with 2 cyclone furnaces in which the primary coal-air mixture is injected at a secant to the tangentially injected secondary air. Each cyclone is directly fed by two beater mills, each supplying alternate ports (6 in all). The slag from each cyclone flows through a discharge slot into a secondary furnace with a slag hole near the front wall and midway between the two cyclones. Details are given of ash fusion points of coals used, auxiliary power required, ash retention, tube erosion and iron attack and measures taken against this, and on pressure drop in the cyclone vortex. Where possible comparison is made with the performance of a pulverized coal fired boiler of the same size and for the same steam conditions.

Czechoslovak Cyclone Furnace for Low-grade Fuels. B. Lumpouch. *Czech. Tech. Digest* (SNTL) 1961, 3 (June), 15–19.

Design details are given of: (*a*) an outdoor vertical-cyclone boiler delivering 75 tons steam per hour at 588 psig and 788 F; its open pulverizing and drying circuit permits a large variety of fuels to be burnt; and (*b*) a horizontal-cyclone boiler delivering 75 tons steam per hour at 940 psig and 932 F equipped with an auxiliary hot-air cycle which effects a 6 per cent saving in fuel.

From C.E.G.B. Digest 1961, 13 (Aug. 5), 2295.

The Vekos-Powermaster Boiler. Anon. *Steam Engr.* 1961, 30 (Aug.), 377–80.

The boiler is designed as a packaged unit for solid fuel firing and consists of a Vekos stoker fitted inside a three-pass dry-back economic boiler. It can use practically any type of coal and achieves efficiencies above 80 per cent without economizer or superheater. The boiler has a built-in multi-cell grit arrester and double-firing of the collected grit and thus conforms to the requirements of the Clean Air Act. It can easily be converted to oil or gas firing or equipped for firing any combination of coal, oil or gas. A table gives test results obtained on a prototype boiler.

Testing of a 3000-kW (th), Liquid-Metal, Model Steam Generator. L. J. Webster, D. E. Fletchall and D. Logan. *A.S.M.E. Preprint* No. 61-SA-46 1961 (June), 12 pp.

Two designs of heat exchangers for transferring heat from liquid sodium to water and steam are described and the results of tests presented. One heat exchanger contained a natural circulation evaporator, the other a kettle evaporator, and both the same superheater. The occurrence of corrosion and weld cracks and their causes are discussed. The heat transfer mechanism in the evaporator and superheater is analysed.

Steam Boiler Damage through Failure of the Automatic Controls. H. Peters. *Tech. Überw.* 1961, 2 (Aug.), 297–301 (in German).

The number of boilers damaged through non-functioning of automatic controls (water level and firing rate) is increasing because insufficient attention is paid to feed water treatment and maintenance of boiler and control fittings. Some typical examples are illustrated. Recommendations are made with regard to improving maintenance schemes and supervision and to better design of controls and their installation.

Repeated Acid Cleaning of Boilers. J. K. Rice. *Combustion* 1961, 33 (July), 45–8.

The occurrence of corrosion in boilers acid cleaned several times, especially those without proper feed water treatment, has been studied. It was found that certain types of organic dispersants in deposits absorb or react with the inhibitor and thus cause the corrosive attack by the acid cleaning medium. It is stressed that acid cleaning should not replace correct feed water treatment.

Water-Side Corrosion and Water Treatment

Feed Water Preparation by Complete Demineralization in the Power Stations of Electricité de France. R. Rath. *Chal. et Ind.* 1961, 42 (July), 207–9 (in French).

Of the 20 most productive French power stations 11 or 63 per cent of the total capacity installed use total demineralization. The first table gives the principal characteristics of these 11 stations (total capacity, steam pressure and temperature, capacity, number of trains and output).

Reducing Corrosion of Power Plant Condenser Tubing with Ferrous Sulphate. T. W. Bostwick. *Corrosion* 1961, 17 (Aug.), 12–19.

Severe corrosion by river cooling wr of condenser tubes made of alu ium brass tubes was completely stopped by admixture of ferrous sulfate to the water. Details are given of amounts used, frequency of additions, effect of chlorination, acid cleaning (liquid and foam) on protective layer formation. The causes of the corrosive attack are discussed.

Gas-Side Corrosion and Deposits

Effect of Sunlight on Corrosion. L. C. Rowe. *Corrosion* 1961, 17 (June), 93–4.

High energy ultraviolet light increases the corrosion rate, infra-red light reduces the effect of subsequent exposure to ultraviolet light. Visible light has little effect on corrosion rate.

Introducing Boron Silicide. E. Colton. *Nucl. Engng.* 1961, 6 (Aug.), 324–5.

Boron silicides have a high corrosion resistance once a thin protective boron silicon-oxygen film has formed on the surface. The powder can be formed by oxide bonding or self-bonding and in its final form, e.g., control rods, has an excellent thermal sho resistance.

Ash and Clinker. J. N. Williams. *Pwr. and Wrks. Engng.* 1961, 56 (Aug.), 655–9.

The difference between ash and clinker, the formation of hard and soft clinker and the influence of ash-fusion temperature on the formation of clinker are discussed. Characteristics of pulverized fuel ash and problems involved in its disposal are described.

Power Generation and Power Plant

Detecting Service Failures in Power Plants. Pt. II. Examples. H. Thielsch. *Combustion* 1961, 33 (July), 32–6.

The various types of defects leading to failure are discussed. Examples are given of notches initiating cracks, cracks produced by forming, fabrication, welding or heat treatment, fatigue failures, corrosion, metallurgical "notches" (brittle condition in the metal), incorrect base metals and casting defects. The prevention of these failures by the most suitable detection method is indicated in each case.

Be Power Station West. Anon. *Engg. Boil. Ho. Rev.* 1961, 76 (July), 228–33.

The total capacity of this recently completed power station is 240 Mw comprising two 30 Mw and three 60 Mw units with four 180 klb/h and nine 220 klb/h boilers. The small boilers operate at 650 psi and 925 F and are of tridrum design, the larger ones at 950 psi and 925 F, three of single drum and six of bidrum design, all are stoker fired. All boilers are provided with automatic combustion and superheated steam temperature control. The total coal consumption is 2000 t/day or 60,000 t/year. The 30 Mw turbines are two-cylinder, the 60 Mw turbines three-cylinder machines, the former with four, the latter with 5 stages of feed heating. The 30 Mw generators are air-cooled, the 60 Mw generators hydrogen cooled in a closed circuit.

1200 Mw Station for E. Lothian. Anon. *Elect. Times* 1961, 140 (Aug. 17), 239.

Consent is being sought for a 1200 Mw power station near the village of Cockenzie on the Firth of Forth to be supplied with coal at a rate of 10,000 t/day from Monktonhill and Bilston Glen. Four units of 300 Mw each are to be installed.

Refiring Grit at Kingston. Anon. *Elect. Times* 1961, 140 (July 27), 113.

On the chain-grate fired boilers at Kingston power station the proportion of coke breeze in the fuel has been increased from 25 to 65 per cent and the coal used is mainly washery fines and slurry. Oil burners and hot gas recirculation are used to improve ignition. The increased grit is briquetted with low-grade coal and pitch and refired and results in the production of clinkers for which there is a ready sale. The cost per unit sent out is only 0.54 d compared with 0.74 d when burning coal of a C.V. of 10,000 Btu/lb.

Ptolemais Greece's Largest Brown Coal Power Station. Pt. II. Operational Results. T. Geissler. *Energie* 1961, 13 (July), 297–306 (in German).

The characteristics of the brown coal are detailed which caused flame pulsation, delayed combustion and excessive superheater temperature but no deposit formation and a good cleaning of all surfaces, including economizer and air preheater without erosion. To stabilize combustion and reduce ignition time separation of pulverized coal and mill vent gases was introduced, a refractory lining in the burner zone installed and the burner design altered. This resulted in a stable flame down to 20 per cent full load without additional oil firing, constant superheated steam temperature down to 25 per cent full load with a maximum employment of spray desuperheating of 7 per cent and a thermal efficiency at full load of 86

per cent. It was possible to operate the boiler for over 10,000 h without cleaning.

Putting the Digital Computer to Work at the H. B. Robinson Plant. W. B. Kincaid and H. Wachtel. *Combustion* 1961, 33 (July), 38–44.

The MARC (Monitoring and Results Computer) system installed at the Robinson station of Carolina Power and Light Co. is described. It can scan up to 396 variables at a rate of 5 per second and prints out an alarm if any value is not normal, logs up to 100 variables on 2 typewriters and averages or integrates selected variables every 24 h. It also produces on request, gives a trend record and can make modifications to the stored program. The equations developed for calculating performance are reproduced. The establishment of the computer program and its modifications based on actual performance data is described.

W. H. Sammis Power Plant Unit No. 3 Undergoing Tests. R. L. Criswell. *Heat Engng.* 1961, 36 (May/June), 34–40.

The W. H. Sammis power station of Ohio Edison Co. is planned for a total net output of 692 Mw from four 173 Mw units. Each boiler is rated at 1250 klb/h at 2450 psi and 1050 F with reheat to 1000 F. Superheated steam temperature can be held constant by coolers from 1/3 to full load, reheated steam temperature from 1/2 to full load by by-pass dampers. The boilers are equipped with 15 intervane burners in the front wall supplied with coal from 5 bowl-type mills. Each furnace is subdivided by 2 steam-cooled partition walls into 3 cells, the walls representing radiant superheater surfaces. Difficulties were experienced with steam flow reversal at low loads in some division wall tubes; installation of orifices to increase full load pressure drop was successful.

Heat Power Station with Hot Water Supply over a Long Distance and a Difference in Level of 406 ft. K. Viktorin. *B.W.K.* 1961, 13 (Aug.), 362–8 (in German).

In an Austrian textile firm with several works sited on a small river over a distance of 1.5 miles and a level difference of 406 ft the problem of adequate heat and power supply arose. After extensive studies it was decided to build a new power station at the lowest level with the easiest access to the railway for the incoming coal and fuel oil and to supply the works with high-pressure hot water in closed circuit, an expan-

sion tank under nitrogen pressure at the highest level keeping the system under constant pressure. Two boilers, each rated at 26,500/32,000 lb/h at 925 psi and 935 F supply a 3 MVA turbogenerator operating against a back-pressure of 85 psi. Steam at this pressure is used to heat the water to 320 F, preheat the water for storage and for process in the adjoining works. The flow and return lines are above ground for most of their lengths to save installation costs. The boilers are provided with traveling grate stokers and oil burners for the separate or simultaneous firing of coal and oil but because of the much lower cost of the fuel oil (77 Austrian shillings per 1×10^6 Btu for oil as against 90 Austrian shillings for coal) this has been used exclusively in recent months. A dolomite-like additive is injected into the furnace; neither deposits nor corrosion (high or low temperature) have been experienced during 2 years of operation.

Modernizing a Steam Power Plant. Anon. *Steam Engr.* 1961, **30**(Aug.), 368–73.

The new boilerhouse at the London works of Bryant and May Ltd. contains two horizontal drum, double pass, double header, natural circulation water-tube boilers each rated at 16,000 lb/h at 250 psi and 550 F, equipped with economizer and pressure jet oil burner for a turndown ratio of 4:1 firing 950 sec oil. The thermal efficiency of the boiler exclusive of economizer and air heater is over 80 per cent. The steam is supplied to 380 kw turbogenerator running in parallel with the Grid. Part of the condensate is used in unit heaters for space heating. The exhaust steam from the boiler feed pumps is used either for heating the fuel oil or the feed water.

A Canadian Chemical Company Chooses Coal. Anon. *Coal Utilization* 1961, **15** (July), 8–10.

Coal for the Sarnia works of Dow Chemical Co. of Canada is brought by self-unloading lake ships from Lake Erie up the St. Clair river and discharged into a large hopper at the water's edge from which it is moved by belt conveyor to a cantilevered radial stacker at a rate of 2500 t/h. The stacker can travel through an arc of 150 deg. and repositions itself when a pile has reached a predetermined height. Crawlers and stackers compact the coal and reclaim to a central hopper from which it is transported to a crusher house and then to the boiler house bunkers at a rate of 440 t/h. The whole coal-unloading system is automatically controlled. Two boilers are each

rated at 300 klb/h at 1415 psi and 880 F, the third at 300.6 klb/h at 475 psi and 935 F, but all operated at 475 psi and 575 F until back-pressure turbogenerators are installed. The boilers are equipped with Turbo Furnaces with liquid slag removal and fly ash refiring.

57 Varieties Rely on Coal. T. S. Spicer. *Coal Utilization* 1961, 15 (May), 14–17.

The greatly increased steam demand of the H. J. Heinz Co.'s food factory at Pittsburgh necessitated the replacement of the old boilers by new ones. First two spreader stoker fired boilers each rated at 70,000 lb/h at 600 psi and 750 F and a thermal efficiency of 82.7 per cent were installed, later 5 boilers rated at 40,000 lb/h at the same steam conditions and an efficiency of 85.5 per cent. These latter boilers are equipped with jet ignition chain-grate stokers which do not require refractory arches but rely on overfire air jets in the front wall for rapid ignition and complete combustion. The ¾-in. coal is tempered by steam to a moisture content of 10–12 per cent. The steam is expanded in two 3000 kw turbogenerators exhausting at 115 psi and 450 F to the process mains.

Atomic Plant is Announced by PG and E. Anon. *Elect. Wrld.* 1961, 156 (July 10), 54.

Pacific Gas and Electric Co. is applying for a licence to build a 325 Mw gross and 313 Mw net nuclear power station at Bodega Bay. The reactor will be of the direct-cycle, boiling water type with forced circulation and internal steam separation, the fuel 75 t of uranium oxide pellets, 2.5 per cent enriched, in stainless steel tubes. The turbine will receive steam at 1000 psi and 544 F. The thermal efficiency will be 32.5 per cent. It is estimated that power can be produced at 5.62 mills per kwh against 5.77 mills/kwh when using oil and a load factor of 90 per cent.

Materials and Manufacturing Processes

Iron, Carbon Steel, and Alloy Steel. H. S. Link and R. J. Schmitt. *Ind. Engng. Chem.* 1961, 53 (July), 590-5.

A review of the literature published during 1960 dealing with new or improved alloys, their welding and corrosion.

Stainless Steels and other Ferrous Alloys. W. A. Luce and J. H. Peacock. *Ind. Engng. Chem.* 1961, 53 (July), 586–9.

This review of the literature of the past year deals with: (1) General; (2) Corrosion; (3) Mechanical properties and structure; (4) High temperature properties; (5) Welding; (6) Manufacture, metal working and sur treatment; (7) Miscellaneous iron ase alloys.

Corrosion of Carbon and Low-Alloy Steels in Out-of-Pile Boiling-Water-Reactor Environment. D. C. Vreeland, G. G. Gaul and W. L. Pearl. *Corrosion* 1961, 17 (June), 95–102.

Data and metallographic and visual observations of specimens tested in saturated steam, saturated water and a steam-water mixture at 545 F and 1000 psi are reported. No appreciable difference of corrosion rates between carbon steels, high-strength low-alloy and alloy steels were found, but these were higher than those of Type 300 stainless steel.

The Connection of Zircaloy-2 with Stainless Steel for Operation over a Wide Temperature Range. C. G. Duff. *Nucl. Sci. Engng.* 1961, 10 July), 278–84.

A method of joining Zircaloy-2 and stainless steel using a controlled expansion transition section is described.

Oxidation of Iron-Chromium Alloys 750–1025 C. D. Lai, R. J. Borg, J. J. Brabers, J. D. Mackenzie and E chenall. *Corrosion* 1961, 17 uly), 309–16.

Alloys containing from 0.2 to 10 per cent Cr were exposed in an oxidizing atmosphere to temperatures of 750–1025 C, the corrosion rates measured and the corrosion products examined. Oxidation rates decreased with increasing Cr content, but no simple rate law could be deduced.

High Temperature Aqueous Corrosion of Aluminium-Plutonium and Aluminium Silicon-Plutonium Alloys. C. Bowen. *Corrosion* 1961, 17 July), 12,

The tests carried out in water at C showed that the corrosion resistance increased with increasing percentage. Addition of silicon eased the corrosion resistance.

High Temperature Aqueous Corrosion Aluminium-Uranium and Aluminium-Silicon-Uranium Alloys. H. C. en and R. L. Dillon. *Corrosion* , 17 (July), 9–11.

Aluminium-uranium and aluminium-silicon-uranium alloys were sheathed in alloy and then exposed to deoxygenated water at 350 C through a 0.5 in. hole in the cladding. Al s ld contain more than 6 per cent uranium, Al-Si alloys with 6 per cent uranium were also satisfactory.

Combustion

DEVOTED TO THE ADVANCEMENT OF STEAM PLANT DESIGN AND OPERATION

volume 33 number 7 **January 1962**

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Published monthly by COMBUSTION PUBLISHING COMPANY, INC., 200 Madison Ave., New York 16. A SUBSIDIARY OF COMBUSTION ENGINEERING, INC.

Charles McDonough, President

Arthur J. Santry, Jr., Vice-President

Lambert J. Gross, Treasurer

Thomas A. Ennis, Secretary

COMBUSTION is sent gratis to engineers in the U. S. A. in charge of steam plants from 20,000 lbs per hr capacity up; and to consulting engineers in this field. To others the subscription rate, including postage, is $4 in the United States, $5.50 in Canada, and $8 in Latin America and other countries. Single copies: Domestic, 40 cents, Foreign, 60 cents plus postage.

Publication Office, Easton, Pa. Issued the middle of the month of publication.

Controlled circulation postage paid at Easton, Pa.

COMBUSTION publishes its annual index in the June issue and is indexed regularly by Engineering Index, Inc. and also in the Applied Science & Technology Index.

The magazine is now reproduced and distributed to libraries on microfilm by University Microfilms of Ann Arbor, Michigan.

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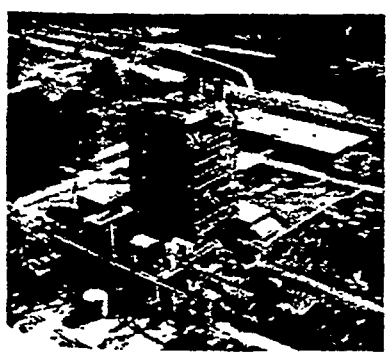
Printed in U. S. A.

COVER PHOTO

Aerial view of the Little Gypsy Station of Louisiana Power & Light Co. as it appeared in late Fall of a year ago



Abstracts from the Technical Press—Abroad And Domestic

(Drawn from the Monthly Technical Bulletin, International Combustion, Ltd, London, W. C. 1)

Instruments and Controls

Aspects of Power Plant Automation. M. Birnbaum, G. Kotnick and D. M. Sauter. *A.S.M.E. Preprint* No. 61-SA-65 1961 (June), 8 pp.

An investigation has been carried out based on an actual plant unit (Crombie No. 2, Philadelphia Electric Co., 200 Mw) to establish which parts of the system should or should not be automatically controlled and how far a digital computer could be used to: (1) Data logging, monitoring and results printing; (2) Sequencing the plant through starting, stopping and operation; (3) For proportional, reset and rate actions required for stability of plant variables during disturbances and load changes. It is concluded that all parts of the system can be safely automated with the exception of coal firing. The economics of a computer controlled plant are discussed.

amic Representation of a Large oiler-Turbine Unit. J. H. Daniels, M. Enns and R. D. Hottenstine. *A.S.M.E. Preprint* No. 61-SA-69 1961 (June), 16 pp.

A mathematical analysis has been made of the entire boiler, turbine and heat cycle of a large unit based on the 200 Mw Crombie No. 2 unit of Philadelphia Electric Co. to develop techniques for the construction of dynamic models from which controls can be designed. Results of digital computer solutions for a number of important plant variables are given as functions of time in response to plant actuators. The appendix gives the assumptions and development of the equations used.

Measurement of Corrosion. Anon. *Coke and Gas* 1961, 23 (Aug.), 344.

The "Corrosometer" of American origin now available in Gt. Britain is suitable for measurement of corrosion of metals and alloys in the laboratory, process and storage plants by giving a direct reading of the corrosion rate in less than a minute. The readings from the probe are direct in micro-inches or centimeters.

suring Microgram Quantities of Dissolved Oxygen. Anon. *Pwr. and Wrks. Engng.* 1961, 56 (Aug.), 667–8.

The instrument is completely specific to oxygen down to concentrations below 1 gram in 2000 million grams of water, operates on the gas transfer method of analysis and is unaffected by the presence of impurities or chemicals used in feed water treatment. The analyzer can be combined with a recorder with two ranges of reading, 0–0.01 ppm and 0–0.10 ppm.

Nuclear Power Control. F. H. Belsey. *AEI Engng.* 1961, 1 (July/Aug.), 260–70.

The characteristics of a power reactor on load are set out and the requirements and methods of functioning of its control system described.

Nuclear Energy

Reactor Materials and Radiation Damage. G. E. Darwin and A. A. Johnson. *Nucl. Pwr.* 1961, 6 (Aug.), 69–75.

A survey is presented of the contents of papers read at the Conference organized by the C.E.G.B. at their new Berkeley Nuclear Laboratories. These dealt with damage flux determinations, focusing collisions, direct and indirect methods of observing defects, irradiation hardening, fracture, corrosion, growth and swelling.

The Safety of Research Reactors. J. F. Croft. *Nucl. Pwr.* 1961, 6 (Aug.), 76–9.

The dangers involved in fission chain reactions, the hazards arising from it and the possibility of guarding against them are discussed. The safety measures incorporated in various types of reactor and their reliability are described.

On-Load Refueling Problems. K. H. Dent. *Nucl. Pwr.* 1961, 6 (Aug.), 69–74.

The problems and especially the hazards which may arise in on-load refueling of nuclear reactors are discussed and the economic advantages and disadvantages set out.

Experimental On-Load Fueling of Calder Hall Reactors. Anon. *Engineer* 1961, 212 (Aug. 11), 241.

Experiments simulating on-load fuel charging as to be carried out in the civil reactors were conducted at the Calder Hall reactors to check if the fuel elements would withstand the temperature changes. No significant effects were found. Similarly, the effect of thermal cycling on fuel elements was studied at Calder Hall and again no ill-effects were found.

Basic Radiation Effects Reactor. Anon. *Nucl. Pwr.* 1961, 6 (Aug.), 75.

The BRER has been designed to provide a high-level, high-energy neutron flux with low thermal neutron and γ-ray background and a neutron energy spectrum peak between 10 and 1000 keV. The reactor is rated at 1 Mwt and has a core volume of 6.9 l with fuel elements of U235 + 2 per cent Zr clad in Zircaloy-2, a maximum surface temperature of 210 C and a lead + steel reflector. Coolant is NaK with an inlet temperature of 60 C and an outlet temperature of 177 C. Some details of the design are given.

Belgium's Novel Research Reactor—BR-2. Anon. *Nucl. Engng.* 1961, 6 (July), 276–80.

The shape of the reactor vessel is that of an hour glass due to the bundling of the core access channels in the centre and their splaying out along the generating lines of revolution of hyperboloids to maintain a negative

coefficient and to obtain a minimum critical size mass. This also allows sufficient space between channels to make good seals where they pierce the reactor pressure vessel. The fuel is 90 per cent enriched uranium alloyed with 75–80 per cent Al in Al sandwich. The core moderator and reflector is light water and beryllium, the coolant light water at 174 psi and 40 C at the inlet and 142 psi and 47 C at the outlet. The research facilities are described.

Compact Reactor Development for Ground Nuclear Power Applications. M. A. Rosen, T. W. McIntosh and R. A. Duval. *A.S.M.E. Preprint* No. 61-SA-42 1961 (June), 11 pp.

The development of nuclear power plants in the range of 3 to 8.2 Mw (th) of the boiling water type and of 10-28 Mw (th) of the pressurized water type for the American army is outlined. These plants have to be so compact that they can be easily transported to their fixed destination or can be transported intact and moved from site to site.

Symposium on the Dounreay Fast Reactor. Various Authors. *J. Brit. Nucl. Energy Conf.* 1961, 6 (July), 159–252.

The complete tests of the contributions to the symposium are presented: (1) Introductory paper by R. V. Moore and R. Hurst; (2) Design and construction of the DFR core, reactor vessel, fuel handling equipment and shielding, by J. Tatlock, A. G. Frame, P. K. Richards and R. Bellinger; (3) Design and construction of the DFR heat-transfer circuits, steam-generating plant and reactor control system, by R. R. Matthews, W. G. Hutchinson, P. K. Richards, A. S. Fenemore and M. H. Ewbank; (4) Dounreay Fast Reactor metallurgical problems, by C. R. Tottle, D. S. Oliver and K. Q. Bagley; (5) Dounreay Fast Reactor physics, by R. D. Smith and D. C. G. Smith; (6) Testing, commissioning and initial operation of the Dounreay Fast Reactor, by J. C. Phillips, R. R. Matthews and W. M. J. Davies.

