FILE NAME: Power Generation (POW)

DATE: 1946

DOC#: POW006

DOCUMENT DESCRIPTION: Published Article from Trade Journal

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Annual Subscription—$1.00
Canada—$1.50; Foreign $2.00

Published Monthly by

W. R. C. SMITH
PUBLISHING CO.

Publishers also of: *Cotton, Electrical South, Southern Hardware, Southern Automotive Journal.*

W. J. Rooke, President; R. P. [illegible], Executive Vice-President; [illegible] McAllister, Vice-President; [illegible] O'Brien, Vice President; W. C. Smith, Vice-President; [illegible] C. Cook, Vice-President; O. A. [illegible], Treasurer; A. F. Robertson, Secretary.

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GRANT BUILDING
ATLANTA, GEORGIA

SOUTHERN POWER AND INDUSTRY

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INDUSTRIAL HYGIENE

Control of Working Environment is Importa

This third installment is a discussion of the working environment — its problems, their evaluation, and recommended control.

By N. V. Hendricks

Chief Engineer Industrial Hygiene Service, Georgia Department of Public Health

EVERY important factor influencing our lives and one which is given little consideration is the environment in which we work. The general environment dictates our requirements as to the clothes we wear, the food we eat, and to a certain extent our mode of living. The average individual will spend at least eight hours a day at some occupation. The remaining portion of the day is usually spent at home. It is obvious that two distinct problems of environment exist: the home or community, and the working environment.

There are certain safeguards thrown about the community as providing safe drinking water, proper sewage disposal, collection and disposal of other wastes including garbage, and immunization programs. The importance of these protective procedures in a community has been long recognized. Their accomplishment is measured in terms of reduced death rates from various communicable diseases. Some diseases which in the past have taken great toll of life have by these methods been reduced to a point of minor significance. As civilization has progressed with an accompanying complexity in our living, the necessity for public safeguards in the community has been given more and more consideration. It is only through these approaches that the proper public health measures for the community environment can be applied.

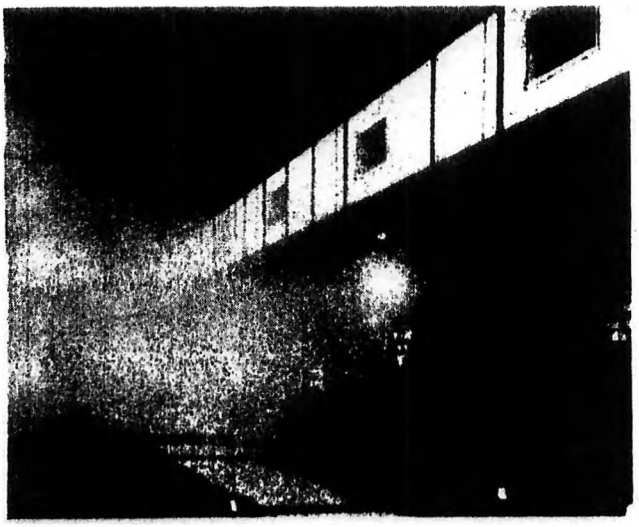
For a number of years, consideration has been given to the development of certain methods by which the working environment of an individual may be modified or adjusted to more healthful working conditions. Many plant operations by the very nature of the materials processed and by the mechanics of the operation produce an atmosphere of toxic or otherwise harmful substances. The final objective in any industrial hygiene program is the alleviation of health hazards incident to industrial operations by the use of scientific methods.

Occupational Diseases