"Dragon" High Temperatures Reactor Project. Anon. *Engineer* 1961, 212 (Aug. 11), 237–9.

The main contents of the second annual report on this project published by the O.E.E.C. European Nuclear Agency are summarized, giving details of research and development on graphite and fuel elements, reactor design and construction.

Long-term Behavior of a Homogeneous Spherical Natural Uranium Heavy Water Reactor with Outer Control Rod Zone. D. Schwalm. *Atomkernenergie* 1961, 6 (July/Aug.), 273–85 (in German).

The problem of so dimensioning the reactor that it has a long life has been studied. Burn-up, poisoning and conversion have been taken into account in determining the change of control rod position with time in the critical state.

Nuclear Reactor Accident in Idaho. Anon. *Engineer* 1961, 212 (Aug. 11), 250–3.

A further report with more details of the reactor design and operation prior to the incident has been issued. Evidence to the extent of damage caused has been obtained and from this the most likely cause of the

Fuels: Sources, Properties and Preparation

Research and Development on Coal. C. M. Cawley. *J. Inst. Fuel* 1961, 34 (*Sept.*), 375–81.

Lines of research and development in winning, storage, handling, transport, preparation and utilization of coal are reviewed and it is suggested that the greatest scope lies in the combustion field. Means of increasing combustion, e.g., slagging (cyclone) furnaces and fixed bed with counterflow, reduction in the harmful effects of the mineral constituents of coal, e.g., finer grinding, and automatic mechanical handling of coal and ash in small and medium size boilers are discussed. The aim should be a new system of combustion with greater heat release rates, lower capital costs and higher efficiency to obtain lower overall costs.

Coal Research. J. S. Shannon. *Reprint from Proc. Roy. Austral. Chem. Inst.* 1960 (*Apr.*), 164–75. The various techniques used for investigating the chemical structure of bituminous coal are described briefly and the often contradictory results obtained critically reviewed. The influence of structure on coal carbonization is discussed.

The Chemistry of Sulfur in Coal. P. H. Given and W. F. Wyss. *B.C.-U.R.A. Monthly Bull.* 1961, 25 (*May*), 165–79.

The review contains the following chapters: 1. Introduction; 2. The chemistry of certain sulfur compounds; 3. Decomposition of organic sulfur compounds; 4. Alkylation of sulfides and its use in the study of sulfur in coal; 5. Desulfurization of coals and cokes; 7. Appraisal and conclusions. It is thought unlikely that an economic method of sulfur removal from coal and coke will become available.

Analysis of the Shatter Breakage of Coal Using a Matrix Method. R. Berenbaum. *J. Inst. Fuel* 1961, 34 (*Sept.*), 367–74.

The matrix analysis technique has been applied to shatter tests of coal. as been found necessary to apply a modification to allow for the variation of probability of breakage of coal in shatter tests with particle size. It is thus possible to classify and predict the shatter breakage of coal assemblies of mixed size by a single parameter.

Pyrolysis of Coal and Shale. M. Gomez and C. H. Prien. *Ind. Engng. Chem.* 1961, 53 (*Aug.*), 674–9.

The review of literature published in 1960 deals with: 1. Pyrolysis of coal (mechanism, kinetics, thermochemistry); 2. Low and high temperature carbonization; 3. Oven operation, products, by-products; 4. Pyrolysis of oil shale (general); 5. Basic research; 6. Retorts and retorting processes; 7. Shale oil and by-products.

Properties and Behavior of Greek Brown Coals in the Furnace and Consequences for the Design and Operation of Boilers. K. Lefas. *Mitt. V.G.B.* No. 73, 1961 (*Aug.*), 243–51 (*in German*).

The various brown coal fields and the properties of the coal and their ash are described. The higher quality wn coals are mostly used for makbriquettes and as fuel in small boilers provided with compartmented traveling grates, under-grate and overfire air; shell-type boilers are less suitable than water-tube boilers. The low quality coal is used in pulverized form in power stations built near the mines and requires pre-drying. Difficulties caused by deposits and corrosion have not been experienced.

Heat: Cycles and Transmission

Analysis of Film Boiling on Vertical Surfaces. J.C.Y. Koh. *A.S.M.E. Preprint* No. 61-SA-31, 1961 (*June*), 8 pp.

Discrepancies between analytical and experimental results made it desirable to solve the film-boiling problem exactly within the framework of the laminar boundary-layer theory and thus to provide a basis for tests on the accuracy of the approximate solutions. The results of this new analysis are compared with previous approximate solutions.

Steam Generation and Power Pro- on

Spherical Vessels Thermal and Pressure Stresses. A. Omerod. *Engineer* 1961, 212 (*Aug.* 25), 313–4.

A design formula for the required wall thickness of pressure vessels in terms of fluid pressure, temperature difference between inside and outside walls and maximum permissible stress in the material has been developed.

Thermal Stresses in the Wall of a Reactor Vessel with Inner Heat Source in Non-Steady-State-Operation. B. I. Maksimenko, K. N. Nikitin and L. I. Baskirov. *Kernenergie* 1961, 4 (July), 569–73 (in German).

Starting from the solution of the non-steady-state thermal conduction equation with inner heat source a comparative analysis of thermal stresses occurring during transition periods is carried out for plane and cylindrical walls of a reactor. The equations can be used in the calculations of fuel elements, reactor vessels and other parts for transition periods, starting and shutdown.

Modern Forced Circulation Waste Heat Boiler in the Trier Gasworks. G. Anders. *Energie* 1961, **13** (*Aug.*), 343–6 (*in German*).

At the Trier gasworks a vertical forced-circulation boiler for the generation of 2540 lb/hrat 184 psi and 572 F has been installed in place of two smoke-tube boilers. Because of the S content of the waste gases with acid dew point of 293–302 F the temperature at the boiler exit was fixed at 365 F and this is obtained by admixing water from the drum to the incoming feedwater. Both passes of the boiler are cleaned by steel shot. The output of this boiler is 60 per cent higher than that of the two previous boilers.

The Merits of a Single Stage Solvent for Simultaneous Removal of Copper and Iron Oxides. J. P. Engle. *Combustion* 1961, **33** (*Aug.*), 41–4.

The theoretical basis of using a complexing agent (thiourea) together with an hydrochloric acid solution for removing both iron and copper oxides is presented and the results of field tests described which confirmed the soundness of the theory. Copper bearing iron oxide matrices have been removed much more easily by the addition of the complexing agent and corrosion has not been increased.

Liquid and Gaseous Fuel Firing

Operational Experience on Oil-fired Boilers during Firing of Fuel Oil with Lowest Excess Air. F. Glaubitz. *Mitt. V.G.B.* No. 73, 1961 (*Aug.*), 289–96 (*in German*).

Following an earlier account on the prevention of clogging and corrosion of air heaters of oil-fired boilers by the modification of the burners and the

mum this report deals with the operational experience of boiler No. 4, a radiant boiler rated at 110/140 klb/hr at 626 psi and 887 F operated under pressure and provided with corner burners of the improved design. During the acceptance tests the excess air was 3.2 per cent and the thermal efficiency 91.4 per cent; since then the excess air has been reduced to 2 per cent, the flue gas temperature from 381 to 284 F and, together with the closing down of the steam-air preheater no longer required, the efficiency increased to 94.8 per cent. A total of 12,000 hr has been reached without corrosion or clogging with blank metal surfaces in the convection pass and only a slight dust film on the superheater. The soot blowers and steel shot cleaners were never used. Contributing to this success was close attention to the whole oil and air control system.

Experience on Oil-Fired Boilers with Corner and Front Wall Burners. P. Ensink. *Mitt. V.G.B.* No. 73, 1961 (*Aug.*), 297–303 (*in German*).

The first boiler rated at 70/88 klb/hr at 953 psi and 932 F was originally equipped with slagging furnace and p.f. coal and oil corner burners and these later supplemented by corner burners near the furnace roof firing downward. Corrosion and clogging of the air preheater occurred when part of the flue gas was used for drying ite lye and the flue gas was re-ned to the air preheater. It is concluded that corner-fired boilers can be operated without difficulties, using oil of any kind, origin and S content if the excess air is kept below 5 per cent. The new second boiler designed for oil-firing and rated at 55/70 klb/hr at 953 psi and 932 F had to be re-equipped with modified front firing burners.

Furnaces and Combustion

The Shock Tube as a Tool in Fuel and Combustion Research. H. B. Palmer. *J. Inst. Fuel* 1961, 34 (*Sept.*), 359–67.

The use of shock tubes for the elucidation of the kinetics of fast gaseous reactions and some of the results obtained in such studies are described. It is suggested that a shock tube may also prove a valuable tool in research of ignition and combustion problems of liquid and solid fuels.

Incinerator Furnace Temperatures—How to Calculate and Control it. H. G. Meissner. *Combustion* 1961, 33 (*Aug.*), 35–9.

The calculations necessary to obtain optimum furnace conditions for the burning of municipal or industrial r . are presented in tables and graphs.

Abstracts from the Technical Press—Abroad And Domestic

(Drawn from the Monthly Technical Bulletin, International Combustion, Ltd, London, W. C. 1)

Fuels: Sources, Properties and Preparation

Fuel Technology in the United States. H. Perry and C. C. Anderson *J. Inst. Fuel* 1961, 34 (Oct.) 421–39.

A broad review is presented, supported by many tables of statistics, of coal, petroleum and natural gas resources, their winning and preparation methods, transportation and utilization. Research on coal and on petroleum and associated hydrocarbons is outlined.

Coal Science. I. G. C. Dryden. *Nature* 1961, **192** (Oct. 14) 116–9.

The 53 papers presented to the fourth International Conference on Coal held at Le Touquet during May 30—June 2 are reviewed under the headings: (1) chemical properties; (2) physical properties, (3) thermal decomposition.

The Selection and Utilization of Industrial Coals—I. A. C. Dunningham. *Steam Engr.* 1961, 31 (Oct.) 16–9.

The first part tabulates and discusses properties and classification of coals.

The Tensile Strength of Coal. I. Evans. *Coll. Engng.* 1961, 38 (Oct.) 428–34.

The various methods used for determining the tensile strength are described and their suitability discussed; the disk method is regarded as the best. The results of tests of tensile and compressive strength are compared. The low tensile strength is caused by the brittle nature of coal owing to the multiplicity of cracks in the material.

Development of and Experience with Coal Loosening Devices in Boilerhouse Bunkers. H. Krüger. *Energietech.* 1961, 11 (Sept.) 410–5 (in German).

The bunkers of the Theissen power station (East Germany) containing coal with up to 58 per cent moisture suffered from frequent arching, clogging and funnel formation leading to complete stoppage of coal feed to the grates. This has now been solved by installing on the lower part of each bunker a number of compressed air (10 at) nozzles which are operated in sequence as soon as arching and clogging is observed.

Steam Generation and Power Production

Behavior of Metallic Thick-Walled Cylindrical Vessels or Tubes Subject to High Internal or External Pressures at Elevated Temperatures. A. E. Johnson, J. Henderson and B. Khan. *Inst. Mech. Engrs. Preprint* 1961, 29 pp.

The first part of the paper develops theoretical relations between stress, strain rate and time, the second applies these relations to several alloys at temperatures within their practical working ranges. A complete example is worked out in detail.

Notes on Incremental Collapse in Pressure Vessels. H. G. Edmunds and F. J. Beer. *J. Mech. Engng. Sci.* 1961, 3 (Sept.) 187–99.

An analysis is presented of simple cases of incremental collapse which may be significant in pressure vessel design. Both incremental collapse limit of strain and the magnitude of the incremental strains after exceeding this limit can then be predicted. The differences between analytical and experimental results are discussed.

Rim Reinforced Openings—Pt. II. R. Kitching and J. Perkins. *Nucl. Engng.* 1961, 6 (Oct.) 423–5.

The methods described in the first part have been extended to allow calculation of the stresses around a branch subject to a bending moment.

Strength of Rim Reinforcements for Manholes in Welded Storage Tanks. R. T. Rose. *Brit. Weld. J.* 1961, 8 (Oct.) 491–501.

The replacement of a doubler plate by a tubular rim for the reinforcement of circular manholes has been studied and found to provide equal safety but to require only $^1/_5$ the material and much less welding. Results of tests and stress calculations are presented.

Calculation of the Thermodynamic Differential Quotients for Water Vapor. L. S. Dzung and W. Rohrbach. *B.W.K.* 1961, 13 (Oct.) 441–5 in (German).

Graphs have been computed for compressibility factor, isentropy exponent, isenthalpy exponent, ratio of specific heat, isobaric expansion coefficient, isochoric stress coefficient, isothermal modulus of elasticity for pressures up to 500 bar (7000 psi) and temperatures up to 800 C (1470 F).

Diagrams for the Calculation of the Tolerance of Enthalpy Differences for Water Vapor. O. Seibert. *B.W.K.* 1961, 13 (Oct.) 446–56 (in German).

The tolerance $\Delta i = i_1 - i_2$ valid for the generating and reheating of steam is discussed if i_1 and i_2 are taken from the steam tables. The actual errors in the measured values are evaluated by statistical methods and their effect on the enthalpies and their differences determined. It is argued that the "Table Tolerances" for the enthalpies in the International Steam Tables do no longer meet present requirements and that the Table Tolerances should be defined as error limits or as standard deviation.

Factors Affecting the Choice of New Boiler Plant—I. W. Short. *Steam Engr.* 1961, 31 (Oct.) 13–5.

This first part deals with practical efficiences of various types of shell-type boilers, target efficiencies and possibilities of increasing the efficiency of boilers in operation.

Fire-tube Packaged Boilers. A. G. Nuttall. *Pwr. and Wrks. Engng.* 1961, 56 (Oct.) 835–42.

Oil-fired packaged fire-tube boilers of 2, 3 or 4-pass design, ratings and efficiency are reviewed, gas flow patterns, burners, control, service and maintenance described and their advantages and disadvantages are discussed. These boilers are now available for outputs of up to 37,500 lb/h, pressures of 250 psi and efficiencies of over 80 per cent.

Water-Side Corrosion and Water Treatment

Flash Evaporator Competes with Demineralizer for Feedwater Treatment. Anon. *Power* 1961, 105 (Oct.) 150–2.

Flash evaporators originally developed for sea-water conversion are proving competitive with demineralizers where highquality feedwater is available for start-up. It is also suggested to use flash evaporators in place of condensers to produce potable water from seawater where such water is in short supply.

Water Treatment. Packaged Systems Take on More Jobs. Anon. *Power* 1961, 105 (Oct.) 82–3.

In America, packaged filters, softeners, demineralizers, chemical feeds

and deaerators are now available and used increasingly in small and medium-sized boiler plants. The reduced cost of such plants has made the introduction in smaller boiler installations economically attractive.

Removal of Humic Acid, Iron and Oil from Ion Exchangers. K. Dickels. *Energie* 1961, 13 (Sept.) 391 (in German).

It is shown that humic acids can be removed by repeated application of solution of sodium chloride and caustic soda in water, iron by the use of hydrochloric acid and traces of oil by the use of benzene.

Gas-Side Corrosion and Deposits

The Occurrence of Corrosion on the Fire Side of Modern Boilers. W. D. Jarvis. *Chem. and Ind.* 1961 (Oct. 21) 1687–95.

A review of recent laboratory and field research of the causes of gas-side corrosion and its prevention.

Measurement of Solids in Flue Gases. P. G. W. Hawksley, S. Badzioch and J. H. Blackett. *Brit. Coal Utilization Res. Assoc.* 1961, 214 pp.

The book is divided into three parts and eleven appendices. Part One "A routine method of sampling" gives detailed procedures for measuring grit and dust with an accuracy of ±2½ per cent. Part Two "Practical aspects of sampling" deals with methods and conditions for accurately determining the mass rate of flow of solids (or of grit, dust and soot separately). Part Three "Theoretical aspects of sampling" discusses the physics of sampling and methods of studying the flow of solids through flue ducts. The Appendices (almost half the contents of the book) deal with: (1) construction of cyclone probe; (2) construction and use of pitot tube; (3) volume flowrate of flue gases; (4) specific gravity of flue gases; (5) efficiency of sampling cyclone; (6) calibration of flow meter; 7) conditions for isokinetic sampling; 8) range of flowrates for sampling; 9) terminal velocities of particles; 10) tabular method of analysis of variance; (11) optical density of smoke.

Experience with Steel Shot Cleaners in Boilers. R. Hamm. *Tech. Überw.* 1961, 2 (Oct.) 374–6 (in German).

Damage to tubes and brickwork caused by unsuitable installation of steel shot cleaners and remedies introduced are described.

Venturi Scrubber for Waste Gases. Anon. *Brit. Engng. and Transp.* 1961, (Nov.) 114.

In this new venturi scrubber water is introduced into the gas stream up

stream of the venturi so that the gas must pass through two cones of water. The droplet size of the water can be varied by moving the spray nozzles toward or away from the nozzle. Efficiencies of 99.8% in the range of 5 to 0.05 μ and dust densities of 0.03 gr/cu. ft. can be obtained..

Fly Ash Concretes Meet Road Specs. F. M. Reinhold. *Elect. Wrld.* 1961, **156** (Sept. 25) 50.

The Connecticut Light and Power Co. has tried out several mixtures of fly ash and cement on an access road to determine their suitability for highway construction. The mixtures were: $6^1/_2$ bags cement—no fly ash, $5^1/_2$ bags—158 lb fly ash, $4^1/_2$ bags—130 lb fly ash, $3^1/_2$ bags—133 lb fly ash, $4^1/_2$ bags—128 lb fly ash per cubic yard. All the mixes with the exception of the $3^1/_2$ bag mix would meet the authority's requirements. Experience over several years is required to prove that roads made of these mixes keep as well as those made of concrete only.

Chimney Design for Industrial Boiler Plant—II. W. N. Varlow. *Steam Engr.* 1961, 31 (Oct.) 20–3.

The second part discusses design and construction of brick chimneys.

Heat Recovery Plant

Air versus Water Cooling. F. Molyneux. *Mech. Wrld.* 1961, **141** (Oct.) 343–9.

The method developed by Murtha and Friedman is used to establish the dimensions required for an air-cooled heat exchanger.

Design of Heat Exchangers by Digital Computers. D. K. Houtby. *Chem. Proc. Engng.* 1961, **42** (Oct.) 442–6.

At Bradford Institute of Technology a universal program for the determination of heat exchanger size by digital computer is in progress. Results obtained so far are outlined.

A New Aluminum Heat Exchanger. L. Forgo. *Allg. Wärmetech.* 1961, **10** (Aug.) 149–56 (in German).

The heat exchangers for the air cooling of the condensate in power stations by the system developed by Prof. Heller are made of aluminum. The inventor of these heat exchangers gives the reasons for choosing aluminium instead of copper, describes the various types of exchanger developed, discusses heat transfer and ventilation power, indicates the fabrication methods employed and compares his design with usual heat exchangers. Prevention of vibration has required careful research; the solutions adopted are described.

Power Generation and Power Plant

1961 Industrial Plant Design Survey. Anon. *Power* 1961, **105** (Oct.) S5–95.

Details are tabulated of 189 industrial and institutional plants with regard to boilers, firing equipment, coal and ash handling, fans, pumps, water treatment, turbines and condensers, boiler controls and total capacity. The trend is toward increased gas and oil firing, higher heat release rates, larger boiler and turbine sizes, pneumatic ash handling and more tubular air preheaters.

1961 Central Station Design Survey. Anon. *Power* 1961, **105**, (Oct.) 159–69.

This survey of 75 steam power stations shows that the trend toward higher steam pressure and temperatures, large boilers and turbines and the employment of pressurized furnaces continues. Pulverized coal is still the main fuel, but gas and oil combinations are advancing. The number of outdoor boilers is also increasing. In coal-fired boilers furnace heat release rates are generally below 20,000 Btu/cu ft h, in oil and gas fired boilers these are mainly between 22,000 and 30,000 Btu cu ft h.

12th Steam Station Cost Survey. D. Braymer. *Elect. Wrld.* 1961, **156** (Oct. 2) 69–84.

The main features of 57 new or expanded steam power stations, including data on space factors, are tabulated and analyzed. The energy costs at the busbars dropped on average from 7.15 mills in 1956 to 6.9 mills in 1960, with 5.63 mills for 500 Mw stations. Average cost has increased by $12 to $152.5/kw. Operating costs have decreased by 6 per cent since 1958, with the average plant factor increasing to 65 per cent, average fuel costs decreasing 3.5 per cent and labour costs averaging 0.19 mills/net kwh against 0.25 mills in 1958. Coal-fired stations required 1.36 to 2.8 times more manpower than gas or oil-fired stations. Average net heat rate was 10,356 Btu/kwh, the best 8975 Btu/kwh.

Small Coal Utilization. P. Tate. *Coll. Guard.* 1961, **203** (Sept. 28) 377–86.

The efforts made to improve the efficiency of burning small coal ($-^1/_2$ in.) slack with 15.5 per cent moisture, 12.1 per cent ash, 31.1 per cent V.M; 1.42 per cent S and 9950 Btu/lb C.V. in two 5500 lb/h and one 11,500 lb/h economic boilers are described. The average annual efficiency is 75.7 per cent, the cost 5/7.9d per 1000 lb of steam with no smoke emission and 0.16 grn/cu ft of grit in the flue gas. Details are given of the

balling test for coal conditioning (moisture content), glass lining of bunkers and chutes, fuel bed depth, air flow adjustments, prevention of deposit formation by modification of the bridge, installation of baffles and ot blowing.

Binary Cycle Proposes to Boost Thermal Efficiency. Anon. *Power* 1961, 105 (Oct.) 149.

A binary cycle using steam and Payon 12 (dichlorodifluoromethane) is described which in a 200 Mw plant would lower the heat rate by 180 Btu/kwh and increase the net output by 5.4 Mw. Steam would be generated at 3500 psi and 1100 F, reheated to 1050 F and the exhaust steam from the ip turbine divided to heat the Payon 12 to 230 F at 500 psi driving a 50 Mw turbine and to drive a 8 Mw non-condensing turbine, both turbines on the same shaft driving a 58 Mw generator. The steam from the non-condensing turbine would be used to preheat the Payon 12 and then combined with the condensate from the Payon 12 boiler, the combined condensate being preheated by steam extracted from hp and ip turbines before being returned to the boiler.

Silencing Steam Exhaust Systems. W. L. Martin. *Brit. Pwr. Engng.* 1961, 3 (Oct.) 44–9.

The various points at which noise is c ted in power stations by steam ust systems and remedial measures are discussed. The main sources of such noise are the vent pipes on blow down vessels, boiler drains and safety valves and advice is given how to achieve silent operation in each case.

Magnetoplasmadynamic Electrical Power Generation. B. C. Lindlag. *Brit. Pwr. Engng.* 1961, 3 (Oct.) 30–7.

Papers presented to the "Second Symposium on Engineering Aspects of Magnetohydrodynamics" in America are reviewed and the prospects of the actual application of this principle of electricity generation discussed.

Carry-over in Boilers at Cowes Generating Station. J. Solari. *J. Inst. Fuel* 1961, 34 (Oct.) 447–56.

Loss of chemicals, reduced superheater temperatures necessitating fortnightly washing, superheater tube failures and turbine deposits led to a lengthy investigation into the causes of carry-over. After modifications to the steam washing and scrubbing devices had proved unsuccessful it was found that the carry-over was caused by essive circulation in some boiler tubes which was remedied by the insertion of ferrules into the tubes to restrict the flow. Although carry-over was not entirely prevented it was sufficiently reduced to operate the boiler without superheater washing; no further tube failure has occurred. The design and application of the Salagraph to continuously measure the conductivity of the steam are described.

Mica Creek Power Station—Queensland. Anon. *Engng. Boil. Ho. Rev.* 1961, 76 (Oct.) 330–5.

This new station is being built by the Mount Isa Mines Ltd. to supply power to their mines and preparation plants and the town of Mount Isa. It contains at present one unit in operation and one under construction but can be enlarged to four units. Each unit consists of a boiler rated at 250 klb/h at 950 psi and 870 F and a 30 Mw turbogeneration both in semi-outdoor design. The boilers are pulverized coal fired supplied by 3 E-type mills per boiler. The feed water is treated in a mixed-bed demineralizer. The turbines are single-cylinder machines with 4 stages of steam extraction. The circulating water is cooled in a five-cell forced-cooling tower.

Con Ed Orders First 1000 Mw Unit. Anon. *Elect. Wrld.* 1961, 156 (Oct. 2) 63.

Consolidated Edison Co. which is part of a 40,000 Mw generating system has ordered a 1000 Mw turbogenerator to operate at 2400 psi and 1000/1000 F with the hp and ip sections on the 3600 rpm shaft and the three lp sections on the 1800 rpm shaft. The unit is to be installed in a new station next to the East River station and to be commissioned in 1966.

Paradise Plant Designed for 1300 Mw in First Two Units. R. A. Elliott, W. F. Emmons and H. T. Loft. *Elect. Wrld.* 1961, 156 (Sept. 11) 48–51, 84.

The two 650 Mw units will each consist of a cyclone-fired, once-through boiler rated at 4900 klb/h at 2450 and 1053 F with reheat to 1003 F, pressurized furnace, feedwater entry temperature of 533 F and tubular air preheater and a cross-compound turbogenerator, each shaft driving a 325 Mw generator. Raw river water will be made up in flash evaporators to save primary water treatment plant. The equipment will include stored-programme data - processing digital computors for performance calculation, partial automation and monitoring; it can later be expanded to complete automation. The net heat rate is calculated to be 8775 Btu/kwh.

A 120 Mw Unit after 20000 Operating Hours. T. Süthoff. *Tech. Mitt.* 1961, 54 (Sept.) 368–70 (in German).

The 120 MW unit of Rauxel power station supplies electricity to mines and to the public network. It consists of two Benson boilers with horizontal cyclones, each rates at 200 t/h at 180 atü, 527/527 C, a flue gas exit temperature of 130 C, air preheating to 450 C and feed water preheating in 8 stages to 256 C. The minimum load of each boiler is 40 per cent of m.c.r. = 80 t/h and it is thus possible to operate the turbine at 20 per cent load. The fuel is a mixture of middlings, dust and slurry and analyses 5005 kcal/kg, 26 (maximum 33) per cent ash, 11 per cent moisture, and 16–24 per cent V.M. Owing to the faulty arrangement of the dust nozzles in the cyclone the dust passed unburnt into the secondary furnace and its combustion took partly place in the radiation chamber; this led to severe fouling of the secondary superheater in the transition section to the convection pass. After modifications in the cyclone 4000 h of continuous operation were possible as against a cleaning of the boiler surfaces every 3 weeks required previously and the primary retention was increased from 63 to 81 per cent. Tube erosion in the corners of the secondary furnaces could be prevented by replacing the eroded plain tubes with studded tubes lined with a vanalized SiC mass. Accumulation of iron and tube failure in the bottom of the secondary furnace could be traced to steel shot being carried with fly ash from the hoppers of the second and third pass into the furnace; the steel shot has now been replaced by gravel.

Starting Up a 150 MW Unit-Type Installation. A. S. Paliichuk, O. I. Chaban, V. N. Shvets, M. Kh. Guseinov, M. Ya. Sluchishkin, V. S. Bobkov and L. A. Kurtsev. *Teploenergetika* 1961, **8** (July) 8–12 (in Russian).

The first Soviet 150 Mw outdoor unit consists of a TGM-94 gas-oil boiler, a PVK-150 turbine and a TGV-200 generator. The boiler output is 500 tons per hour and the rated parameters of the live steam in front of the turbine are 130 ats abs and 565 C, and of the secondary steam are 27.5 atm abs and 565 C. Described in this article is a simplified system for starting up the installation without a reduction cooling apparatus, and without initial heating of the boiler by extraneous steam, which was proved superior to the method employing reduction-cooling installations. (A.E.I. abstract).

From C.E.G.B. Digest 1961, **13** (Oct. 14) 2967.

Calder Hall 1956 to 1961. G. D. Ireland and J. R. Treharne. *Brit. Pwr. Engng.* 1961, 3 (Oct.) 50–5.

Maintenance of the reactor and ancillary equipment is described, especially the precautions necessary in handling contaminated materials and in working in contaminated areas. So far no signs of deterioration or incident failures have been observed and the plant utilization factor is as good as that of conventional stations.

Indian Point. Con. Edison's Thorium Converter. Anon. *Nucl. Engng.* 1961, **6** (Oct.) 413–23.

Indian Point nuclear power station on the Hudson river 24 miles north of New York city is expected to reach criticality by the end of 1961 and full power operation in 1962. It has a gross output of 275 Mwe of which 112 Mw is produced from oil-fired superheat. The pressurized water reactor has an output of 585 M with a fuel mixture of highly enriched uranium oxide and thorium oxide, the core being divided into three concentric zones with different uranium-thorium ratios. Details are given of the fuel and its arrangement in the core, the controls and control rod drives, pressure vessel, coolant system, pressurizers and boilers, secondary circuits, superheaters, turbogenerators and auxiliary machines.

Superheated Steam at Indian Point. E. C. Koch. *Heat Engng.* 1961, **36** (July/Aug.) 55–9.

The development of the design of the 2 separately-fired radiant-convection superheaters is described. Steam inlet conditions are 395 psi and 447 F and outlet conditions 360 psi and 1000 F; the pressure in the furnace is 25-in. H_2O. The superheating of the steam raises the output of the reactor from 163 to 275 Mw. Each superheater is arranged to be fired by 8 steam-atomizing oil intervane burners, but provision is made for future coal firing. Steam temperature control is by variations of the fuel and air input.

Materials and Manufacturing Processes

Heat-resistant Steel for Fastenings in Power Installations. L. Ya. Liberman and M. N. Sokolova. *Teploenergetika* 1961, 8 (May) 28–34 (in Russian).

The results are given of investigations into steels used for securing elements in power installations. Four types of steel were studied and details of the composition and types of treatment are given. The basic steel resembled the English steel "Durehete 950" and this was alloyed with Nb, W, Ti and B to give the four different grades. One of the four, which contained Ti and B, was found to be the most heat-resistant and relaxation-free and can be recommended for fastenings (bolts, studs, etc.) subject to temperatures of 565 C and 580 C in turbines, etc. (A.E.I. abstract).

From C.E.G.B. Digest 1961, **13** (Oct. 14) 2974.

High-strength Austenitic Stainless Steels. K. J. Irvine, D. T. Llewellyn and F. B. Pickering. *J. Iron and Steel Inst.* 1961, **199** (Oct.) 153–75.

The production of austentic stainless steels with tensile strength levels of up to 70 t/in² using precipitation reactions is discussed and the results of a large number of tests are presented. Analysis of experimental steels, mechanical properties of steels in solution-treated condition and mechanical properties of C–N, C–P, C–N–P, Ni-Al, Ni–Ti and Ni-Al–Ti steels after aging are given. The preferred composition is suggested to be one containing 25 per cent Ni, 15 per cent Cr, 1 per cent Al and 2.5 per cent Ti which has a good all-round combination of mechanical properties.

Coating Systems for Steel at 250 to 1200 F. G. Norman. *Corrosion* 1961, **17** (Sept.) 12–4, 16, 20.

Tests carried out over a period of 3½ years of different coatings for steel at temperatures up to 1200 F are reported. Silicones, aluminum coated steel, aluminum sheathing, alkyds, zinc rich organics, catalyzed epoxy, air drying phenolics, inorganic zinc silicates and others were tried. Best results were obtained by an inorganic zinc silicate primer followed by a top-coat of silicone or inorganic silicate with zinc oxide pigment.

Inhibition of Stress-corrosion Cracking of Austenitic Stainless Steel. P. P. Snowden. *Nucl. Engng.* 1961, **6** (Oct.) 409–11.

The effect of several inhibitors on the stress-corrosion behaviour of an 18/9 Cr–Ni, Nb stabilized, austentic stainless steel has been investigated under different conditions and the results are presented in tables.

Tensile Stress Corrosion and its Prevention. Pt. I. Nature and Fundamentals. I. Class. *Tech. Überw.* 1961, **2** (Oct.) 361–6 (in German).

The difficulties in ascertaining the circumstances and conditions in which tensile stress corrosion may occur and in evaluating other contributory factors are discussed. The conditions for the occurrence of this type of corrosion are formulated as the simultaneous presence of sufficiently high tensile stress, a critical medium and a critical state of the material. Laboratory tests to study the causes of stress corrosion and the results are described.

Welding in Nuclear Power Stations. F. S. Dickinson. *Nucl. Pwr.* 1961, 6 (Oct.) 66–9.

Established and new welding processes are reviewed under the headings: (1) process plant construction; (2) gas-cooled reactor construction; (3) reactor vessel construction; (4) heat exchanger fabrication; (5) properties of available processes; (6) electroslag welding; (7) "3 o'clock" welding.

Some Special Applications of Welding in Steam, Gas Turbine, and Nuclear Power Plants. J. M. Robertson. *Brit. Weld. J.* 1961, 8 (Oct.) 463–72.

Welding procedures and strength investigations of parent material and welded joints are described for: (1) welded austenitic steel rotors; (2) butt welded tubes in dissimilar metals (Nimonic 90 to Mo–V steel); (3) butt welded steam pipes (ferritic, austenitic and austenitic-ferricitic transition joints); (4) feed water heaters with welded steel tubes; (5) welding of expansion bellows; (6) welding fins to heat exchanger tubes.

Instruments and Controls

Develops Transistorized Burner Control. D. R. Whitson. *Elect. Wrld.* 1961, **156** (Sept. 25) 58.

A new system of automatic and remote controls of burner operation and flame sensing devices using transistorized circuits is described.

Trends in the Design of Digital Computers and their Applications. R. L. Grimsdale and J. C. Gladman. *Proc. Cont. and Autom.* 1961, 8 (Oct.) 427–30.

Digital Computers for Industrial Production Control and Optimization. E. M. Grabbe. *Proc. Cont. and Autom.* 1961, 8 (Oct.) 431–4.

Examples of application of computers to improve production control and to optimise processes are described. The chemical and petroleum, electric power, nuclear power, steel, cement, aircraft and missile industries have profited from their installation.

Power Station Control by Digital Computer. H. B. Opladen. *Energie* 1961, 13 (Sept.) 395–407 (in German).

The application of digital computers to the fully automatic control of power stations is described. The design of the computer and its memory, the calculations necessary for programming the various control functions and the mode of action of the computer are presented. The difficulties of programming for normal operation and load changes are outlined.

Computer Control Starts up at Philadelphia Electric. Anon. *Power* 1961, 105 (Oct.) 153-4.

Philadelphia Electric Co. has installed a digital computer to control the output from 27 steam turbine driven and 7 water-turbine driven generators to obtain the most economical loading. The controller samples desired steam generation every 10 sec., calculates new economic allocations, sets these values sequentially on differential control amplifiers which hold the output constant by controlling the turbine-governor actuators.

Determining Neutron Energy Distribution. R. S. Hall. *Engineering* 1961, 192 (Sept. 29) 416–7.

The various techniques and apparatus used for determining neutron energy distribution are described. The relevance of such measurements to reactor engineering is outlined.

Closed-circuit Television at Trawsfynydd. I. M. Waters and P. Barratt. *Nucl. Engng.* 1961, 6 (Oct.) 431–2.

The two installations of closed-circuit television, one for the charge machines, charge chute test rig and irradiated fuel disposal room, and the other for the control rod servicing bay, are described.

Nuclear Energy

Euratom's Research and Development Program. Anon. *Nucl. Engng.* 1961, 6 (Nov.) 450–3.

The four Community Centres and the work to be carried out at Ispra (Italy), Geel (Belgium), Karlsruhe (Germany) and Petten (Holland) are described. Work is also sponsored by Euratom on the following projects: (1) dragon; (2) halden; (3) suspop; (4) orpel. Development work is in progress on: (1) elaborate critical assembly (ECO); (2) specific test reactor (Essor) for fuel elements, coolants and structural materials; (3) fast reactors. Euratom further cooperators in the construction and operation of power reactors, nuclear merchant vessels, a joint development program with the U. S., the Belgium BR-2 high flux reactor operation, controlled thermonuclear reactions, biological and radioisotope studies, automatic scientific data processing.

France. Anon. *Nucl. Engng.* 1961, 5 (Nov). 459–65.

The French research and test reactors, critical experiments, experimental and production reactors and heavy main data are listed and the whole nuclear development program reviewed. The EDF-3 reactor, 1200 Mw (t) and 370 Mw (e) output, is the first to have a concrete pressure vessel.

Abstracts from the Technical Press Abroad And Domestic

(Drawn from the Monthly Technical Bulletin, International Combustion, Ltd, London, W. C. 1)

Water-Side Corrosion and Water Treatment

Proceedings Twenty-First Annual Water Conference. Various Authors. *Engineers Soc. of Western Pennsylvania* 1961 (*Aug.*), 176 pp.

Subjects discussed at this meeting held at Pittsburgh on October 24–26, 1960 included: 1. A survey of steel corrosion mechanism pertinent to steam power generation; 2. Pretreatment—the key to effective production of cooling water systems; 3. Panel discussion on chemical cleaning of high pressure power station units prior to initial start-up; 4. Water treatment experiences during the start up and initial operation of the Avon supercritical unit; 5. Chemical cleaning of boiling water reactor and steam-water system at the Dresden nuclear power station.

Dissolved Gases in Boiler Water. A Survey of Existing Knowledge and Experience. R. J. Saunders. *Engineer* 1961, 212 (*Sept.* 1), 356–9.

The Behavior of Silicic Acid in the High-Pressure Circuit. Pt. I. Physical Processes. H. E. Hömig. *Mitt. V.G.B.* No. 73, 1961 (*Aug.*), 252-5 (*in German*).

It is shown that in boilers operating above 1400 psi it is not possible to increase the silica solubility at boiler water temperature by increased alkalinity, though this is possible to a certain extent at lower pressures. In boilers with completely demineralized feed water deposits and tube failures can occur if the local heat release is excessive; values of about 40,000 Btu/ft²hr are regarded as critical. The silica solubility in steam is directly proportional to the pressure, about 0.1 per cent at 700 psi, 1 per cent at 1400 psi and 10 per cent at 2800 psi but the alkalinity (or pH value) has no practical influence at the values common today in high-pressure boilers. Deposit formation on turbine blades can be reduced by reducing the silica content of the steam but is mainly a mineralogical problem and depends on the total mineralogical composition of the steam. The precipitation of silica from the steam is a function of pressure and temperature for which the term "silicic acid dew point" has been coined analoguous to the acid dew point of the flue gas.

The Behavior of Silicic Acid in the High-Pressure Circuit. Pt. II. Mineralogical Processes. H. Kirsch. *Mitt. V.G.B.* No. 73, 1961 (*Aug.*), 256–60 (*in German*).

The investigations have shown that water-side deposits on tubes contain very little SiO_2 and mainly ferrous oxides and mixed phosphates, but those on turbine blades mainly amorphous SiO_2 (over 60 per cent), often in the form of silica gel or silica glass, but also sodium-aluminium silicates. It was found that silicates form between 250–500 C, silica gel between 50 and 300 C, quartz between 100 and 200 C. Temperature and pressure conditions in the tube system generally preclude the precipitation of SiO_2, in the turbine the gradually decreasing temperature and pressure favour it. The flocculation of the negatively charged SiO_2 sol as silica gel is often caused by the positively charged ferrous hydroxide sol, but also by the presence of Na_2O.

The Electrochemistry of Corrosion, especially Pitting and Tensile Stress Corrosion. H. Gräfen. *Mitt. V.G.B.* No. 73, 1961 (*Aug.*), 280–9 (*in German*).

The theory of electrochemical corrosion is reviewed, passivity of metals explained and the causes of intercrystalline stress corrosion discussed. The conditions are described in which either pitting corrosion or transcrystalline stress corrosion or both together may occur.

Gas-Side Corrosion and Deposits

Thermal History from Corrosion Product. P. K. Foster. *J. Iron and Steel Inst.* 1961, 199 (*Sept.*), 18–21.

X-ray diffraction analyses of scale from a failed boiler showed that part of the furnace tube had been heated above 570 C not more than 16 hr before failure. This non-destructive testing technique can be used to detect prior heating of steel above 570 C in oxidizing media and possibly also roughly the date of overheating.

Flue Gas, Ash and Dust

The N.I.F.E.S. Chart: A New Method of Estimating the Loss of Sensible Heat in Flue Gases. T. F. Hurley and G. R. Stern. *J. Inst. Fuel* 1961, 34 (*Sept.*), 393–405.

A series of formulae has been derived which can be used either algebraically with the aid of tables or in the form of two charts. From one of these the sensible heat loss is obtained as Btu/lb of fuel, from the other as percentage of the heat in 1 lb of fuel. A further nomogram has the O_2 content as parameter instead of $CO_2 + SO_2$ and gives more accurate assessments where O_2 analyses are available.

Ash and Clinker. Utilization. J. N. Williams. *Pwr. and Wrks. Engng.* 1961, 56 (*Sept.*), 746–9.

The utilization of fly ash for the production of bricks, concrete foundations, building blocks aggregate and road making and of clinker for breeze block manufacture, filtration and road making is described.

Chimney Design for Industrial Boiler Plant—I. A. F. Webber. *Steam Engr.* 1961, 30 (*Sept.*), 399–401.

The validity of the formula for maximum concentration at ground level of the products of combustion, quoted in the Beaver Report, is discussed and shown to be of little reliability. Reduction of deposition of fly dust and SO_2 can only be achieved by returning to single stacks for boiler batteries made of bricks instead of steel as usual today.

Heat Recovery Plant

Investigations on Cross-Flow Heat Exchangers with Tubes of Different Shapes. H. Brauer. *Mitt. V.G.B.* No. 73, 1961 (*Aug.*), 260–76 (*in German*).

Heat transfer and pressure drop tests were made on a crossflow heat exchanger with circular, oval (long or small axis in direction of flow) and tubes of special cross-sections invented by A. Huet, in different arrangements. The tests were made with air and flow investigations in open and closed water channels using colored jets and aluminum powder for flow visualization. Heat exchangers with oval tubes gave the best results for heat transfer and pressure drop; an equation has been developed for heat transfer in oval tube bundles valid for any size and arrangement of the tubes and any liquid or gaseous media.

The Froth-Contact Heat Exchanger. W. Smith and A. Poll. *Brit. Chem. E* . 1961, 6 (*Sept.*), 614–6.

Experiments have been carried out on a new type of heat exchanger in which the fluid to be cooled is passed through the tubes around which froth is generated by air flowing upward through a tray containing water and fitted with a perforated plate. The heat transfer coefficient is approximately the same as that of a shell and tube exchanger. Examples of calculation of the size of heat exchanger required for various duties are included.

Strength Calculation of Structural Parts of Tube-Bundle Heat Exchangers. M. Grashof. *Chem. Ing. Tech.* 1961, 33 (*Sept.*), 613–9 (*in German*).

The most important standard equations are presented as nomograms and it is shown how these influence the design of standard heat exchangers at higher temperatures and pressures. The standard equations for the calculation of tube plates are compared with those of foreign standards.

Air Versus Water Cooling. F. Molyneux. *Mech. Wrld.* 1961, 141 (*Sept.*), 30–1.

The advantages and disadvantages of heat exchange by air and water cooled are discussed and illustrated by an example comparing a water cooled tube and shell heat exchanger and an evaporative pre-cooled air heat exchanger for the same duty.

Power Generation and Power Plant

Actual Problems of Modern Steam Power Station Design. K. Schröder. *Mitt. V.G.B.* No. 73, 1961, (*Aug.*), 227–42 (*in German*).

Present German, American, Russian and British design practices and the solutions adopted in these countries for the various problems are compared. The problems discussed are: 1 Unit size and heat rate; 2. The key position of the working media streams (air-gas, water-steam, cooling water); 3. The steam outlet of the turbine, the narrowest cross-section of the unit; 4. The pressure level; 5. The layout of the unit; 6. The completely automatic unit; 7. Operating personnel; 8. Characteristic curves (cost, heat rate, personnel per kw installed); 9. The European network.

TVA Breaks Own Records for Production, Efficiency. Anon. *Elect. Wrld.* 1961, 156 (*Aug.* 28), 37.

During the year ended June 30, 1961, TVA generated 64.5×10^9 kwhr of which 74 per cent were produced in steam plants. The net heat rate of these dropped from 10,720 Btu/kwhr in 1960 to 9500 Btu/kwhr in 1961 and on average 0.804 lb of coal was required to generate 1 kwhr.

Build First Automatic Coal-Fired Unit. R. S. Talton. *Elect. Wrld.* 1961, 156 (*Aug.* 21), 41–2, 83.

Unit No. 3 at Goldsboro power station (240 Mw, 2400 psi, 1000/1000 F) will be provided with a SPARC control system developed from the MARC system used at the M. B. Robinson plant. It is able to start the unit from cold, supervise its running and stop it and includes the ability of arriving at logical predetermined operating decisions, generating the appropriate signals to execute the decisions and record its action, inputs and outputs. The main core memory will contain 8192 and the auxiliary memory 86,000 words. The controller will operate the plant and auxiliaries so that the lowest Btu/kwhr rate for a given load results.

OG and E Combined-Cycle Unit Offers 4 per cent Gain in Efficiency. J. B. Stout, J. J. Walsh, T. D. McKone and A. G. Mellor. *Elect. Wrld.* 1961, 156 (*Aug.* 14), 72-5.

Unit No. 7 at the Horseshoe Lake station of the Oklahoma Gas and Electric Co. now under construction will comprise a boiler rated at 1350 klb/hr at 1900 psi and 1005/1005 F, a

188.5 Mw steam-turbogenerator and a 25 Mw gas-turbogenerator and have a net heat rate of 9530 Btu/kwhr when burning natural gas. The gas turbine exhaust gases are supplied as combustion air to the furnace bottom to maintain steam temperatures at low loads and at the furnace top to temper the flue gas. Instead of an air preheater a primary economizer is installed which receives feed water in parallel with three stages of feedwater preheating both flows being combined before passing through the secondary economizer. The gas turbine is an open-cycle, two shaft unit, one shaft driving the compressor, the other the generator.

Combined Steam/Gas Turbine Plant for American Power Station. J. Grindrod. *Steam Engr.*, 1961, **30** (*Sept.*), 402-5.

The generating plant consists of a 5000 kw gas turbine and a 12,500 kw steam turbine, the exhaust from the gas turbine providing combustion and tempering air for the pulverized coal fired boiler and preheating feedwater in a special economizer. This combination raises the thermal efficiency from a 26.2 to 28.4 per cent and 29.2 per cent at full load. The gas turbine can supply further combustion air to a boiler generating steam for a 30 Mw turbogenerator and this would raise the overall efficiency of the station to 32 per cent.

Utility Selects 2400 Psi for 510 Mw Unit. R. G. Schmidt. *Elect. Wrld.* 1961, **156** (*Sept.* 4), 40–3.

Unit No. 4 at Will County station of the Commonwealth Edison Co. will consist of boiler rated at 3900 klb/hr at 2400 psi and 1000/1000 F and a cross-compound 510 Mw turbogenerator. The boiler is of tangentially fired, forced-circulation twin-furnace design with steam platen superheaters and 8 pulverized coal burners and four oil ignition torches in each corner. The super-heater platens continue as solid plates down to the economizer water outlet and control the gas flow over the width of the furnace through the convection pass. Because of the pressurized operation the ash hopper will be directly attached to the furnace bottom. The hp and ip sections of the turbine will run on one shaft at 3600 rpm, the double-flow lp section on the shaft running at 1800 rpm. Three boiler feed pumps are driven by non-condensing turbines, a fourth motor-driven pump is for start-up purposes. A low-level economizer between the precipitator and the chimney heats water in closed circuit to preheat the air to 145 F and reduce the flue gas temperature to 220 F. The stators of the generators will be water-cooled, the rotors hydrogen-cooled. Feedwater will be heated in 8 stages. The net heat rate is calculated to be 8947 Btu/kwhr.

Saturated Steam Reheater Applied in New Nuclear Power Station. F. W. Gettler and J. H. Potter. *A.S.M.E. Preprint* No. 61-SA-47, 1961. (*June*), 8 pp.

The Enrico Fermi nuclear power station of the Italian network will have a pressurized water reactor with an output of 176 Mw (e) and include moisture separation and reheating of the steam by saturated steam between the hp and lp turbines. The advantages of this arrangement are presented and the design of the extended surface reheater described.

From Hinkley to Sizewell. Anon. *Nucl. Engng.* 1961, **6** (*Sept.*), 364–70.

A comparison of station parameters, costs and design details.

Instruments and Controls

Operations Research Study of Steam Power Plant Automation. J. K. Dillard and J. L. Everett. *A.S.M.E. Preprint* No. 61-SA-66, 1961 (*June*), 5 pp.

As a result of the study undertaken of the sequential and dynamic actions to be taken by the automatic control installation of a steam power plant a mathematical model has been developed for a complete power station and a new scientific procedure conceived for the design of control systems. It is stressed that plant and controls must be designed together to achieve optimum results and that in this way the cost of the whole plant will be reduced.

Supervision of Operation of Modern Unit Power Stations. M. Sack. *Elektwirtsch.* 1961, **60** (*Aug.* 20), 581–92 (*in German*).

Since the controls used for supervising the correct operation of boiler-turbine units are very costly it appears necessary to attempt a reduction of indicating and recording instruments to facilitate their reading and to simplify the layout. Supervision can be improved by applying analogue or digital computers presenting heat consumption and thermal efficiency calculations in directly usable form. The role of the human operator in highly automated plants is discussed briefly.

Flow Measuring Instruments in Industry. V. Chalfont. *Pwr. and Wrks. Engng.* 1961, **56** (*Sept.*), 754–62.

A broad review of the various types of flowmeters, their design, operating mechanism and fields of application.

Nuclear Energy

Reactor Future. *Anon. Elect. Times* 1961, 140 (*Sept.* 21), 405.

Sir William Cook, U.K.A.E.A. member for reactors, expressed the opinion that the Canadian heavy-water moderated and cooled reactor with pressurized tubes offered the best prospects for the future and was capable of considerable further improvements. He urged that a reactor of this type should be built in Gt. Britain to allow experiments to start as soon as possible.

Thermal Optimization of Reactor Plants. Pt. I. J. Krebs and L. Gabriel. *Energietechnik* 1961, 11 *Aug.* 371–9 (*in German*).

Calculations are presented for optimum temperatures and flow volumes in the primary coolant and secondary steam circuits of pressurized water reactors to arrive at the lowest price per unit for a given reactor size.

Formation and Control of Turbidity in Aluminum-Water Reactor Systems. S. R. Hatcher and H. K. Rae. *Nucl. Sci. Engng.* 1961, 10 (*Aug.*), 316–30.

The corrosion rate of Al fuel sheaths in NRU is much higher than expected under static conditions at the same temperature and due to a mass transfer mechanism of corrosion whereby corrosion products are released as disordered oxide. A mechanism of crystal growth is responsible for deposits on heat exchanger surfaces and suspended alumina in the water. The turbidity concentration can be controlled by purification.

On the Possibilities of the Operation of a Natural Uranium Breeder Reactor with Fuel Element Reprocessing. K. Fuchs and H. Hessel. *Kernenergie* 1961, 4 (*Aug.*), 619–23 (*in German*).

Calculations have been made and the results obtained are reproduced to show that such a reactor of the homogeneous type with the natural uranium in a suitable solution is feasible and compares well with American and Russian fast reactors.

An Economic Fast Reactor. L. R. Blake. *Nucl. Engng.* 1961, 6 (*Sept.*), 371–5.

The design of a 750 Mw (th) fast reactor is described which could be constructed at much lower costs compared with the American Enrico Fermi station. The most important item, the selection of the fuel composition, is discussed in some detail. It is believed that this reactor would cost no more than £60/kw installed and at 0.7 load factor, interest charges of 5.5 per cent and 20 years life could produce power at 0.32d/kwhr.

Abstracts from the Technical Press—Abroad And Domestic

(*See also p. 50, this issue*)

(Drawn from the Monthly Technical Bulletin, International Combustion, Ltd, London, W. C. 1)

Power Generation and Power Plant

Tanners Creek 600 Mw Design Profits by Breed-Sporn Lessons. P. Sporn. *Elect. Wrld.* 1961, 156 (Oct. 30), 60-3.

The unit No. 4 ordered for Tanners Creek power station will consist of a forced-flow boiler rated at 3840 klb/h at 3625 psi and 1000/1025/1050 F and tandem-compound turbogenerators with a total output of 682 mva. The main difference between the Breed and Sporn units and the new one is the lowering of the temperature of the superheated steam to permit fewer and larger pipes of ferritic instead of austenitic steel to be used for the connection between boiler and turbines; by increasing the temperature of the reheated steam the thermodynamic economics and thermal efficiency are not affected. The boiler is provided with eleven cyclone furnaces, only pendent superheaters and reheaters, a tubular air preheater and a low level economizer between the precipitator. Only minor changes have been introduced on the electrical side. The net heat rate is estimated to be 8450 Btu/kwh.

Wood Waste for Steam Generation at a Plywood Factory. Anon. *Steam Engr.* 1961, 31 (Nov.), 55-9.

British Plywood Manufacturers Ltd. have installed a Corner Tube boiler rated at 15,000 lb/h at 210 psi and a Lambion stepped grate for the firing of saw dust, chips, off-cuts, bark and other wastes and obtained an output of 5 lb of steam per 1 lb of waste wood consumed. Because of the high efficiency of operation and low cost of the steam generated the company now buys additional wood chips from neighbouring firms. In the winter months steam is also generated in a coal-fired and/or an oil-fired shell-type boiler.

The High-Pressure Steam Plant for the Steelworks of Empresa Nacional Siderúrgia S.A., Avilús, Spain. M. Caravatti. *Sulzer Tech. Rev.* 1961, No. 2, 27-34.

The steam plant comprises four boilers (275 klb/h, 1350 psi, 968 F), turbine driven blowers for the blast furnaces, a 7.5 mw, a 30 mw and a 60 mw turbogenerator. The boilers are designed for the separate or combined firing of coal middlings and blast furnace gas, of the monotube type and the furnace provided with fixed corner burners for blast furnace gas near the bottom and pulverized coal manually tilted corner burners higher up. The blast furnace gas is preheated in a flue gas heated exchanger, the combustion air in a tubular preheater. The arrangement of economiser, evaporating and superheating surfaces is detailed. In boiler trials efficiencies of 87.88 to 91.6 per cent were obtained and boiler availability was consistently above 98 per cent, during 1960 it was 100 per cent.

Influence. Anon. *Engineering* 1961, 192 (Oct. 27), 532.

A report has been issued on the performance of the Calder Hall 'A' reactor over the past 5 years and the improvements obtained during this time. Output of the station has been increased by 25 per cent from 180 to 225 Mw (t) by increasing the fuel element temperature from 408 to 418 C and increasing the blower output. A more uniform temperature distribution has been obtained by the use of neutron absorbers in the position of maximum flux. Burn-ups of 3900 Mw days per ton and an average of 2700 mw days/t have been reached. A total of 4.7×10^9kwh has been generated and of 3.7×10^9kwh has been sent out. The load factor has been increased to 88 per cent and loading time for fuel elements reduced to 3 weeks. Six serious failures of fuel elements and about 200 cans with cavitational leaks were detected. Experiments have been conducted for the civil nuclear power stations on new fuel elements, element vibration fuel elements, element vibration and effects of charging and discharging elements on load.

Abstracts from the Technical Press Abroad And Domestic

(*See also p. 17, this issue*)

(Drawn from the Monthly Technical Bulletin, International Combustion, Ltd, London, W. C. 1)

Fuels: Sources, Properties and Preparation

The Selection and Utilization of Industrial Coals—II. A. C. Dunningham. *Steam Engr.* 1961, 31 (Nov.), 60–2.

The second part considers the combustion process and its control by flue gas analysis, the difference between overfeed and underfeed combustion and the conditioning of small coal for combustion.

Physical and Chemical Properties of Bituminous Coal Structure Components. XV High Vacuum Pyrolysis and Coal Constitution. C. Kröger and R. Brücker. *Brennst Chemie* 1961, 42 (Oct.), 305–11 (in German).

These investigations of vitrinite, micrinite and exinite by high vacuum decomposition have shown that the macerals contain the same number of structural elements but in different proportions, that the formation of volatile bitumen and consequently of tar is determined by the methylene bridges between aromatic and hydroaromatic structures and that oxymethylene bridges connect the nonvolatile bitumen with the residual carbon.

Coal Briquettes without Binders. A. G. Arend. *Coll. Guard.* 1961, 203 (Nov. 2), 537–8.

Some details are given of the successful briquetting of mixtures of coal and lignites and of coals without binders but it is not stated where the tests were made nor are cost comparisons given.

Non-Sticking Sliding Gates for Hoppers. Anon. *Engineering* 1961, 192 (Nov. 24), 667.

The steel plate forming the gate is suspended from two pieces of trolley track and can be adjusted on suspension bolts to control the distance between hopper and plate. In this way dust and fines cannot build up. The movement of the gate is by roller chains, levers, rack and pinion gears or power cylinders.

Heat: Cycles and Transmission

The C.E.G.B. Studies Heat Transfer. J. A. Hitchcock and J. Lis. *Nucl. Pwr.* 1961, 6 (Dec.), 65–8.

Heat transfer studies are described carried out on: (1) fuel elements under atmospheric and higher pressures; (2) rod cluster systems; (3) heat exchangers, both gas and water side characteristics and coefficients.

Heat Transfer and Pressure Loss Characteristics of Cross-Flow Tubular Arrangements with Studded Surfaces. N. G. Worley and W. Ross. *Brit. Nucl. Energy Conf.* 1961, 6 (Oct.), 289–99.

Experiments with bare and studded tubes in different arrangements are described and the results presented and evaluated. The effect of tube diameter, stud pitch and tube arrangement on heat transfer and pressure drop is discussed; sufficient information has been obtained for the prediction of heat transfer performance of a wide range of surface patterns and tube pitches.

Heat Transfer and Pressure Drop Performance of Helically Finned Tubes in Staggered Cross-Flow. C. Rounthwaite and N. Cherrett. *Brit. Nucl. Energy Conf.* 1961, 6 (Oct.), 300–6.

Heat transfer and pressure drop tests have been made on various staggered arrangements and from the results heat exchanger matrices of given duty designed. A relation connecting corresponding heat transfer and pressure drop results has been deduced.

Finned Tubes in a Cross-Flow of Gas. A. Lymer and B. F. Ridal. *Brit. Nucl. Energy Conf.* 1961, 6 (Oct.), 307–13.

Experimental results of heat transfer and pressure drop in finned tube banks in cross-flow are reported. A method of calculating fin efficiency is presented and theoretical results confirmed by experimental results. A water model has been used for flow visualization experiments which helped in the understanding of the processes involved and in the explanation of the local heat transfer coefficient distribution over an annular fin.

Investigations into Heat Transfer to Boiling Water in Horizontal Tubes. H. E. Müller. *Wärme* 1961, **68** No. 2, 50–2 (in German).

Cooling of superheated steam in a surface cooler was studied and the use of cooling surface sections determined serving preheating, evaporating and superheating of the cooling water. For the section through which a water-steam mixture flows a relationship between heat flow density and inner heat transfer coefficient was obtained valid for boiling water in horizontal tubes and heat flows of 20,000 to 120,000 kcal/sq m/hr.

Steam Generation and Power Production

Exergy. Various Authors. *B.W.K.* 1961, **13** (Nov.), 481-508 (in German).

This issue is devoted to a series of papers explaining the term "Exergy," its meaning, the reasons for its introduction and its practical application: (1) the practical importance of exergy by F. Bosnjakovic; (2) energy and exergy by P. Grassmann; (3) the term exergetic energy by W. Fratzscher; (4) exergy losses in the steam power process by H. Rögener; (5) the influence of air preheat on the nonreversibility of combustion by Z. Rant; (6) investigations of phase diagrams by means of exergy by G. Gr[illegible]n and E. Kaiser; (7) literature on exergy by N. Gasparovic.

The Dispersion of Water Globules in Steam: A Preliminary Study. D. J. Ryley. *Engineer* 1961, 212 (Oct. 27), 692–6.

The size and space dispersion of water droplets in steam has been investigated experimentally and the problems are discussed requiring solutions before a mathematical description of space dispersion of globules can be evolved.

Pressure Vessel Design in Sweden. E. Jonnerby. *Chem. Proc. Engng.* 1961, **42** (Nov.), 479–81.

A brief review of Swedish design practice and equations used in the calculations of pressure vessel and examples of fabrication are presented.

Design of a Reinforced Cylinder for a Nuclear Reactor Pressure Vessel. R. W. Lakin and S. S. Gill. *Proc. Inst. Mech. Engrs.* 1961, **174** No. 29, 813–30.

The strengthening of the cylindrical part of a pressure vessel by thin laminar strips to make it suitable for working at the same pressure as the thicker cylindrical ends is described. Vessel design, effect of practical imperfections, permissible design stress, standards and methods of manufacture and effect of temperature gradients are discussed.

Factors Affecting the Choice of New Boiler Plant—II. W. Short. *Steam Engr.* 1961, **31** (Nov.), 51–4.

The second part discusses the effects of peak load and seasonal load variations on boiler size and suggests that it is often preferable to install boilers of different sizes so that each can operate at its optimum efficiency. Although automatic control is today regarded as a matter of course the choice between simple on-off or modulating control will depend on local conditions.

Babcock and Wilcox Recommended "Once-through" Boilers on 2000 psi and up. Anon. *Elect. Wrld.* 1961, **156** (Nov. 6), 82.

Babcock and Wilcox Co. consider that once-through boilers provide lower construction costs, increased plant economy and availability and lower maintenance costs and should thus be advantageous at all pressures above 2000 psi. At present 16 units constituting 6450 Mw generating capacity are in operation or on order.

A New Large Boiler Unit TPP-110 for High-Temperatures and High-Pressure Steam Generation. V. S. Patichenko, I. N. Goldenfarb and L. A. Ostrovskii. *Energomashinostroenie* 1960, **6** (Aug.), 1-11. *C. E. Transl.* 1985.

The design, construction and costs of a supercritical pressure boiler rated at 2100 klb/h at 3627 psi and 1085/1058 F is described. The boiler has two furnaces, one containing the superheater, the other the reheater and supplies steam to a 300 Mw turbogenerator.

Design and Operational Experience with Waste-Gas Cooling Plants in Oxygen Converter Steel Works. H. Rasworschegg. *Mitt. V.G.B.* No. 74, 1961 (Oct.), 356–64 (in German).

The intermittent production of CO in oxygen converter plants and the utilization of the CO as fuel in boilers installed above the converters is discussed. Designs with additional fuel firing and with accumulators for constant or variable pressure are described, with special emphasis on the design of the hood to permit control of the excess air. The controls required for such boilers are more complicated than for ordinary power station boilers and must be closely linked with those for the converter plant.

Heat Transfer and Pressure Drop Characteristics of Concentric Arrangements of Helical Coils. F. V. Davies and J. Lis. *Brit. Nucl. Energy Conf.* 1961, **6** (Oct.), 314–23.

Experimental studies relating to the design of boilers for nuclear reactors of heat transfer and pressure drop of concentric arrangements of finned tube coils and the results are presented.

Fuels and Firing

Distribution of Primary Air in Chain-grate Stokers. T. J. K. Rolfe. *J. Inst. Fuel* 1961, **34** (Nov.), 481–93.

Research into improving the efficiency of operation of chain grate stokers has led to the installation of fixed vertical baffles in the windbox to obtain uniform primary air distribution and the adoption of the shortened version with increased combustion rate sq ft for a given fuel rate. The first improvement led to an increase in permissible combustion rate of 18 per cent and improved efficiency by 1 to $1^1/_2$ per cent. The second permitted a higher boiler efficiency to be maintained at lower fuel feed rates by improving the heat transfer performance. Combustion efficiency suffered when low fuel feed rates were obtained by reducing the fuel bed depth below 3-in.

Experience with Oil Firing in a Horizontal Cyclone Boiler. K. Sauerwein. *Mitt. V.G.B.* No. 74 1961, (Oct.), 373-6 (in German).

In a boiler rated at 71 klb/h at 953 psi and 932°C and equipped with a horizontal cyclone furnace coal was gradually replaced as fuel by oil and the boiler operated on oil up to 20 per cent above m.c.r. without any difficulties. Film boiling on the cyclone tubes did not occur owing to the very high mass flow rate of the water and a heat release rate of 565,000 Btu/cu ft. Excess air was restricted to a minimum so that the O_2 content in the cyclone was below 1 per cent and the dew point of the flue gas around 160 F.

Experience with Combined Firing of Oil and Coal in Vertical Cyclone Boilers of an Industrial Power Station. L. Lichtenwalder. *Mitt. V.G.B.* No. 74, 1961 (Oct.), 3767 (in German).

In the two boilers each rated at 188 klb/h at 910 psi and 842 F and equipped with vertical cyclone furnaces, a mixture of 60–70 per cent oil and 40-30 per cent coal is fired at all loads; fly ash is reinjected together with that from 3 other dry-bottom furnace boilers. The diffusor above the cyclone must be freed of deposits every 6 weeks despite soot blowing in each shift. The oil burners are cleaned every second day. The air is preheated in a steam exchanger and part of it is bypassed so that the flue gas exit temperatures are between 392 and 446 F. The O_2 content of the flue gas is between 1.8 and 2 per cent, the CO_2 content between 15 and 16 per cent. No difficulties were experienced during 25,000 h of operation.

Research on Turbulent Diffusion Combustion. A Survey of the Present Position with Special Reference to Ijmuiden and Sheffield. M. W. Thring. *J. Inst. Fuel* 1961, 34 (Nov.), 494–502.

Water-Side Corrosion and Water Treatment

Water Treatment for High Pressure Boilers. G. I. Early. *Brit. Pwr. Engng.* 1961, 2 (Nov.), 33–5.
A review.

Silica Removal by the Magnesia Method. Anon. *Brit. Pwr-Engng.* 1961, 2 (Nov.), 49–52.

Translation of a Russian article describing the magnesia method of water treatment and its advantages and disadvantages.

Gas-Side Corrosion and Deposits

Furnace Corrosion Taking into Account the Mutual Effect of Slags and Refractory Mass. M. T. Mackowsky, D. Hallbauer and H. Kirsch. *Mitt. V.G.B.* No. 74 1961 (Oct.), 311-9 (in German).

The composition and properties of the most generally used refractory masses and of the slag and the attack of the slag on these masses in various furnace atmospheres and at different temperatures have been studied. None of the masses is resistant to this attack at furnace temperatures of 1800 C and frequently at much lower temperatures. The flue gases, especially sulfur oxides, penetrate the pores of the mass and attack the tube metal. Experiments aimed at finding new refractory masses resistant to slag at 1800 C and above have not yet been successful.

Chimney Design for Industrial Boiler Plant—III. A. F. Webber. *Steam Engr.* 1961, 31 (Nov.), 63-5.

Chimney height on the basis of the recommendations of the F.B.I. Working Party is discussed and brick, steel and plastic chimney construction compared.

Heat Recovery Plant

Air Versus Water Cooling. F. Molyneux. *Mech. Wrld* 1961, 151 (Nov.), 373–4.

The calculation of an example started in a previous article is finished.

New Regenerative Heat Exchanger Concept. D. G. Wilson. *Engineering* 1961, 192 (Nov. 24), 694-5.

The new idea is the use of layers or disks of flexible material which is periodically separated to allow cross-flow of one medium and squeezed together before entering the duct carrying the second medium to prevent any carry-over loss and permit higher heat transfer rates to be obtained. Only a small test model has been made so far.

Power Generation and Power Plant

Electricity Supply Problems. Anon. *Elect. Rev.* 1961, 169 (Nov. 24), 841–2.

A summary of the 1961 Mitchell Memorial Lecture by Sir Christopher Hinton in which the reduction in capital costs of power station per kwh sent out between 1948 and 1965 through the application of larger units and higher steam parameters was traced, the doubtful advantages of supercritical units discussed and the reasons given for persisting in building nuclear power stations despite their higher cost of producing a unit compared with conventional power station.

Starting-up and Shutting-down of a Power Station Unit. A. Stoll. *Mitt.*

V.G.B. No. 74, 1961 (Oct.), 345–51 (in German).

The apparatus and equipment required and the conditions to be observed during starting-up a boiler-turbine unit from cold and from hot ar during normal and emergency sh. own are discussed with special reference to once-through forced-flow reheat boilers. Measures to be taken to avoid excessive rises of temperature in the superheater and reheater are outlined. Automatic starting and stopping of a unit is touched upon very briefly.

Power Station Optimization. A. Sherry. *J. Inst. Fuel* 1961, 34 (Nov.), 466–80.

The factors were considered and tested in a power station containing five 60 Mw sets which could be controlled so that the highest efficiency at minimum cost was obtained. Since the cost of the coal is about 90 per cent of the cost of electricity generated, the savings obtained by reducing fuel costs are large; the individual factors affecting fuel costs are detailed. Other important factors are optimum methods of operation such as load distribution between machines, optimum number of machines in operation, pumping power, boiler optima, air supply, stack loss, auxiliary consumption, unburnt heat loss, mill reject loss, sootblowing, coal fineness mber of mills in commission nd ner angle, and maintenance ontrol (frequency of cleaning and verhaul). The final step would be a igital controller adjusting the plant ontrollers to arrive at the best setting r given conditions.

bservations Regarding Eddystone o. 1 after Inspection following First ear of Operation 5000 psi and 1150 J. H. Harlow. *A.S.M.E.-A.I.E.E. ower Conf.* 1961 (Sept.), 24 pp.

An account is presented of service ilures, difficulties encountered in d remedial measures applied to the eam generator materials, the main eam system, stop and by-pass valves, rbine rotor, superpressure blading, eam inlet piping and control valves, oper oxide deposits on turbine ides and boiler feed pumps.

ercer Generating Station Features. on. *Power* 1961, **105** (Nov.), 70-1.

Mercer station of New Jersey's blic Service Electric and Gas Co. tains two 320 Mw units each ved by a pulverised coal fired n-furnace boiler supplying steam 2400 psi and 1100/1050 F. The heat rate is 8636 Btu/kwh but it op o improve on it. The turs a indoors but the generators, er-feed pumps and their drives nd through the wall.

Abstracts from the Technical Press—Abroad And Domestic

(*See also p. 61, this issue*)

(Drawn from the Monthly Technical Bulletin, International Combustion, Ltd, London, W. C. 1)

Fuels: Sources, Properties and Preparation

A New Approach to the Dense Phase Conveying of Powders. G. H. Zimmer. *ASME Preprint* No. 61-WA-294 1961 (Dec.), 8 pp.

A helical-screw pump is used to convey the powder fluidized by air at the entrance and exit of the pump through the pipelines. The advantages are smaller pipe diameters, lower velocities, smaller air and consequently lower compressor requirements, reduced wear and damage to the powder. The limitations of the system are set out.

Getting "Difficult" Materials out of Bins. A. D. Sinden. *ASME Preprint* No. 61-BSH-8 1961 (Oct.), 9 pp.

The various types of flow inducers, viz. vibrators, pulsators, air streams and mechanical dislodgers, are compared. The planetary arch breaker designed for conical hoppers and bins is described which travels round the inside of the cone and dislodges and moves the contents downward to the outlet. This breaker has proved superior to other appliances in moving materials which do not easily discharge by gravity alone.

Heat: Cycles and Transmission

Calculation of Radiant Heat Transfer Using Electronic Digital Computers. V. P. Detkov. *Teploenergetika* 1961, 8 (Sept.), 33–6 (in Russian).

The normal method of calculating radiant heat transfer in furnaces, boilers, etc., is the "zone" method, in which the surfaces and volumes are divided into zones which are treated separately. The integral equations for radiation are replaced by a system of linear algebraic equations. It is known how an algorithm can be devised for the calculation, on a digital computer, of radiant heat transfer. An example of such a calculation is described (AEI abstract).

From *C.E.G.B. Digest* 1961, 13 (Dec. 23), 3924.

The Use of Visible Light Models for the Study of Radiant Heat Transfer in Furnaces. C. H. Schwartz, S. A. Gold and A. A. Orning. *ASME Preprint* No. 61-WA-303 1961 (Dec.), 8 pp.

In these furnace model tests flame radiation was simulated by miniature lamps, partial wall reflection by strips of high reflectance paint and the measurements made with an integrating sphere light meter. Glass wool distributed within the array of lamps simulated a partially opaque flame. The models represented the gas-fired furnace of the Sterlington and the pulverized coal fired furnace of the Paddy's Run boiler, both front fired, for which measurements were available so that comparison between model and actual measurements were possible. The agreement was remarkably close. It is suggested that such model tests which are simple could be carried out to obtain advance information on effect of flame position on distribution of radiant heat transfer to furnace walls in new designs.

Rapid Calculation of Radiant Energy Transfer Between Nongray Walls and H_2O or CO_2 Gas. D. K. Edwards and K. E. Nelson. *ASME Preprint* No. 61-WA-175 1961 (Dec.), 6 pp.

An approximate method is presented permitting the designer to estimate roughly the coarse spectral distribution of the gaseous emission or absorption of the entire range of variables covered by Hottel's correlations. The methods available for the calculation of radiant heat transfer to isothermal H_2O-CO_2-N_2 mixtures are reviewed.

An Enclosure Theory for Radiative Exchange Between Specularly and Diffusely Reflecting Surfaces. E. M. Sparrow, E. R. G. Eckert and V. K. Johnson. *ASME Preprint* No. 61-Wa-167 1961 (Dec.), 6 pp.

A systematic and convenient method has been developed for calculating the radiant interchange within an enclosure containing both specularly and diffusely reflecting surfaces. The application of the method is illustrated by an example.

Heat Transfer by Combined Forced Convection and Thermal Radiation in a Heated Tube. M. Perlmutter and R. Siegel. *ASME Preprint* No. 61-WA-169 1961 (Dec.), 11 pp.

This problem occurring in the heating of the coolant passages of a nuclear reactor is analyzed and a solution of the energy equation governing the heat exchange is provided by two methods which are in good agreement.

Combined Free and Forced Convective Flow in Vertical Circular Tubes—Experiments with Water and Oil. G. A. Kemeny and E. V. Somers. *ASME Preprint* No. 61-WA-161 1961 (Dec.), 7 pp.

Heat transfer and pressure drop data were obtained for water and oil flowing upward in vertical tubes with I.D. of $^1/_4$- to $1^1/_2$-in. Flow rates from 10 to 400 lb./hr were investigated. Non-laminar flow was observed during many of the tests and its effects are discussed.

The Effect of Corrosion by Steam at 1100–1500 F upon the Heat Transfer Through Superheated Tube Alloys. H. L. Solberg, J. E. Brook and W. J. Rebello. *ASME Preprint* No. 61-PWR-1 1961 (Sept.), 6 pp.

Comparative tests on heat transfer through ferritic and austenitic steel tubes, one set with bright, smooth, honed inner surface and the other with scaled inner surface showed that the heat transfer through the scaled ferritic tubes was reduced by up to 15 per cent, while that through scaled austenitic tubes increased by up to 8 per cent over the clean tubes.

Steam Generation and Power Production

Tables for the Specific Heat C_p of Water and Steam. M. P. Vukalovich, B. V. Dzampov, D. S. Rasskazov and S. A. Remizov. *Teploenergetika* 1961 (Dec.), 70–7 (in Russian).

Tables are presented for the specific heat C_p of water and steam, compiled from all the available experimental data, and extrapolated to $p = 1000$ kg/cm² and $t = 1000$ C.

CEGB abstract.

Steam Generators

Developments and Future Trends in Large Boiler Plant Design. G. H.

Hanford, *Brit. Pwr. Engng.* 1962, **4** (Jan.), 32–8.

Trends in Modern Industrial Steam Generation and Their Effect upon Boiler Design. C. T. Smith and R. S. Rocheford. *ASME Preprint* No. 61-WA-298 1961 (Dec.), 11 pp.

Designs developed for burning various waste fuels such as bark, CO, black liquor, blast furnace and refinery gases are described together with details of wall construction and cyclone steam separators. Feed water requirements are also discussed.

Factors Affecting the Choice of New Boiler Plant—IV. W. Short. *Steam Engr.* 1962, **31** (Jan.), 129–13.

This last part deals with the influence of structural work, labor and finance on the choice of plant.

Development of the Smaller Types of Sulzer Boilers. E. Köpfer. *Sulzer Tech. Rev.* 1961, No. 3, 17–20.

Various types of economic and three-pass smoke tube boilers, small water-tube and tubular, drumless boilers for outputs of up to 30,000 lb/hr at pressures up to 350 psi and suitable for coal, oil or gas firing are described.

Survey of Packaged Boilers. D. E. Fiford. *Engng. Boil. Ho. Rev.* 1962, **77** (Jan.), 4–11.

This survey includes: (1) fire-tube dry-back types; (2) wet-back type units; (3) water-tube types.

Steam Generation from Waste Products. G. H. Johnson. *ASME Preprint* No. 61-WA-311 1961 (Dec.), 8 pp.

Boilers, firing and auxiliary equipment required to burn bark and wood refuse, black liquor, blast furnace gas, coke oven gas and coke breeze, CO, and bagasse are described.

The Dynamics of Steam Generation in the Benson Boiler. J. French and G. Klefenz. *BWK* 1961, **13** (Dec.), 532–7 (in German).

Equations of the dynamics of steam generation of a Benson boiler have been developed for use with an analogue computer so that the controls can be designed for the desired response of the boiler turbine unit to changes of conditions. The same equations can be used for the control of a drum-type boiler.

Developing Techniques for Accelerated Starting of Pulverized-Coal Fired Units. (1) System Economics and Operating Procedures. (2) Practical Operating Guides. (3) Plant Design Considerations. O. L. Gann, J. A. Donald, G. G. Halfinger and R. C. Sherrill. *ASME Preprints* Nos. 61-WA-327, 329 and 328 1961 (Dec.), 7 pp, 9 pp, and 8 pp.

Tests of a new starting procedure were carried out initially on eight 285 klb/hr natural circulation boilers operating on a steam range and later extended to a 525 klb/hr controlled circulation boiler supplying a 75 Mw turbine in which pulverized coal sufficient to sustain combustion and a small quantity of oil are used to light off the boiler and bring it up to pressure. The main alteration required was to the fuel feeders by installing a 600 rpm feeder drive motor in tandem with the original 1200 rpm drive motor to reduce the fuel feed during the initial starting period. The time required for bringing the boiler and turbine on the line from cold or after various periods of banking and consequently the amount of fuel used have been considerably reduced. The procedure, monitoring devices, changes in equipment (mills, feeders) and results are presented in detail.

Preventing Boiler-Furnace Explosions. Report of the ASME Fuels Division Sub-Committee on Flame Safety Devices and Safe Operating Practices. E. R. Mitchell. *ASME Preprint* No. 61-WA-197 1961 (Dec.), 7 pp.

The various possible causes of furnace explosions during light-up, operation and shutdown are listed and specific solutions proposed. The absence of explosions in English and German boilers is noted, the former being attributed to improved operator training, the latter to the use of slagging furnaces and uniform distribution of pulverized coal to burners of dry furnaces. A "Recommended Practices Code" is now being drafted.

Review of Furnace Protection Design Principles. K. W. Hamming, W. L. Livingston, A. W. Hindenlang and R. M. Lundberg. *ASME Preprint* No. 61-WA-292 1961 (Dec.), 8 pp.

The causes and increasing severity of furnace explosions are discussed and measures for reducing the accident rate outlined under improving equipment design, supervisory versus anticipating controls and reduction of number of system components.

Faster Chemical Cleaning for High-Pressure Boilers. W. Bell and S. Alfano. *Pwr. Engng.* 1961, **65** (Dec.), 66–8.

After the boiler has cooled to 200 F ammonium citrate solution (1.8 per cent and pH 4.5) is injected to dissolve iron oxides, to form stable iron-citrate chlates, an additional quantity of citric acid injected to increase the stability of the solution of iron oxides, more ammonia added and sodium nitrite injected with air to remove copper deposits and convert these into copper ammonium complexes. The whole process including four rinses takes about 14 hr. The boiler is then clean and can be left empty without additives, blanketing, or neutralizers. Natural, controlled and forced circulation boilers can all be treated equally well.

Chemical Cleaning Can Pay Off. I. B. Dick and J. W. Snyder. *Power* 1962, **106** (Jan.), 140–2.

The Consolidated Edison Co. of New York regularly acid clean all their boilers to remove deposits likely to cause hot spots or corrosion. In addition, turbines, feed heaters, condensers and air preheaters are chemically cleaned. If the occurrence of hot spots is suspected the hydrogen content of the steam is measured as increased hydrogen content indicates break down of steam on hot surfaces. Correct chemical cleaning will not lead to tube metal attack even if it is repeated many times.

(*Continued on p. 61*)

Abstracts from the Technical Press

(Continued from p. 59, this issue)

olid Fuel Firing

onc ns Required to Burn Fuels afely in Boiler Furnaces. R. M. Hardgrove. *ASME Preprint* No. 1-FU-3 1961 (Oct.), 12 pp.

The frequency and causes of furace explosions are reviewed and re-ults of tests with pulverized coal pre-nted. The operating instruments quired, air fuel ratio meter, coal ow meter, flame detector, tem-rature recorder at pulverizer out-, interlocks on fans, pulverizers, eders, torches and purge controls e discussed and correct procedures scribed. Use of the procedures in mputer control of burner start-up d shutdown is discussed.

. Oscillating Grate Spreader Stoker stallation. R. P. Perkins. *ASME eprint* No. 61-FU-2 1961 (Oct.), 7

The grate installed in a single-pass ter tube boiler rated at 90,000 hr 12 ft 9 in. wide by 15 ft long, has ee sections and discharges at the nt. It is oscillated by an eccentric-ght shaft rotating at 1200 rpm for s every 20–30 min. Ash from the ier t hopper and multicyclone ara hopper is reinjected to in-ase the efficiency by 2.6 percentage nts; although the dust loading is eased by 50–70 per cent, when the collector ash is reinjected the dust cent of the cleaned gas is still be-0.25 gr/ft.^{3} Thermocouples are ted below the grate surface to de-hot spots and to start corrective edures. Excess air is generally at 25 per cent. After overcom-some initial difficulties the grate given every satisfaction.

d and Gaseous Fuel Firing

national Flame Research Foun-n: Some Results of the First s on Pressure Jet Oil Flames in Ijmuiden Furnace. J. M. Beer. *st. Fuel* 1962, 35 (Jan.), 3–15.

e effects of air velocity, oil pres-and a disk stabilizer on position me front, flame shape, gas tem-ure and composition and mixing e flames, soot concentration and ion, and jet aerodynamics are bed and discussed.

es and Combustion

N elling of Furnaces and . R. C. Patterson and R. F. amsen. *ASME Preprint* No. A-45 1961 (Dec.), 11 pp.

Water and air flow and smoke table models have been used to study design parameters and predict operating characteristics of new designs. Flow distribution, velocity and direction data and pressure loss prediction have been obtained. Correlations between model and full scale plant data are presented.

A Study of Pulverized Coal Flames. C. R. McCann and A. A. Orning. *ASME Preprint* No. 61-WA-302 1961 (Dec.), 8 pp.

Studies of ignition temperature, apparent flame velocities, time required for ignition and effect of changes in flame position on completeness of burning carried out with a venturi-type burner burning about 1 lb/hr of coal are reported and discussed.

Operational Experience with Cyclone Furnace Boilers, 500 t/hr, 211 atü, 535 C with Reheat to 535 C. H. Becker. *Mitt. VGB* No. 75, 1961 (Dec.), 404–11 (in German).

The 7 ft cyclone furnaces of the older boilers at Walsum had tangential injection, carbon steel studs and chrome-ore refractory masses and were operated with an O_2 content of 0.8%. Erosion and corrosion in the cyclone, secondary and tertiary furnace necessitated replacement of the old by new cyclone furnaces with secant injection of the coal and primary air, of the carbon steel by Sicromal studs with closer spacing and of the chrome-ore by SiC refractory mass. Similar modifications were carried out in the larger 10 ft cyclone furnaces of the new boilers. In addition, the O_2 content was increased to 2–2.5 per cent and soot blowers regularly used in the tertiary furnace. Since then the boilers have been in operation for 10,000 hr without any visible damage in the cyclone or other furnaces and it is hoped to continue 20,000 hr when the major overhaul of boilers and turbines is carried out.

Experience with a New Vertical Cyclone Furnace. L. Spennemann and W. Krull. *Elektwirtsch.* 1961, 60 (Dec. 5), 855–60 (in German).

The two Benson boilers at Gerstein power station each rated at 375 t/hr at 210 atü and 530/535 C are equipped with vertical cyclone furnaces in which the burners and air ports are arranged in 12 groups in the inclined roof at regular intervals, each group consisting of 4 burners in pairs directed tangentially toward a circle between the outside wall and the gas outlet. The secondary air (400 C) is injected around each burner, its velocity being kept constant at all loads by dampers. Full load can be obtained with 3 or 4 mills depending on the kind of coal being fired.

Throttling valves are installed in the 12 parallel circuits to equalize the flow resistance but because of the spiral winding of the circuits in the cyclone and radiation furnace the heat uptake and evaporation by each is very uniform. Liquid slag removal is possible down to 25 per cent. Ash retention is 60–65 per cent at full load. The mixing of the flue gases in the gas outlet is so good that the temperatures of the tube walls of the platen superheater do not differ by more than +6.5 deg C and −8 deg C from the average. Both boilers were free of deposits after 8000 and 5000 hr respectively, although the soot blowers were used only occasionally. The chrome-ore refractory of the gas outlet had to be replaced after 6000 hr. The time required when starting from cold until synchronization is 50–80 min.

Water-Side Corrosion and Water Treatment

Industrial Water Treatment—II. W. F. Gerrard. *Steam Engr.* 1961, 31 (Jan.), 138–40.

The second part deals with methods of internal treatment and their supervision, priming, foaming and carryover and treatment of standby boilers to prevent internal corrosion.

The Effect of Polymerous Phosphate on the Hardness Removal of Base Exchangers. G. Peter. *Energie* 1961, 13 (Dec.), 541–4 (in German).

Experiments carried out by Sulzer in Winterthur have shown that the addition of polymerous phosphate upstream of the base exchanger to water treated by hydrated lime does not increase the residual hardness above the given limits if the addition is restricted to threshold treatment, i.e., 2–5 mg./l. Larger additions may lead to difficulties in the base exchanger.

Capacity and Life of Weakly Basic Anion Exchangers. H. Busch. *Mitt. VGB* No. 75, 1961 (Dec.), 383–5 (in German).

The life of anion exchangers depends on operating temperature and the presence of organic substances of larger molecule diameter in the raw water which clog the pores of the exchange particles and cannot always be removed during regeneration. A comparison of an American, Dutch and German exchange material showed that the particles in the American and Dutch material have small pores and are easily clogged while the particles in the German material have large pores. In consequence, the American and Dutch materials lost 80 per cent of their exchange capacity in the same time as the German material lost only 5 per cent.

Operational Experience with Complete Demineralization Plants. W. Klump. *Mitt. VGB* No. 75, 1961 (Dec.), 386–8 (in German).

The plant at the Franz Hanich colliery has a capacity of 100 t/hr for the preparation of make-up water for the high pressure boiler plant and consists of 3 large and 3 small strongly acid cation exchangers in series, 3 weakly basic anion exchangers, a CO_2 removal plant, 3 strongly basic anion exchangers and 2 mixed bed exchangers (100 t/hr each) which latter can be used separately for condensate polishing. Each exchanger contains two special filters to retain the exchanger mass during operation and regeneration. All exchangers are regularly aerated with compressed air to remove ferrous hydroxides. The procedure for the regeneration of the exchangers is given in detail. During 4 years of operation no loss of capacity of any exchanger has occurred, the anion exchangers suffered a reduction of their mass of 3–5 per cent per year.

Experience with Complete Demineralization Plants in Frimmersdorf Power Station. R. Kretzer. *Mitt. VGB* No. 75, 1961 (Dec.), 388–92 (in German).

The methods developed for regenerating the two plants each of a capacity of 40/50 t/hr and consisting of two cation, two anion and a mixed-bed exchanger are described and the various devices in reducing the filter retardation by higher water temperatures pointed out. There is also a condensate demineralization plant of 350/-0 t/hr capacity which can deal with the condensate from a 150 Mw turbine during starting or leakage in a condenser; it has proved particularly valuable during starting of new units. Hydrazine is added to the treated condensate and make-up water before storage in tanks.

Experiences with Hydrazine in Marine Steam Generators. J. S. Archer, E. A. Savinelli and J. A. Ul-.. *ASME Preprint* No. 61-WA-1961 (Dec.), 7 pp.

Three cases of marine boilers are cited in which boiler and superheater tube failures occurred caused by overheating due to deposits of iron oxides. The use of hydrazine reduced in all cases dissolved oxygen to such low levels that no more corrosion of the boiler section occurred and no tube deposits were observed in the boiler.

Waterside Corrosion in Oil-Fired Boilers. C. Janssen. *Mitt. VGB* No. 75, (Dec. 1961), 427–31 (in German).

The role of oxygen and copper in causing waterside corrosion of boiler tubes is discussed. In two boilers of a

Dutch power station originally fired by a traveling-grate tube failures occurred after the installation of oil burners, in the vicinity of the burners and zones of highest heat release. These failures were probably caused or accelerated by copper deposits and later avoided by reducing the boiler load and the salt content of the feed water from 30–120 mg/l to 1.5–9 mg l and by adding cyclohexylamine to the condensate.

Selected Corrosion Cases from Power Station Operation. A. Bachmair and H. Kaes. *Mitt. VGB* No. 75, 1961 (Dec.), 411–21 (in German).

Tensile stress and pitting corrosion of ferritic and austenitic steels are discussed and some typical cases and their causes presented. Cases of failure caused by erosion followed by corrosion and by cavitation are also shown. Measures available for avoiding these different types of corrosion are described.

Corrosion of Boiler Materials in Supercritical Steam. W. Stiefel. *Sulzer Tech. Rev.* 1961, No. 3, 21–7.

A large number of austenitic and a few ferritic steels were exposed for twice 500 h to steam at 500 kg/cm² and 490–650 deg C, the two series differing in the hydrogen content of the feed water. The tests showed that supercritical steam is no more aggressive than subcritical steam.

Gas-Side Corrosion and Deposits

High Temperature Gas-Side Corrosion in Water-Tube Boilers. J. A. C. Samms and W. D. Smith. *BUCRA Monthly Bull.* 1961, 25 (Nov./Dec.), Pt. II, 454–84.

The subject is reviewed under the headings: (1) introduction; (2) corrosion in coal-fired boilers; (3) corrosion in oil-fired boilers; (4) conclusions; (5) bibliography.

Testing of Various Coatings for Protection Against Corrosion by the Flue Gas of Oil-Fired Boilers. H. Mika. *Mitt. VGB* No. 1961 (Dec.), 431–8 (in German).

Various metallic coatings and coatings on plastic basis were applied to special water-cooled test bodies and exposed to the flue gas of an oil-fired boiler at different temperatures of the gas and the cooling medium. Only one plastic based coating withstood the corrosive attack to a certain extent but was not immune against it, all others were destroyed after comparatively short times of exposure. The tests could not be continued because the firing conditions were so much improved during the tests by the reduction of excess air that acid film formation no longer occurred.

External Corrosion Due to Sulfur Compounds on Boiler Tubes in Steam-enerators Without Slag-tap Firing. 3. Buchholz and F. Börsig. *Maschnenschaden* 1961, 34 (Oct.), 141–6 in German).

Tu damage to three steam-genratc ithout slag-tap firing is inestigated.. The tube-wall areas afected by corrosion were in regions of ntensive combustion and high concenration of the combustion products. Provision of an air screen in front of he tube walls prevented, to a considrable degree, corrosion of boiling tubes n steam-generators without slag-tap ring.

From *CEGB Digest* 1962, 14 (Jan.), 15.

lue Gas Ash and Dust

The Application of the Roto-Flux Magnetic Separator to Pulverized Coal Fly Ash. L. J. Minnick. *ASME Preprint* No. 61-WA-313 1961 (Dec.), pp.

Studies of many different types of fly sh have shown that their main differnces are in the content of magnetic nd non-magnetic fractions each of hich has distinct properties. It is uggested to remove first the coarse ractions by screening since this conains the free carbon, unfused ash nd mullite which generally have etrimental effects on the products nad om or including fly ash. he non-magnetic fraction is paricularly suitable for producing a ght-weight aggregate of high softenng temperature and in cementitious ompositions (mortars, concretes, cements, grouting mixtures), the magetic fraction as a heavy media sepration material, ferral cements for ense mortars and concretes for pipene coatings, shielding concrete for eactors and structural concrete.

New Use for Fly Ash—A Lightveight Ceramic Building Material. S. Griffith, J. T. Dusek and E. C. Bailey. *ASME Preprint* No. 61-WA-291 1961 (Dec.), 8 pp.

Fly ash is mixed with a foaming gent, water and clay, poured into moulds and dried and then fired. Bricks, blocks and panels containing p to 90 per cent fly ash have been nade which are fire and vermin proof, ave adequate strength and provide eat and noise insulation.

n Analysis of the Vortex Flow in the yclone Separator. J. L. Smith. *ASME Preprint* No. 61-WA-188 1961 Dec.). 8 pp.

A theoretical study of the flow conitic presented which gives an exlana..on for the reentrainment of sepated particles and dust streaks on ne walls of separators.

Abstracts from the Technical Press—Abroad And Domestic

(See also p. 61, this issue)

(Drawn from the Monthly Technical Bulletin, International Combustion; Ltd, London, W. C. 1)

Mechanical Handling

The Motion of Hydro- and Aero-Mixtures in Pipes. A. E. Smoldyrev. *Dokl. Akad. Nauk S.S.S.R.* 1961, No. 137, 545–8 (in Russian).

An attempt is made to find an approximate solution to the problems of calculating the hydraulic resistance and determining the transport capacity in the piping of coal and other minerals. Three fractions are considered namely, 0.03–0.15, 0.15–2.0 and material larger than 2.0 mm. Theoretical and experimental results obtained with tubes up to 700 mm in diameter are presented graphically.

From *CEGB Digest* 1962, **14** (Feb. 3), 336.

Heat: Cycles and Transmission

Heat Transfer in a Vertical Evaporator Tube with Natural Circulation. H. A. Leniger and J. Veldstra. *Chem. Ing. Tech.* 1962, **34** (Jan.), 21–6 (in German).

The influence of apparent liquid level, temperature drop and boiling point on the heat transfer coefficient of tubes of stainless steel of 1 and 2 m length and 18 and 47 mm diam was studied and the circulation rate measured. The results are presented in graphs and discussed.

The Effects of Nucleate Boiling Versus Film Boiling on Heat Transfer in Power Tubes. H. S. Swenson, J. R. Carver and G. Szoeke. *ASME Preprint* No. 61-WA-201, 1961 (Dec.), 9 pp.

Heat transfer coefficients for forced-convection film boiling were experimentally determined for water at 3000 psi flowing upward in a vertical stainless steel tube with an inside diam of 0.408 in. at heat fluxes between 90,000 and 180,000 Btu/sq ft/hr. Nucleate, transition and stable film boiling occurred simultaneously in different zones of the tube. In a second series of tests the tube had an inside helical rib when moderate boiling could be maintained to much higher steam qualities than in a smooth tube. The results are related to the design and operation of large, once-through subcritical pressure boiler.

A New Method of Calculating the Radiant Exchange between a Gas and a Gray Wall. K. Elgeti. *B.W.K.* 1962, **14** (Jan.), 1–6 (in German).

An exact equation has been deduced for the radiant exchange ratio. The values of this ratio are presented for carbon dioxide and water vapor in a single diagram with the absorption ratio of the black or gray radiating wall as parameter. The values obtained by the exact equation differ considerably from those obtained by various approximate solutions.

Heat Transfer to Air, Carbon Dioxide and Helium Flowing Through Smooth Circular Tubes under Conditions of Large Surface/Gas Temperature Ratio. J. F. Barnes and J. D. Jackson. *J. Mech. Engng. Sci.* 1961, **3** (Dec.), 303–14.

Experimental results have shown good agreement with theoretical predictions.

Steam Generation and Power Production

Preparation of Steam Tables with the Aid of a Digital Computer. R. W. Bain. *J. Mech. Engng. Sci.* 1961, **3** (Dec.), 289–94.

The use of a digital computer in deriving an empirical equation of state for steam based on experimental data is described. A table of specific volume has been computed but must be regarded as preliminary only.

Viscosity and Thermal Conductivity of Water; Gaseous and Liquid States. R. V. Theiss and G. Thodos. *ASME Preprint* No. 61-WA-204, 1961 (Dec.), 8 pp.

Reduced state correlations hav been developed, the two transpor properties based on a review of th literature.

Measurement of Viscosity of Stear by the Capillary Method. O. W Witzell. *ASME Preprint* No. 61 WA-331, 1961 (Dec.), 8 pp.

Viscosity of steam has been meas ured at 400, 500, and 600 F from at to near saturation pressure by th capillary method. The results ar presented in graphs and compare with those of other investigators Measurements in the supercritica region will follow.

Measurement of Velocity of Sound at High Pressure and Temperature. J. Woodburn. *ASME Preprint* No 61-WA-293, 1961 (Dec.), 9 pp.

Velocity measurements have been carried out in steam at up to 1000 psi and 750 F with a sound source of 750 kc; these are now being extended 2000 psi to include also absorption and dispersion in steam. It is intended to compare the results with those calculated from the steam tables. The experimental methods and apparatus are described.

Comments on Measurements of Joule-Thomson Coefficients for Water. G. N. Richter, H. H. Reamer and B. H. Sage. *ASME Preprint* No. 61-WA-330, 1961 (Dec.), 7 pp.

Preliminary values of Joule-Thompson coefficients of water between 500 and 800 F and up to 7000 psi are presented and these coefficients, isobaric heat capacity and enthalpy compared with published data. Difficulties with the apparatus made a postponement of further measurements necessary.

Survey of Packaged Boilers. D. E. Fiford. *Engng. Boil. Ho. Rev.* 1926, **77** (Feb.), 55–9.

The second part reviews flash steam, vertical and corner-tube boilers. A table presents the names of suppliers, trade names and evaporative capacity of packaged boilers available in Gt. Britain.

Packaged Boilers. M. L. Jones. *ASME Preprint* No. 61-WA-89, 1961 (Dec.), 3 pp.

Packaged, oil or gas fired water-tube boilers with output up to 120 klb/hr are discussed. Their advantages are weighed against their many disadvantages and suggestions made to improve the design of such boilers. All boilers should be easily convertible to coal firing in view of the rising costs of gas and oil.

Attempt at Calculation of the Transient Performance of Forced-Flow

Boilers for Gas-Cooled Reactors. W. E. Bausa. *Atomkernenergie* 1962, 7 (Jan.), 15–20 (in German).

An attempt is described of finding a method suitable for calculating the transient performance of forced flow boi' -s used for gas-cooled reactors in wl the change of state of the water in forced-flow system is taken into account. Systems including reheaters or two-pressures are also treated.

Developments and Trends in Superheater and Reheater Design. K. E. Merefield. *Brit. Pwr. Engng.* 1962, 4 (Feb.), 45–51.

Comparison of Dynamic Models of a Superheater. M. Enns. *ASME Preprint* No. 61-WA-171, 1961 (Dec.), 8 pp.

The requirements a model has to satisfy are discussed with special reference to a superheater section of a boiler. Two kinds of models, one with lumped and one with distributed parameters are analyzed and compared. Conclusions are drawn on the adequacy of one or other of the models for certain given conditions.

Chemical Cleaning of High Pressure Systems Containing Austenitic Stainless Steels. J. P. Engle and C. F. Reich. *ASME Preprint* No. 61-WA-275, 1961 (Dec.), 5 pp.

Since austenitic steel is subject to chloride stress corrosion cracking, the us- f hydrochloric acid, even if inhi d, for cleaning boilers, especially once-through types, is not recommended. Other acids tried out such as phosphoric, sulfuric, formic and critric acid, did not give satisfactory results either. The new acid, L21, a mixture of several organic acids, which can hold more iron in solution, has proved successful in preliminary trials on various metals used at Eddystone No. 1 unit and has been used there several times since.

Liquid and Gaseous Fuel Firing

A Burner with an Electrical Discharge Superimposed on the Combustion Flame. D. L. Richardson and B. Karlovitz. *ASME Preprint* No. 61-WA-251, 1961 (Dec.), 8 pp.

A burner has been developed in which an electric high-voltage a-c discharge can be superimposed on the flame from solid, liquid or gaseous fuel with 15 kw of thermal combustion and 7 kw of electric discharge power, increasing the specific enthalpy from 1100 to 1600 Btu/lb at stoichiometric air fuel ratios and to 1900 Btu/lb with rich fuel flames. It requires ionizing ac ves (KCl) to obtain steady operation. Temperatures of up to 5500 F have been reached. The burner is believed to be of advantage where very

high temperatures are required previously obtained by high preheat, oxygen enrichment or electric furnace or where lower temperatures but very rapid heating rates are required.

Development of Burners for Industrial and Utility Boilers. G. Musat and J. M. Rackley. *ASME Preprint* No. 61-WA-286, 1961 (Dec.), 8 pp.

The facilities available at the Babcock and Wilcox Research Centre, Canton, Ohio, and their use in the development of burners are described. They include various firing tunnels, water models, high speed cameras, flame spectrum and flue gas analyzers, and heat absorption equipment. The Laboratory experiments are followed by large-scale plant trials and in most cases the latter have confirmed the results of the experiments. Burner atomization, flame impingement on walls, influence of moisture in air on ignition, flame spectra, heat absorption on furnace walls and automatic control of burners have been investigated.

Water-Side Corrosion and Water Treatment

Hydrazine for Preventing Oxygen Corrosion in High Pressure Boilers. G. Weidlich. *Energietechnik* 1961, **11** (June), 260–3 (in German).

Hydrazine is continuously added to thermally degassed boiler feedwater to reduce the dissolved oxygen below 5 $\mu g/l$ to prevent pitting. A table is given for determining the hydrazine concentration of a solution from its density. Methods for determining hydrazine concentration using bromide/bromate, dimethylaminobenzaldehyde and picrylchloride solutions are also given.

From *CEGB Digest* 1962, **14** (Jan. 20), 201.

Corrosion Cracking of Austenitic Steels in Power Stations. P. A. Akolzin, V. N. Gulyaev and I. N. Laguntsov. *Russia: Symposium-Korroziya Reaktornykh Materialov* 1960, 93–102 (in Russian).

In two boilers without austenitic bends, operating at 170 atm, and 550 C, intercrystalline cracks were observed initially but later cracks developed along the grain boundaries and across the grain. After the bends had been austenized and the boiler water made alkaline no further cracking occurred. The suitability of various steels for the construction of boilers and the appropriate dosing necessary for the respective boiler waters is considered.

From *CEGB Digest* 1962, **14** (Jan. 20), 184.

Gas-Side Corrosion and Deposits

External Corrosion in Modern Large Boiler Plant—Pt. I. W. D. Jarvis. *Corr. Techn.* 1962, **9** (Jan.), 9–13.

The various kinds of corrosion found in boilers, the factors contributing to corrosive attack, the chemical processes involved and remedial measures are described.

The Catalytic SO_2 Oxidation as a Function of Residence Time of the Gases in the Reaction Chamber. K. Wickert. *B.W.K.* 1962, **14** (Jan.), 20–1 (in German).

Laboratory experiments using platinum, V_2O_5 and oxidized iron as catalysts were carried out with air containing 2 vol. per cent of SO_2 and the influence of residence time at maximum reaction temperature (platinum 500 C, V_2O_5 550 C, oxidized iron 700 C) on conversion rate of SO_2 to SO_3 determined. For V_2O_5 the maximum rate occurs above a residence time of 1.4 s and since residence times of combustion gases in modern boilers vary between 5 and 2 s a high rate of SO_3 formation can be expected when burning V containing oil and with tube surface temperatures from 500–1200 C.

Corrosion of Superheater Spacers and Hangers. S. P. Castle and D. B. Peplow. *Brit. Pwr. Engng.* 1962, **4** (Feb.), 59–62.

In boilers converted from pulverized coal to oil firing heavy corrosion of superheater hangers and spacers exposed to gas temperatures of 1400–1500 F occurred. The examination of the corroded parts showed that sulfur, sodium and vanadium in the oil ash were responsible. This type of corrosion can be avoided by either internal cooling of the hangers and spacers or the use of a 60-40 Cr-Ni alloy or ceramics but these materials are very expensive.

Sulphur Attack on Nimonic 75 in Contact with a Heat Insulating Material at 800 C. S. R. Billington. *Metallurgia* 1962, **65** (Jan.), 3–9.

The attack on Nimonic at a temperature of 800 C by a silica-magnesium/calcium carbonate insulating material containing 0.04 per cent S is described; within a few hours local penetrations to a depth of 0.05 in. occurred. It is similar to attack by sulfur containing fuel ash on steel.

Heat Recovery Plant

Calculation of the Evaporators in Nuclear Power Stations with Pressurized or Boiling Water Reactors. V. Ferencik and K. Riebel. *Kernenergie* 1961, **4** (Oct./Nov.), 793–800 (in German).

A method is presented for the comparison of heat exchangers for which the heat transfer coefficients and ther-

ıal load are given. Although orig-
ıally developed for heat exchangers of
ressurized and boiling water reactors
ıe method is also applicable to other
:actor types.

**ffect of Impurities on Heat Ex-
ıang ıd Aerodynamic Resistance
ı an Experimental Air Preheater with
Heating Surface of Sectional Plates.**
. I. Volper and T. A. Savitskii.
nergomashinostroenie 1961 (Nov.),
-13 (in Russian).

The results of an investigation into
ıe effect of gas flow rate and tempera-
ıre conditions on heat exchange and
:rodynamic resistance in the un-
ılating channels of an experimental
atetype air preheater when the
ıannels are fouled with a soot deposit,
:e presented. Data are given on the
ficiency of compressed-air soot blow-
g to remove the deposit.

CEGB abstract.

ɔwer Generation and Power Plant

**atisfying the Industrial Power De-
ıand.** T. M. Hendrickson. *ASME
reprint* No. 61-WA-114, 1961 (Dec.),
pp.

The factors to be considered in
:eciding whether to buy electric power
om the grid or to generate it in the
orks are examined. The three main
ıses are discussed where power only-
ɔwer and steam and mainly steam
'e re 'red. The availability of by-
'odı .uel is also considered in this
ɔntext and a few simple rules es-
:blished as guidance to power engi-
:ers.

**'aste Heat Recovery from Conden-
ıte.** Anon. *Pwr. Wrks. Engng.*
)62, **57** (Jan.), 38.

At the Milk Marketing Board's
eamery at Aberdeen the condensate
om the driers at 324 F is flashed into
eam which is used in space heaters.
he remaining condensate passes
:rough calorifiers in which water for
ıe underfloor heating system is pro-
ıced at a flow temperature of 140 F.
p to 1,800,000 Btu/hr can be pro-
ded in this way for various heating
ırposes.

'ench Steam Power Stations. Anon.
ngineer 1962, **213** (Jan. 26), 205–6.

The development of electricity gen-
ation since 1946 is briefly reviewed.
ɔtal consumption in 1960 was 72,000
whr, 40,300 Gwhr from hydro-
:ectric and 31,800 Gwhr from thermal
ations. EDF produced 63 per cent
this total. The first standard sets
:re of 60 Mw capacity, the second
ts of 125 Mw and the third sets now
'ing ıtalled of 250 Mw capacity.
ıe .ers of these sets are rated
1700 klb/hr at 2360 psi and 1050/-
)50 F and the turbines of 4 cylinder
design. The next step will be 500 Mw units with steam at 4270 psi and 1110/1050/1050 F, and a heat rate of below 8000 Btu/kwhr. Space requirements would be about 11.5 cu ft/-kw and area requirements 0.01 sq ft/-kw, a saving of 40 per cent on the 250 Mw sets.

Multiple Innovations Keep Down Costs at Brunner Island Plant. M. D. Engle and B. Van Ness. *Elect. Wrld.* 1962, **157** (Jan. 15), 52–4.

The unit consists of a controlled circulation boiler rated at 2100 klb/hr at 2400 psi and 1000/1000 F, the 40 tangentially firing burners in the divided furnace being supplied by 5 mills and a 300 Mw cross-compound 3600/3600 turbogenerator with 7 extraction stages. There is a central control room but computer control of a coal fired unit was not thought to be sufficiently developed yet. The chimney has an inner brick lining and outer concrete shell separated by a ventilated space, an epoxy-tar coating on the inner concrete face preventing damage from acid and a silicone water-repellent treatment of the outside to prevent moist air entering the concrete through hair cracks. Various new features on the electrical and civil engineering side have reduced overall costs.

Highveld Power Station to Reach Final Capacity by 1963. Anon. *Sth. Afr. Elect. Rev.* 1961, **52** (Dec.), 32–43.

This station will have a final capacity of 480 Mw when the last two of eight 60 Mw units are commissioned in 1963. Four boilers are of Babcock and Wilcox and four of International Combustion design, all of the bi-drum type, pulverized coal fired, the former each supplied by 4 pressure mill and 16 circular burners in the rear wall, the latter by 4 suction mills and tilting corner burners; each boiler is rated at 550 klb/hr at 950 psi and 925 F. Two boilers each are connected to a reinforced concrete chimney of 300 ft height. Coal is supplied direct by 3 belt conveyors of 650 t/hr capacity each from the nearby coalfields. Seven of the turbines are by Brown Boveri, the eighth by Metropolitan-Vickers, they are all of the two-cylinder impulse type with 5 extraction stages for feed water preheating. The generators are hydrogen cooled.

The Overhavel Power Station, Berlin. Anon. *B.W.K.* 1962, **14** (Jan.), 21–2 (in German).

On November 1, 1961, the first 100 Mw unit of this new power station was commissioned. The Benson boiler with slagging furnace is rated at 775 klb/hr at 2560 psi and 977/977 F and fired by pulverized coal or oil and coal in a ratio of 1:1. The turbine has 3 sections and 9 extraction stages to heat the feed water to 572 F. The feed water pump is turbine driven receiving steam from a l-p stage of the main turbine. The generator is hydrogen cooled. A second unit is under construction and should be ready early in 1963. A third unit may be installed later on but cooling water scarcity will then necessitate the erection of a cooling tower.

Design Features of the BONUS Nuclear Power Station. A. S. Jameson. *ASME Preprint* No. 61-WA-235, 1961 (Dec.), 28 pp.

The BONUS (Boiling Nuclear Superheat) power station under construction is rated at 50 Mwt and 17.3 Mwe and will provide 152 klb/hr of steam 950 psi and 900 F by internal superheating. Design criteria are presented and all essential parts are described in detail.

Performance and Operating Experience of the Dresden Nuclear Power Station. I. L. Wade and T. Trocki. *ASME Preprint* No. 61-WA-268, 1961 (Dec.), 12 pp.

The dual-cycle, boiling water reactor has an output of 180 Mwe net and supplies 1.4×10^6 lb/hr of primary steam at 990 psi and 543 F and secondary steam at 520 psi at full flow and at 950 psi at minimum flow. Various tests prior and during commissioning are described, especially those concerning the self-regulating ability between half and full load without movement of the control rods, plant radioactivity (primary and secondary water/steam circuits) and feedwater and reactor water operating conditions. The cracking of index tubes and control blades and their replacements by improved materials are described; inspection during shutdown of other parts of the reactor and auxiliaries showed these to be in

excellent conditions. The reactor is now operated at 192 Mw during the day and 160 Mw during the night, increase and decrease of load being carried out at a rate of 5 Mw/min.

The Garigliano Nuclear Power Power Station. M. Covino. *Nucl. Pwr.* 1962, **7** (Feb.), 65–7.

The reactor for this 150 Mwe station is of the forced circulation, dual-cycle boiling water type based on the American Dresden station but containing many improvements. The following are described briefly: (1) Shielding; (2) Reactor internals; (3) Control system; (4) Fuel; (5) Coolant chemistry; (6) Waste disposal.

The Construction of Latina. H. C. Newsome. *Nucl. Pwr.* 1962, **7** (Feb.), 72–3.

The progress at this single gas-cooled reactor station is outlined. It is expected to start the first tests later in 1962.

Improvements in the Design of the Selni Nuclear Power Station. F. Castelli. *Nucl. Pwr.* 1962, **7** (Feb.), 68–71.

The Enrico Fermi is a pressurized water reactor for an output of 160 Mwe using the multi-region loading and cycling concept. The reactor core, mechanical, thermal and nuclear designs, steam generating system, control and instrumentation, chemistry and radiochemistry and the conventional plant are described.

The SENA Underground PWR. Anon. *Nucl. Pwr.* 1962, **7** (Feb.) 79.

Construction of this 242 Mwe pressurized water reactor station at Chooz has started. The main data are tabulated. The fuel will consist of uranium oxide pellets with 3.1 per cent enrichment in stainless steel tubes and a mean burnup of 14,700 Mwd/t; the coolant will be at a pressure of 2148 psi and a temperature of 267 C at the inlet and 300 C at the outlet. The net efficiency of the station is 29.3 per cent.

Shippingport Operating Experience. L. R. Love. *ASME Preprint* No. 61–WA-229, 1961 (Dec.) 8 pp.

Operation with the first seed of Core I from 18/12/57 to 7/10/59, modifications carried out during replacement of the first by the second seed and operation with this from 9/5/60 to August 1961 and replacement by the third seed are outlined. System station compatibility, reactor stability, equipment reliability, refuelling, personal qualifications and requirements and radiation exposure and contamination control are discussed. A table gives the radiation levels measured in various parts of the plant.

Equipment Performance and Operating Experience at the Yankee Atomic Electric Plant. G. A. Reed. *ASME Preprint* No. 61-WA-227, 1961 (Dec.), 8 pp.

The Yankee reactor is of the closed cycle, pressurized light water type with a closed-system pressure of 2000 psi and temperature of 514 F. The associated turbogenerator is rated at 145 Mw but the plant is probably capable of 175 Mw. The net thermal efficiency at 120 Mw is 29.4 per cent. Operational difficulties of the reactor have not occurred but turbine vibration and governor control have caused some troubles. It is believed that with improvements resulting from the operating experience of this plant, a plant capable of producing nuclear power competitive with other fuels could be designed.

Materials and Manufacturing Processes

Properties of some Alloys and Weld Metal Deposits at Low Temperatures. R E. Lismer. *Weld. Met. Fabr.* 1962, 30 (Jan.), 19–27.

The results of tests carried out at the Research Laboratories of Lloyd's Register of Shipping on Al-Mg, cupro-nickel and Kunifer alloys, Nb stabilized austenitic stainless steel, various ferritic plate steels of C-Mn or low alloy compositions and C-Mn plate materials at temperatures down to −200 C are set out in graphs and tables.

Experimental Study of the Vortex in the Cyclone Separator. J. L. Smith. *ASME Preprint* No. 61-WA-189 1961 (Dec.), 7 pp.

The experimental studies have largely confirmed the theoretical studies presented in the previous paper.

Corrosion Problems in Stack and Ducts. D. O. Thompson. *ASME Preprint* No. 61-WA-136 1961 (Dec.), 4 pp.

The Commonwealth Edison Co. of Chicago found that their concrete chimneys with corbel-supported brick linings and 2-in. spun glass insulation were leaking, the insulation damaged and coal tar mastic coating had disappeared where liquid H_2SO_4 had accumulated. A new mastic coating "Stackfas" has been developed which appears to withstand corrosive attack. For new chimneys a Cor-ten lining, possibly with this new mastic coating, is regarded as the best solution. Recommendations are made also for insulation of steel stacks, electrostatic precipitators and ducts.

Operational Experience with the Gas Turbines of Vahr Power Station. A. Brandes. *BWK* 1961, **13** (Dec.), 542–6 (in German).

Vahr district heating and power station contains two 25 Mw gas turbine-generators, four oil-fired boilers for heating peaks, four electrode boilers for night heat supply and two accumulators to balance electric and heat demands. The fuel for the turbines is heavy fuel oil preheated to 320 F containing about 2.5 per cent S and V and Na in a molar ratio of 0.33. An additive called Perolin is used to reduce corrosive attacks. Deposits on heat exchangers and turbine blades require regular washing with water followed by careful drying. The thermal efficiency is 24.5 per cent at full load and a cooling water temperature of 50 F. The measures taken to reduce noise nuisance to the surrounding housing estate and within the station are detailed.

Pulverized Fuel Firing at a Dairy Boiler Plant. Anon. *Steam Engr.* 1962, 31 (Jan.), 121–8.

The new boilerhouse of the Express Dairy Co.'s works at Appleby has been provided with two economic boilers each rated at 22,000 lb/hr at 120 psi and equipped with an Atritor pulverizing plant and auxiliary oil burn-

s. A refractory plate was installed the combustion chamber to improve the burning out of the fuel and tain most of the ash. The average iciency of the plant has been 78 per nt.

eci ion Hardening of Stainless eels .. Water-Cooled Reactors. .C.. Rowland and W. R. Smith. *ucl. Engng.* 1962, **7** (Jan.), 14–22.
Because of failures encountered in ictors in which such steels were used ther investigations were carried t into the stress corrosion susceptiity of precipitation hardening stains steels. The composition and propies of these steels are given, the t procedure described and the re-ts presented in tables.

e Failure of 304 Stainless Steel by ermal Strain Cycling at Elevated mperatures. A. E. Carden and J. Sodergren. *ASME Preprint* No. WA-200 1961 (Dec.), 8 pp.
Specimens of 304 stainless steel re subjected to thermal strain cyng tests at 700 to 1700 F and 100 to),000 cycles. The test temperature s less influential on the cycles to iure than the plastic strain.

aling Behavior of Superheater Tube oys in ASME High Temperature eam Research Tests at 1100–1500 F. Eberle and C. H. Anderson. *ASME eprint* No. 61-PWR-3 1961 (Sept.), pp
The ults of tests on 7 ferritic and austenitic steel tubes exposed to air d steam at 2000 psi and 1100–1500 F r periods of 6–18 months are preted.. Details are given of adence, thermal shock resistance, ckness, structure and chemical comition of the scale and of the resiste of the steels to scaling.

tallurgical Evaluation of Superter Tube Alloys after 12 and 18 nths' Exposure to Steam at 1200, 0 and 1500 F. C. L. Clark, J. J. B. therford, A. B. Wilder and M. A. dovi. *ASME Preprint* No. 61-R-4 1961 (Sept.), 30 pp.
The tests reported earlier (see abact 5694, 1960) were continued and ults obtained after 12 and 18 nths are now presented. All the els and alloys appeared to be in sfactory conditions after exposure steam at 1200 and 1350 F for 18 nths, but most failed during expoe to steam at 1500 F. The decrease ductility and impact resistance ed after 6 months did not continue. onel showed the least microstruc-al change.

du n of Weldments Joining erheater Tube Alloys after Expoure to Steam Temperature of 1000–1500 F. W. E. Clautice. *ASME Preprint* No. 61-PWR-5 1961 (Sept.), 12 pp.
In conjunction with the ASME sponsored research on steels suitable for service at temperatures up to 1500 F welds of similar and dissimilar steels exposed for 6–18 months to steam at 1100–1500 F were examined. The welds were in satisfactory condition with only minor defects and some indication of fissure propagation with time and a function of the temperature. There was some carbon migration in joints of ferritic and austenitic welds and in increase of corrosion with time of exposure.

Operational Trial of Superheater Steels in a CEGB Pulverized-Fuel-fired Boiler Burning East Midlands Coal. A. M. Edwards, P. J. Jackson and L. S. Howes. *J. Inst. Fuel* 1962, **35** (Jan.), 16–28.
Eleven ferritic and six austenitic steels (composition given) were exposed to gas temperatures of 935 to 1240 F for 12,719 hr in a boiler at North Wilford station burning a coal averaging 18 per cent ash, 0.3 per cent chlorine and 0.9 per cent S. The ferritic steels at temperatures up to 1125 F showed a loss on the fire and water side not exceeding 0.020-in. had a maximum service temperature of 1075 F and fireside deposits did not significantly increase the oxidation rate. The austenitic steels suffered severe wastage of 0.06-in. at a temperature of 1240 F caused by attack of the chromium-containing oxides by alkali-metal chlorides in the deposits. The difference in wastage is due to the oxidation products on the ferritic steels being adherent and forming a protective layer but spalling from the austenitic steels.

Wastage Trials of Superheater Steels in CEGB Power Stations at Westwood (Wigan) and Bromborough (Birkenhead). G. G. Foster and L. H. Toft. *J. Inst. Fuel* 1962, **35** (Jan.), 28–40.
In these trials at temperatures up to 1240 F and with coals containing 0.5 per cent chlorine and 2.5 per cent S and 0.27 per cent chlorine and 1.9 per cent S, respectively, the austenitic steels showed less wastage than the ferritic steel and this appeared to be a function of the Cr content. No acidic deposits were found in either trial in contrast to those at North Wilford station. Wastage on the gas and steam side was about equal. A reliable quantitative assessment of metal wastage of steels of higher Cr content would require a longer trial period than that available at Bromborough station.

The Bursting Performance of Pipes. D. Uebing. *BWK* 1961, **13** (Dec.), 537–41 (in German).
The bursting pressure and fracture deformation has been determined for pipes of different steels and radius ratios of 1.5 to 4.0 and the course of fracture traced by stress analysis, microscopic fracture observation and a special fracture initiation test. The fractures may start on the outside or the inside.

Chart Method for Pipe Stress Calculations. H. Porter. *Engineer* 1961, **212** (Dec. 29), 1074–7.
A chart has been prepared for obtaining a reasonably precise solution for the stress in two-anchor pipe systems by a drawing-board method. The results agree closely with those obtained by accepted analytical methods. The chart may also be used with three-plane pipelines having two anchors.

Uranium Oxide—Fuel of the Future. B. T. Bradbury. *Research* 1961, **14** (Nov.), 423-9.
The properties, irradiation behavior and potentialities of UO_2 as a reactor fuel are discussed.

Contribution to the Problem of the Scaling Behavior of Boiler Steels. A. Rahmel. *Mitt. V.G.B.* No. 74, 1961 (Oct.), 319–32 (in German).

Scale formation on most metals and alloys is subject to a parabolic time law though this may also be cubic, logarithmic or reciprocal-logarithmic; it is also a function of temperature and atmosphere. Extended studies of the scaling of 7 ferritic and 4 austenitic steels in air and steam at temperatures up to 700 C over several years are reported and the differences in the composition of the scale formed at various temperatures in the two atmospheres discussed. Corrosion of the steels on the gas-side by deposits, such as V_2O_5 alone and in the presence of alkali metals, by double sulphates and by chlorides has also been studied. It is believed that the development of metals of sufficient strength at high temperatures and high corrosion resistance has little prospect of success.

Tensile Stress Corrosion of Low-Alloy Steels for Boiler Construction. W. Rädeker. *Mitt. V.G.B.* No. 74 1961 (Oct.), 332–44 (in German).

The literature on tensile stress, fatigue and pitting corrosion of low-alloy ferritic-pearlitic steels is critically reviewed and supplemented by the author's own research. It is concluded that there are possibilities of transitions between the various kinds of corrosion but that many of the problems are not yet solved. It is necessary to investigate the limit stress of metals, limit concentration of attacking media, effect of higher temperatures and the nature of the attack. Improved alloys, improved design and fabrication method should also help in reducing the corrosion problem.

Tensile Stress Corrosion and its Prevention—II. I. Class. *Tech. Überw.* 1961, 2 (Nov.) 482-8 (in German).

The second part deals with preventive measures such as the application of chemical agents, choice of material, artificial generation of compressive stresses on the surface, heat treatment, design, fabrication and operation.

Reduction of Fatigue Crack Propagation. Anon. *Engineering* 1961, 192 (Nov. 3), 593.

Research carried out by the U. S. National Bureau of Standards into means of reducing the propagation of fatigue cracks is outlined. It has been found that by applying a coating of an organic liquid such as dodecyl alcohol to a variety of metals access of molecules of oxygen to the notch or crack is prevented and the duration of the crack propagation period considerably increased.

Progress in Welding of Boiler Tubes in Pipelines for High Pressure Boilers. R. J. Hardress. *Weld. Fabr. Des.* 1961, 4 (Aug.), 20–30.

ıe Action of Caustic Soda Solutions Steel in Relation to the Problem of .ustic Embrittlement in Boilers. S. Thornhill. *Centre Belge d'Et. et Doc. des Eaux Bull. Trim.* 1961/IV, 3–26 (in French).

The rosion of steel exposed to ustic oda solutions and to mixres of caustic soda and sodium rate has been measured to furnish ta on caustic embrittlement and e preventive action of sodium rate added to boiler feedwater. ustic soda solutions are more corroe at high and low concentrations an at medium, and the concentrans at which corrosion occurs are termined for different temperatures tween 20 C and 300 C. Highly ıstic solutions attack steel with the olution of hydrogen, giving magtite, hydrogen ferrite and sodium rite as corrosion products. Corron is not prevented by the addition sodium nitrate and can even be inased, but the hydrogen evolved is gely eliminated by the reduction of dium nitrate to sodium nitrite. The thor suggests that the prevention of ıcks of caustic origin by treating iler feedwater with sodium nitrate actually due to the fact that the ıcentrated solutions obtained, which responsible for the attack, no ger cause a type of corrosion accomnied by hydrogen evolution.

From *CEGB Digest* 1962, **14** (Feb.), 4

rruments and Controls

)I/VDE Specifications for the Purase of Controls for Boilers. R. ack. *B.W.K.* 1962, **14** (Jan.), -9 (in German).

The latest drafts are presented for cussion. They concern: (1) Fuel d combustion air control; (2) Drum ter level control; (3) Superheated am temperature control.

namic Characteristics of a Feed ntrol System for Once-through ilers Based on the "Heat-water" tio. I. I. Aizenshtat. *Energomanostroenie* 1961 (Nov.), 5–9 (in ssian).

A method of feedwater control used high-pressure once-through boilers based on the "heat-water" ratio. Heat" here is the sum of signals ıoting steam consumption and the ssure change rate at the superıter inlet.) Factors determining stability of such a feed control tem are considered, and the effect these factors of conversion from h to supercritical pressures is dis- A means of increasing the gree of damping of the system by roducing a further signal into the d regulator to denote the tem-

perature of the medium at one or more points in the steam delivery line renders the system suitable for 255 atm 950 ton/hr boilers.

CEGB abstract.

Flue Gas Temperature Measurement. Anon. *Fuel Eff.* 1962, **10** (Jan.), 48.

At the Central Laboratories of Shell International Petroleum Co. a simple suction pyrometer for use with the Shell Moray smoke meter has been developed. It has two ranges, from 0–500 and 0–1000 C and an accuracy of 2–3 per cent. Its application is described.

Photoelectronic Smoke Density Monitor. G. v. Hacht. *Elektwirtsch.* 1962, **61** (Jan. 20), 46–7 (in German).

The instrument developed by A.E.G. consists of a light emitter and receiver, electronic amplifier and recorder or indicating instrument and measures the smoke density in Ringelmann numbers. Both emitter and receiver are air cooled and a jet of air prevents settling of dust on the lenses. The voltage of the lamp and the bridge circuit is kept constant with an accuracy of 0.05 per cent.

Instruments and Controls

The Problem of Simulating the Dynamic Behavior of Steam Generators in Analogue Computers. F. Läubli. *Sulzer Tech. Rev.* 1961, No. 2, 35–42.

The dynamic phenomena in steam generators are mainly governed by heat storage between tube wall and the flowing medium and the way in which temperature disturbances in the working medium are propagated through the boiler. Three methods of approximation have been derived for single-phase flow through heat storing tube systems and investigated with respect to numerical stability and speed of convergence. The three methods are described and the third method recommended for use.

Saturn. A Large Analogue Computing Installation. 1. T. O. Jeffries, C. B. Newport, H. A. Darker and R. A. Flint. *Nucl. Pwr.* 1961, **6** (Dec.), 80–4.

This analogue machine divided into 6 computers is specifically designed for studies of nuclear power station. The first part describes machine and system design, linear computing units and nonlinear computing units.

New 342 MW Unit to be Controlled Automatically. R. A. Baker. *Elect. Wrld.* 1961, **156** (Nov. 13), 54-7, 104.

Sewaren No. 5342 Mw unit will operate on steam at 2400 psi, 1100/1050 F supplied by a 2200 klb/h once-through boiler fired by oil which simplifies automatic control. The digital computer has a 4000 word core and a 45,000 word memory and will control starting, operation, normal and emergency shut-down. The various functions the computer has to undertake are set out and the problems arising in the application of control computers to steam plants are discussed.

The Design of an "Everclean Window" for the Observation of the Optical Density of Flue Gas. P. A. E. Crosse, D. H. Lucas and W. L. Snowsill. *J. Inst. Fuel* 1961, **34** (Nov.), 503–5.

Two slightly different windows have been developed, one for ducts with subatmospheric and one for positive and/or subatmospheric pressure. The window consists of an aluminum honeycomb of a large number of hexagonal tubes of $^1/_4$ mesh bonded together and sealed to a glass window with Araldite. The photocell or light is contained in a dust-tight box and fixed to the tube containing the window. These windows remained clean for over a year. The window is patented under B.P. 877918.

Capacitative Level Recorders Help to Control Automatically Coal Bunker Charging Plant. H. Madeisky. *Handling Convey. Autom.* 1961 (Nov.), 429.

Each bunker contains a robust articulated rod made of Zirconium-silicate through which a silometer unit continuously records the level and switches the feeding conveyor off when the maximum level is reached and switches it on when the contents have fallen to the minimum level. The conveyor carriage has fitted to its front end a chain-rod which stops the feeding operation when the maximum level is reached and moves the conveyor to the next bunker to be filled.

Instruments and Controls

Use of Electronic Computers for the Calculation of Thermodynamic and Strength Problems of Steam Boiler Plants. W. Schultes. *Energie* 1961, **13** (Dec.), 553–4 (in German).

The German boiler manufacturer Walther und Cie and IBM have together undertaken the programming of an IBM 650 digital computer which has solved the following problems: (1) thermodynamic calculation of an oil-fired boiler with tubular air pre-

C and also steel consumption per ton steam generated, space occupied, etc.; 2) calculation of double slagging furnaces for a Benson boiler with reheater rated at 365 t/hr, 190 atu and 535/545 C including the performance of the furnaces at two different slag fusion em[illegible]tures; (3) calculation of water and steam circulation in a system for pressures of 135 and 67 atu including the velocities in the various sections, steam and water content, rate of circulation and entry energy of the mixture into the drum; (4) calculation of plate thickness of a smoke-tube boiler for various diameters, pressures and materials; (5) permissible rate of heating and cooling of superheater tubes made of different materials; (6) thermodynamic calculation of smoke-tube boiler at various pressures and the influence of pressure on flue gas temperature and efficiency.

Combustion Monitoring of Large Flames from Flame Spectra. F. A. Baumgartel and W. T. Hage. *ASME Preprint* No. 61-WA-299 1961 (Dec.), pp.

The development of a flame detector responsive only to radiation below 3000 A (far ultraviolet) and its unique advantages over other flame detectors are described. A modification of Geiger-Muller counters operating in the glow-discharge region has given most satisfactory results: it has been named "Flamon" detector.

Dissolved Oxygen in Boiler Feed Water. G. Jessop and H. W. Holy. *Brit. Pwr. Engng.* 1961, 4 (Jan.), 40–43.

Two instruments, one working on a physical and the other on a chemical basis are described. The results of comparative determinations have been satisfactory.

Nuclear Energy

Selection of Optimum Parameters of Nuclear Power Stations. A. J. Kramarov. *Kernenergie* 1961, 4 (Sept.), 618–16 (in German).

A system of equations has been developed with which the parameters for the optimum, i.e., minimum costs for the generation of one unit can be determined.

New Method for the Calculation of Burn-up in Reactors. E. Kern. *Atomkernenergie* 1961, 6 (Oct.), 397–408 (in German).

A general formulation of the charging calculation is presented, a method of solving the equation by analogue computer described and an example of the application of the calculation given.

Combustion

DEVOTED TO THE ADVANCEMENT OF STEAM PLANT DESIGN AND OPERATION

volume 33 number 9 **March 1962**

Published monthly by COMBUSTION PUBLISHING COMPANY, INC., 200 Madison Ave., New York 16. A SUBSIDIARY OF COMBUSTION ENGINEERING, INC.

Charles McDonough, President
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Lambert J. Gross, Treasurer
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COMBUSTION is sent gratis to engineers in the U. S. A. in charge of steam plants from 20,000 lbs per hr capacity up; and to consulting engineers in this field. To others the subscription rate, including postage, is $4 in the United States, $5.50 in Canada, and $8 in Latin America and other countries. Single copies: Domestic, 40 cents, Foreign, 50 cents plus postage. Copyright 1962 by Combustion Publishing Company, Inc. Publication Office, Easton, Pa. Issued the middle of the month of publication.

Controlled circulation postage paid at Easton, Pa

COMBUSTION publishes its annual index in the June issue and is indexed regularly by Engineering Index, Inc. and also in the Applied Science & Technology Index.

The magazine is now reproduced and distributed to libraries on microfilm by University Microfilms of Ann Arbor, Michigan.

Printed in U. S. A.

BPA

COVER PHOTO

Color photography is used at the C-E Kreisinger Development Lab in three dimensional model studies of furnace flow.

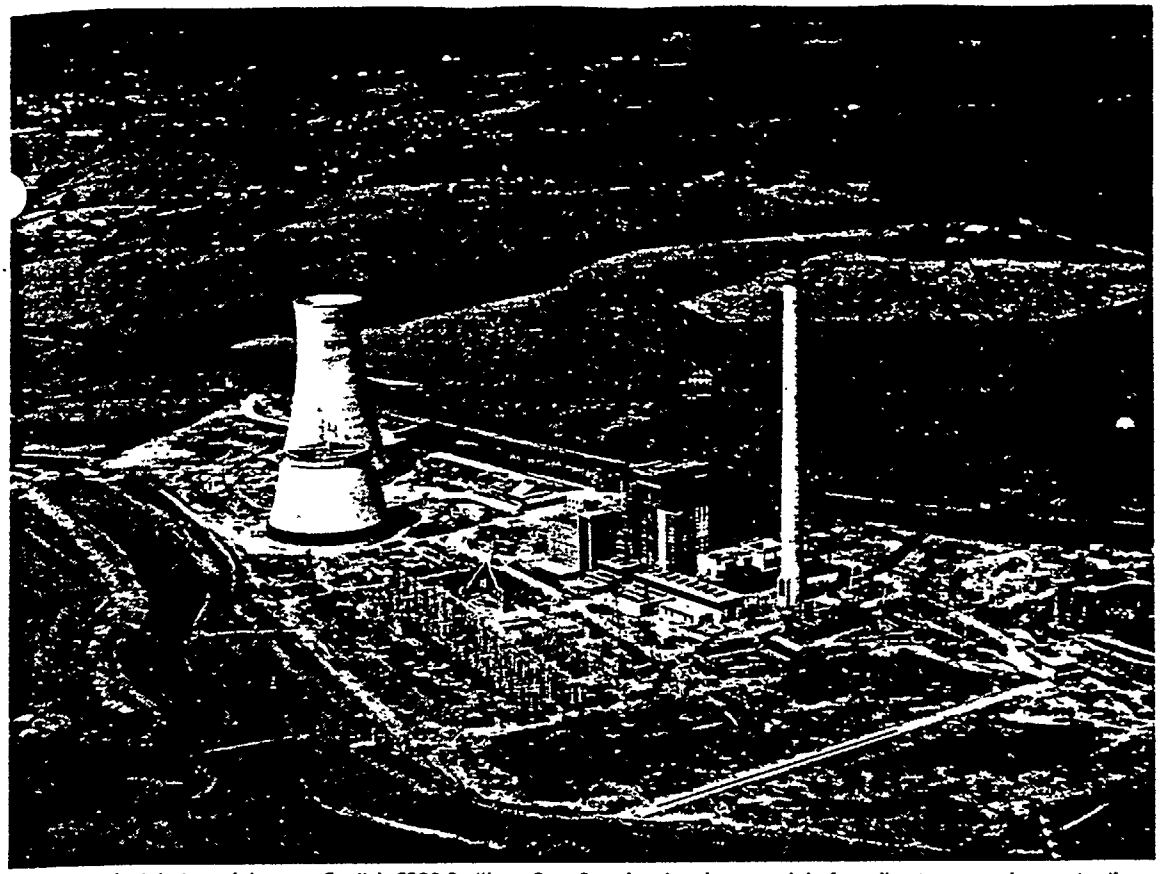

Fig. 1.—Aerial view of the new English CEGB Padiham Gen. Sta. showing the natural draft cooling towers under construction

Cooling Towers Benefit From New Thinking and New Materials

ALTHOUGH the cooling tower of today differs considerably in construction from its ancestor of some fifty years ago, the basic principle of oling water by allowing it to fall against a rising air eam remains unaltered. The cooling tower is in effect large chimney through which air is being continually awn by natural, forced, or induced draft from openings ovided in the base of the structure. The bottom of ery tower is packed with a network of slats at a height about 10 to 30 ft above the cill. Radiating sprayer pes are fitted over these slats, and it is into these pipes at the heated circulating water is pumped. This water then converted by the nozzles into a fine spray and gins its fall down the tower against the rising air eam. The function of the network of slats is to read the falling water into a thin film, or in some cases ray, thereby ensuring that it receives optimum cooling fo aching a collection pond at the base of the tower om ..ich it is returned to the boiler water cycle, in the se of a power plant.

The first cooling towers were often of wooden construction, being timber framed and boarded. They were rectangular in shape and at that time performed their function adequately. As time went by and the volumes of water involved became greater a number of structure changes occurred. In the U.S.A. the fan, both induced and forced, played a larger role and steps had to be taken for the greater mass transfer under the new draft conditions. Throughout Europe and the continent, however, natural draft was retained and reinforced concrete was introduced to meet the larger tower sizes. As the towers grew the now familiar hyperbola of revolution was employed for a natural draft designs, Fig. 1, which offered a good shape for resisting wind forces. Today we find cooling tower construction undergoing more changes. The following are two notable examples.

In the U.S.A. the Foster Wheeler Corp.[1] has announced a recent innovation in industrial cooling tower structural

[1] "A New Approach to Cooling Tower Design" by E. E. Goitein, *Heat Engineering*, Nov.-Dec. 1961.

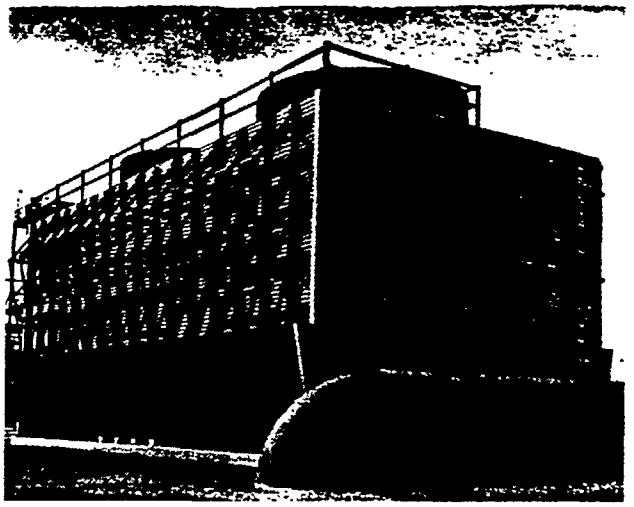

Fig. 2.—Fully assembled fan-powered cooling tower with structure-free interior

design that they are employing at the Texas Division of The Dow Chemical Co., Freeport, Texas. The new design permits a structure-free interior below the water distribution system. As developed, all support columns are on the exterior of the sheathing, Fig. 2, thus protecting the column material from biological attack or corrosion by the moist atmosphere, as well as making inspection and maintenance of the columns a simple matter. In vidual cells are uniform in size, rectangular in cr section, and designed to effect even and intimate cont of air and water on a counter-flow basis.

The paramount feature of the structure is the exten use of trusses for horizontal beams and columns. effect, the structure consists of a series of rigid be secured to each other by cross bracing. The horizo trusses support the mechanical equipment, fan st fan deck, eliminators, distribution system and the racks. In this arrangement, it is possible to lowe complete section of fill members, Fig. 3, to the b level. The vertical column trusses are protected fr the hot, moist cooling tower atmosphere by the sheath

The first rigid bent structural design furnished commercial service, the 2-cell tower installed at previously mentioned Dow Chemical Co.'s Free plant, is successfully performing under the design ope ing conditions specified. The tower was structur completed this July and was placed in operation sho thereafter. Since then, the tower was subjected to high velocity forces of Hurricane Carla and withst them without damage.

Completely prefabricated trusses have been develc as well as factory-assembled fill grids. These g Fig. 3, were originally held in suspended position monel cables. Nylon rope, however, proved more s factory and is depicted in the final assembly, Fig. 3 white lines.

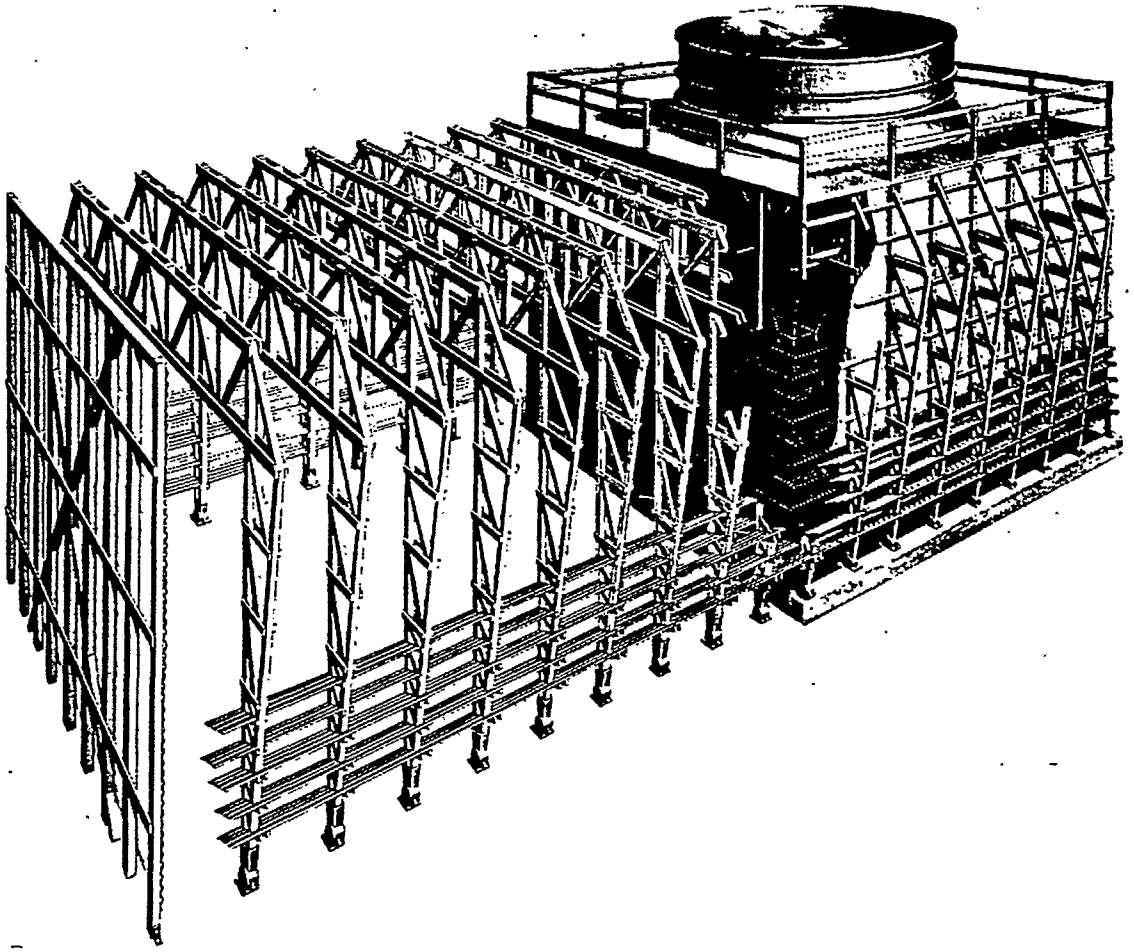

Fig. 3—This telescope view shows how new design places all the support columns outside the cooling tower sheathing. Note white nylon r hold fill grids in suspension

Fig. 4a—Top view of new cooling tower packing gives an excellent view of the many uniform flow paths possible for the air and water

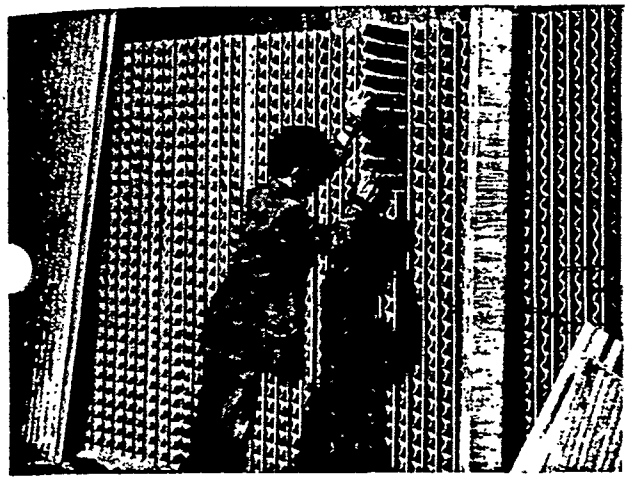

Fig. 4b—Workman is seen applying a 3-in. horizontal packing element

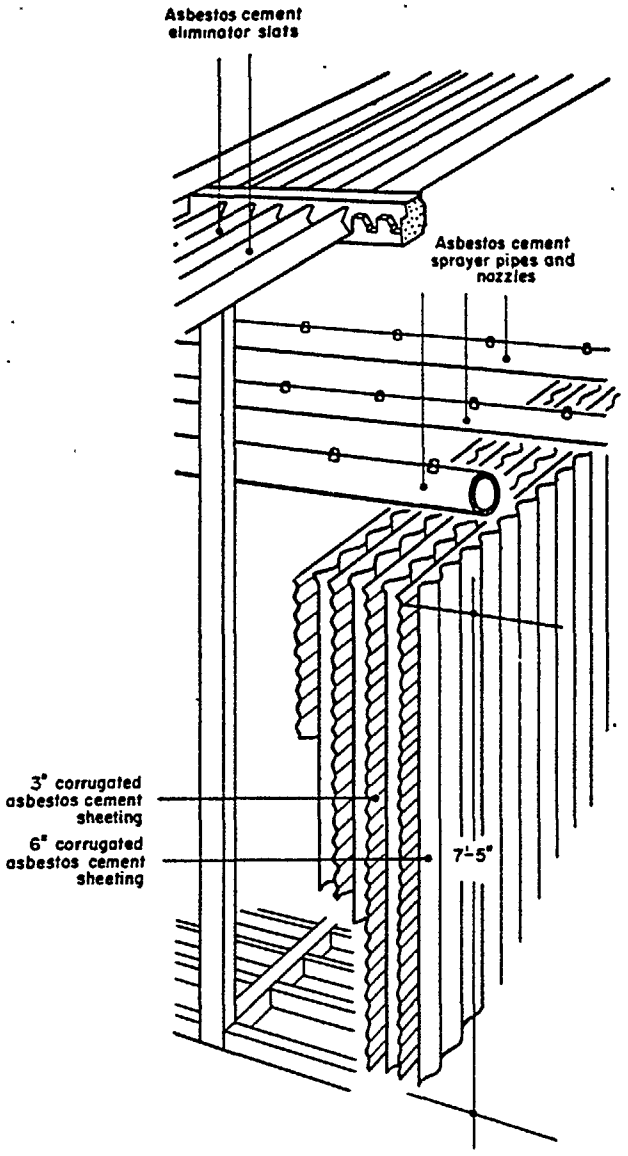

Fig. 5—Schematic of asbestos cement tower interior shows how pieces fit together

European Practice

One very significant contribution to modern day cooling tower construction has been advanced by the Universal Asbestos Manufacturing (UAM) Group of Companies.[2] Their interest in asbestos cement has prompted their participation in all possible outlets for their products. The advent of the reinforced concrete hyperbolic stack for cooling tower service made this device a familiar one to the asbestos cement industry. In fact in addition to the stack itself asbestos cement has been used for years in pipe fabrication for the branches, the flange sand spray nozzles and other elements in the cooling tower distribution system.

For some time UAM people have been working with specialists in the design of cooling towers in the hopes of developing asbestos cement packs to compete with the traditional timber packing. Out of this work has come a relatively simple cooling pack, Fig. 4, which requires neither spacers nor ancillary fixings. In this pack 6-in. corrugated sheets, with the corrugations running vertically, are interleaved with 3-in. corrugated sheets, with the corrugations running horizontally, Fig. 5. The many points of contact between the corrugations serve as stiffeners to give added strength and rigidity to the packs.

The first cooling towers to contain these packs are at the new CEGB Padiham Generating Station, Fig. 1. The two towers are 300 ft high and have a diameter at pond cill level of 190 ft. Each tower handles $3^1/_2$ million

[2] "Asbestos Cement in Cooling Towers," UGIB 5, Series Three, 1961.

gallons of water per hr and produces a temperature drop of about 18 F.

Precast reinforced concrete columns and bearer beams are used to support the asbestos cement packs which are made up on the site. By proper storage and transport the handling and the packing of the individual corrugated sheets can be made to go very smoothly and efficiently. Six workmen, Fig. 4, succeeded in packing over 100 tons in a week. Site breakages were relatively minor—one sheet in every 400.

Saline Water Conversion to Provide all Municipal Water for Arizona Town

The town council of Buckeye, Ariz., recently awarded an historical $297,741 contract for construction of the first saline water conversion plant of any type to treat an entire municipal supply in the United States. A Phoenix general contracting firm was the lowest of five bidders on the project which calls for installation of a 650,000 gallon-per-day brackish water desalting plant manufactured by Ionics, Inc., of Cambridge, Mass.

The new plant scheduled for completion in the summer of 1962 under the supervision of John A. Carollo, Consulting Engineers, will be the largest and lowest cost commercial "electrodialysis" plant ever built.

The new plant will be almost three times as large as any commercial electrodialysis plant previously built and will produce fresh water at an estimated average treatment cost of 50 cents per thousand gallons including all charges for operation, maintenance, and bond amortization of the treatment plant, but not including water supply, distribution or general water system costs. The 50 cent figure compares with treatment costs of $1.50 or more for other saline water converters currently in operation here or abroad. Reported costs of 90 cents to $1.25 for such plants are actually about $1.50 on a comparable load basis, since low winter-time water usage reduces the annual output of most municipal water plants to approximately half of their full capacity. The water costs at Buckeye will decrease in future years as the new Ionics plant, which has excess capacity, serves a larger demand.

"This breakthrough in practical saline water conversion is particularly fitting on the 50th anniversary of Arizona's Statehood because of the importance of good water to the past and future of Arizona," said Mayor John W. Beloat, a life-long resident of the Buckeye area.

"I understand that there are more than one thousand towns and cities which have highly mineralized water like Buckeye, but the Buckeye project is the first to bring modern, large-scale saline water conversion to the community level on a self-supporting basis without any Federal or outside aid."

"The Town of Buckey's existing water supply is a hard, corrosive and salty liquid derived from deep wells with a mineral content of 2200 parts per million by weight —about one-fifteenth as salty as sea water," explained George Hamner, Buckeye Town Clerk. "The new plant will remove nearly five tons of excess salts and minerals from the town water supply per day, thereby reducing the total mineral content to 500 ppm—the level recommended by the State of Arizona and the U. S. Public Health Service. Ninety-four per cent of Buckeye's qualified voters turned out for a special election last September 12 to approve a $305,000 water revenue bond issue for the project by a two to one margin. A new water rate schedule was also approved to provide the additional water revenues needed for the project. Water rates were increased by about 50 per cent for municipal users and 85 per cent to 174 per cent for larger users."

"In spite of the higher water rates, we believe most of the citizens of Buckeye will save money on water when the new plant goes into operation," said Leonard Dankowski, Chairman of the Industrial Development Committee of the Buckeye Chamber of Commerce. "For many years Buckeye residents have suffered the annoying and costly effects of a highly mineralized water supply—poor taste, purchasing and handling bottled water, waste of soap, purchase of water-softening agents, corrosion and salting-up of appliances, and rapid deterioration of everything which the water touches—from plumbing to automobile radiators. For every dollar which we spend to purchase the untreated water from the municipal system, we pay about two dollars more in hidden costs to use or avoid the salty water. Our committee conducted a survey in 1960 which reached two-thirds of all the municipal water customers in Buckeye. Fifty-seven per cent of those interviewed reported spending an average of $6.42 per month for the purchase of bottled water for drinking; 98 per cent said they wanted better water; and about two thirds said that they would be willing to pay more for it. We estimate that the hidden costs associated with highly mineralized water costs each municipal water customer an average of $10 per month, not counting what he pays the Water Department for the untreated water in the first place."

To dramatize the advantages of "good" water, a public demonstration of a small Ionics desalter of 6000 gal daily capacity was organized with the cooperation of local firms and service groups and held in Buckeye last summer, giving all citizens an opportunity to see the "before" and "after" effects of the water in washing machines, dishwashers, evaporative coolers, and beverages. This small plant has been operated in Buckeye since last May on a 24-hr day, 7-week basis. Citizens of Buckeye and surrounding communities have been driving into the station and hauling away about 1000 gal each day in bottles and tanks to try out the new water.

In the electrodialysis process developed by Ionics, excess salt and mineral particles are electrically forced out of the brackish water through special plastic membranes leaving fresh water behind and producing a brine on the other side of the membrane.

The electricity for the project will be purchased from the Arizona Public Service Company, whose Western Division headquarters are in Buckeye, and who also operated with other Buckeye firms in the project demonstration.

COMBUSTION

DEVOTED TO THE ADVANCEMENT OF STEAM PLANT DESIGN AND OPERATION

VOLUME THIRTEEN NUMBER ELEVEN

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FOR MAY 1942

FEATURE ARTICLES

EDITORIALS

DEPARTMENTS

H. STUART ACHESON, *Advertising Manager* — ALFRED D. BLAKE, *Editor* — THOMAS E. HANLEY, *Circulation Manager*

Published monthly by COMBUSTION PUBLISHING COMPANY, INC., 200 Madison Avenue, New York

A SUBSIDIARY OF COMBUSTION ENGINEERING COMPANY, INC.

Fredrik A. Scharff, President; Charles McDonough, Vice-President; H. H. Berry, Secretary and Treasurer.

COMBUSTION is sent gratis to engineers in charge of steam plants from 500 rated boiler horsepower up and to consulting and designing engineers in this field. To others the subscription rate, including postage, is $3 in the United States, $2.50 in Canada and Great Britain and $3 in other countries. Single copies: 25 cents.

Issued the middle of the month of publication.

Publication office, 200 Madison Ave., New York ABCA Member of the Controlled Circulation Audit, Inc.

Printed in U. S. A.

Dust Problems in Burning Blast-Furnace Gas Under Steam Boilers

By A. R. MUMFORD

Combustion Engineering Company, Inc.

A survey of a number of installations indicates that dirty gas, when not supplemented with other fuels, is satisfactory for burning under boilers, even with refractory settings. When supplementary fuel, such as oil or pulverized coal, is employed, the higher resulting gas temperature may cause the dust to fuse and produce slagging on the heating surfaces. In such cases segregation of the burning zones is desirable. However, the cost of boiler cleaning in such cases is usually much less than that of subjecting the gas to primary washing and appears to justify the use of "dirty" gas

ALTHOUGH blast-furnace gas is being used for an increasing number of purposes in the steel industry, the greater part of it is burned under boilers for the generation of steam. The next larger portion of the gas is burned in the stoves that heat the blast for the furnaces while lesser portions are burned in soaking pits, with or without enrichment with coke-oven gas, and under coke ovens. Some is still utilized in gas engines driving blowers or electric generators, but this practice is fast giving place to turbine-driven compressors and turbine generators.

The degree to which the gas should be cleaned before being used as a fuel for steam boilers cannot be generalized but must be influenced by local conditions governing the economic efficiency of the combined cleaning and burning operation and because of the differences in local conditions the use of dirty or clean gas in boiler furnaces has long involved a difference of opinion in the steel industry. It is obvious that gas used in engines must be as clean as possible to prevent excessive wear on the valves and reciprocating parts but in soaking pits only partly cleaned gas is used in some cases while thoroughly cleaned gas is used in others. In stoves the use of thoroughly cleaned gas has made possible the use of closer checker spacing or inserts with a resultant lower average flue gas temperature and increased efficiency. Some of the factors bearing on the influence of the degree of cleanliness of blast-furnace gas when burned in boiler furnaces as brought out by discussions with prominent engineers in the industry during visits to their mills are given in the following paragraphs

Blast-furnace gas is generally cleaned in three stages but special conditions may add one or more stages to the process. The first stage is common to all blast furnaces and consists of passing the gas discharged from the furnace through a cyclone which is termed a dust catcher in the industry. In the more modern blast-furnace installations the take-off pipe, from the furnace to the dust catcher, rises vertically, in some cases to a height above the relief stacks, before turning down to reach the dust catcher. The increased lift before the turn causes more of the material, initially in suspension, to drop back into the furnace.

From the dust catcher the practice varies but all or part of the gas is then passed through a washer. Washer design has developed in the direction of increasing height, more effective contact surfaces and greater spray capacity. In one of the plants visited the fine size of the ore (ferro-manganese) made it necessary to operate two washers in series in order to primary wash the gas effectively. In another plant the use of salt water in the washer made an additional stage necessary. The salt water carried over from the washer was removed in a drier."

Where part or all of the gas is to be cleaned further one of two types of apparatus is usually installed. The most common type is called a disintegrator and is a power-driven washer while the other type of secondary cleaning device is the electrostatic Cottrell precipitator

Where local restrictions on the contamination of adjacent bodies of water or sewage systems require that the discharge water from washers of both the primary and secondary types be cleared of its dust content before disposal, the usual equipment for this de-sludging process is a Dorr thickener.

In Table 1 the performance of some of the cleaning equipment is indicated.

TABLE 1: PERFORMANCE OF GAS-CLEANING EQUIPMENT

Equipment	Dust—Gr/Cu Ft. Entering	Dust—Gr/Cu Ft. Leaving	Efficiency, Per Cent
Dust catcher	10.6	4.81	55.6
Washer			
Single or basic iron	0.81	0.257	68.2
Two in series on F-M iron	7	0.93	7
Disintegrator			
On basic iron	0.257	0.011	95.7
On F-M iron	0.93	0.008	99.0
Precipitator			
On basic iron	0.2517	0.00501	98.8

Gas discharged hot from the dust catcher has been found to contain approximately 50 gr of moisture per cubic foot of gas. The cooling occurring in the wet washing process reduces the moisture content to a total of 25 gr of which 10 per cent is entrained. Secondary washing by disintegrators further reduces the moisture content to about 10 gr per cu ft.

[illegible] are presented in Table 2

[illegible]

[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

What other [illegible] may have been [illegible] at the time [illegible] these observations [illegible] these observations are not sufficient to indicate [illegible] single [illegible] adverse effect of [illegible] [illegible]

From many data [illegible] these [illegible] figure for the operating costs [illegible] gas cleaning equipment seems to be $ [illegible] per [illegible] gas equivalent to $0.0130 per [illegible] pounds of steam made from the gas. The figures that were [illegible] average indicated that at some [illegible] and dust concentration [illegible] were [illegible] times the average and at others one fifth the average. The wide range is probably due to variation in the cost of water and power because the dust concentrations as discharged from the dust catcher were not widely varying except in those instances where a special [illegible] was occasionally used at some one plant.

Some additional expense is incurred in the cleaning of the mains through which primary washed gas is distributed because of the mud formed by the dust and moisture condensed from the gas in cold weather. The cleaning process consists of hosing down the deposited mud to drip pockets from which it may be dumped to the ground.

The foregoing figures apply to operation only. The investment necessary for the cleaning process will depend upon the degree of cleanliness desired and the quantity of gas to be cleaned in each device. One well-informed source estimates that if all the gas from one furnace were to be cleaned to 0.01 gr per cu ft the equipment would cost close to half a million dollars. However, if "dirty" gas as discharged from the dust catcher is to be burned under the boilers, only 22 per cent of the total gas flow from one furnace need be cleaned for use in the stoves and a tremendous saving in first cost and fixed charges would be effected.

Observed Conditions

In all plants visited the boiler furnaces were observed and the effects of different quantities of dust in the gas at different plants noted. In one of these plants "dirty" gas from the dust catcher was burned without further cleaning in refractory boiler furnaces. The dust settled out on the bottom and accumulated in a pile to a depth of 3 ft in thirty days. This accumulation was the criterion for taking the boiler off the line for cleaning, although in the interim it was the practice occasionally to poke the dust adhering to the tubes. The dust on the furnace bottom did not sinter seriously and could be removed by hand shovels. No wear was apparent on the burners, nor was it the practice to clean them.

At two other plants primary-washed gas was burned under the boilers and oil was burned as supplementary fuel. The flame in each of these was somewhat clearer and accumulations on the furnace bottoms were materially less than in the first case. However, the dust adhering to the tubes was difficult to remove and complete removal could be accomplished only by hand scraping.

A fourth plant burned blast furnace gas and pulverized coal simultaneously with horizontally opposed burners in an air cooled refractory furnace. Here, the point at which the dust in the blast furnace gas met the ash in the pulverized coal was the location at which slag formed and deposited in the form of a dam which built up in height to several feet. It is possible that the dust in the blast furnace gas, containing approximately 50 per cent iron, acted as a flux on the coal ash and created a low-temperature slag. Also, it is probable that the high furnace temperature existing with pulverized coal raised the dust temperature well above its fusion point, which would account for adherence of dust to the tubes. Where blast furnace gas is burned without supplementary fuel, the flame temperature is below the fusion point of the dust. It is pertinent that at another boiler house where only dry cleaned gas was burned, little trouble was encountered.

At another plant burning primary washed gas with pulverized coal as the supplementary fuel the two fuels were fired through a common burner at a water-cooled refractory target a short distance from the burner discharge. Furnace temperatures did not appear to be much higher than those in which gas alone was burned, probably because only 100 tons of pulverized coal was burned on the average day in the entire plant. Little slag accumulated on the refractory target but the water-cooled furnace tubes had a flaky deposit on them which peeled off on shutdown of the boiler. The lack of serious difficulties arising out of the mixing in the burning of the two fuels may rest in any one of a number of factors or a combination of some of them. Observations indicated that the furnace appearance was about that of a furnace burning gas alone, that the deposit on the furnace bottom was loose and flaky, and that the boilers could be operated for six months without excessive plugging of the gas passages. The amount of excess air, controlled by the speed of blowers on each burner, may have been high and thus maintained the iron in an oxidized condition.

In one plant depending on underfeed stokers for about 80 to 90 per cent of its steam production, some precipitator cleaned blast-furnace gas is introduced into the furnace through four burners in the rear wall. No cleaning troubles are experienced with the burners which are of special design. Although only a small part of the fuel supply is in the form of gas, significant differences exist between those boilers fired by coal alone and those burning some gas in addition. The external cleaning of the heat absorbing surfaces requires the same number of man hours in each case but the effect of the addition of gas is shown by the frequency of cleaning. This, for the combination fired boilers, is about twice that for the others. The probability is that the introduction of even the small quantity of blast-furnace dust remaining in precipitator-cleaned gas into a high-temperature furnace, containing cinder in suspension from an underfeed stoker, fluxes the ash in the cinder and causes it to adhere to the heating surfaces in larger quantities and with greater strength.

Another indication of the effect of supplementary fuels was obtained in one plant in part of which so little oil was burned with the gas that the gas could be said to be

the only fuel, whereas on other boilers in the same plant coke breeze was burned on stokers with blast furnace gas introduced through the front wall above the arches and some coke oven gas always that. The blast furnace gas, in each case, had been cleaned by precipitators. The deposits on the heating surfaces in the water cooled furnace unit burning gas alone were not heavy and could be removed by soot blowers and air lancing, whereas deposits on the water cooled rear arch and side walls of the combination unit and coke breeze had to be chipped from the walls to a height of 10 ft.

Even with the small residual dust content in precipitator or scrubber cleaned gas, significant differences in operating performances appear when the gas is burned with or without a supplementary fuel.

In those plants which burned primary washed gas under the boilers the burners all required cleaning but with different frequency. Some resorted to poking to remove the partially baked mud, whereas others employed water or steam jets for this purpose. In all cases great care was used to prevent the escape of unburned gas while cleaning the burners.

Costs for boiler cleaning (external surfaces) varied from $0.000125 to $0.0858 per thousand pounds of steam produced, depending generally upon the dust concentration in the gas.

Where supplementary fuels are available, capacity is often maintained at a sacrifice of efficiency by increasing the amount of supplementary fuel burned. The limit of such procedure is, of course, the complete stoppage of the gas passage with deposited dust. At one of these plants experimental runs were made during the depression years to determine the maximum period between cleanings permitted by the use of blast-furnace gas alone or pulverized coal alone, or a combination of these two fuels. The results indicated that the boiler could be operated six to seven times as long on either fuel alone compared with burning them together. The average loss in capacity between cleanings in four units of those visited was about 30 per cent.

Conclusions

A study of the data and observations on which the foregoing was based leads to the following conclusions:

(*A*) The use of "dirty" gas unmixed with other fuels is perfectly feasible in boiler furnaces even with refractory settings. The principal operating cost in such furnaces is the removal of dust accumulating from the furnaces and this could be almost completely eliminated by the installation of modern ash hoppers protected by water screens with a modern disposal or handling system. Dust pockets throughout should be amply sized. In such cases flame temperatures are close to or below the fusion point of the dust and further water cooling should be justified on a refractory maintenance basis. This latter promises to be difficult. Adherence of dust to boiler surfaces is not strong and soot blowers should be effective. No burner cleaning difficulties need be expected.

(*B*) The use of primary washed gas makes necessary the cleaning of mains and burners. Usually pulverized coal or oil is burned as a supplementary fuel in such furnaces. Higher furnace temperatures result from the use of a supplementary fuel which causes the residual dust to adhere more strongly to the boiler surface making necessary lancing with water or air mixture and, for more thorough cleaning, hand scraping. If the residual dust in the blast furnace gas makes intimate contact with the pulverized coal ash the fusion point of the mixture is lowered because of the iron content of the dust and slag will form, particularly at elevated furnace temperatures. It is advisable, therefore, to segregate the two fuels into separate burning zones in so far as possible. In such cases the gas should be burned in the lower zone so that the dense and heavy iron dust need not drop through the high temperature pulverized coal burning zone before reaching the protection of the water screen. Water-cooled furnaces can be justified on the basis of the higher furnace temperatures obtained with the supplementary fuel.

Obviously, the use of "dirty" gas with pulverized coal would require more careful segregation of the two burning zones. In all cases in which primary washed gas is used the burner should be arranged for easy poking or lancing with provision for shutting off the gas during cleaning. With oil as a supplementary fuel little dust will accumulate in the pits, but with pulverized coal the gas dust will be deposited with the usual quantities of coal ash. Ample provision should be made for the lancing of boiler surfaces in the hotter zones and for soot blowers in the cooler zones.

Some gases contain dusts which appear to be more troublesome than basic iron dust, probably because of the composition of the dust. That produced when ferro-manganese ore is used is such a dust. It is reported to be more adherent to boiler surfaces than basic iron dust and greater care must be used, therefore, to lessen the difficulties arising out of the greater tendency of the dust to adhere. The gas may have a 30 per cent higher heating value and a higher flame temperature when burned, causing the dust to be more sticky.

(*C*) Where the use of "dirty" gas is considered or where water is scarce or expensive, the data collected thus far indicate that boiler cleaning, when burning straight gas, can be made so low in cost that the saving over the use of primary washed gas will be large. Furthermore a simple boiler setting, as was suggested under *A*, will suffice in most cases.

Pertinent Oil Figures

The average tanker, according to the American Petroleum Institute, in 1940 carried 80,000 bbl of petroleum or its products and made a round trip to the Gulf or to the Caribbean in 20 days. This was equivalent to the delivery of about 4000 bbl per day. The 1,500,000 bbl carried in a year by a single tanker was about equal to the annual average consumption of 100,000 passenger cars or 35,000 domestic oil burners. In 1941 loadings were greater but complete figures are lacking. Hence, for every tanker sunk or transferred from coastal service, at least the foregoing number of car or oil burners on the Atlantic Seaboard must either get their fuel by other transportation means or, by sharing with other users, get along with less. From these figures one can readily understand how the situation affects oil-fired power-plant boilers.

BARON & BUDD
A PROFESSIONAL CORPORATION
ATTORNEYS AND COUNSELORS
THE CENTRUM
3102 OAK LAWN AVENUE
SUITE 1100
DALLAS, TEXAS 75219-4281
(214) 521-3605
TELECOPIER (214) 520-1181

TO: Bruce Carter DATE: 5/14/98

COMPANY NAME: Baron & Budd

FAX NUMBER: (513) 539-2901

TELEPHONE NUMBER:

FROM: Julie Cyblad

TOTAL NUMBER OF PAGES SENT: 5
(including cover sheet)

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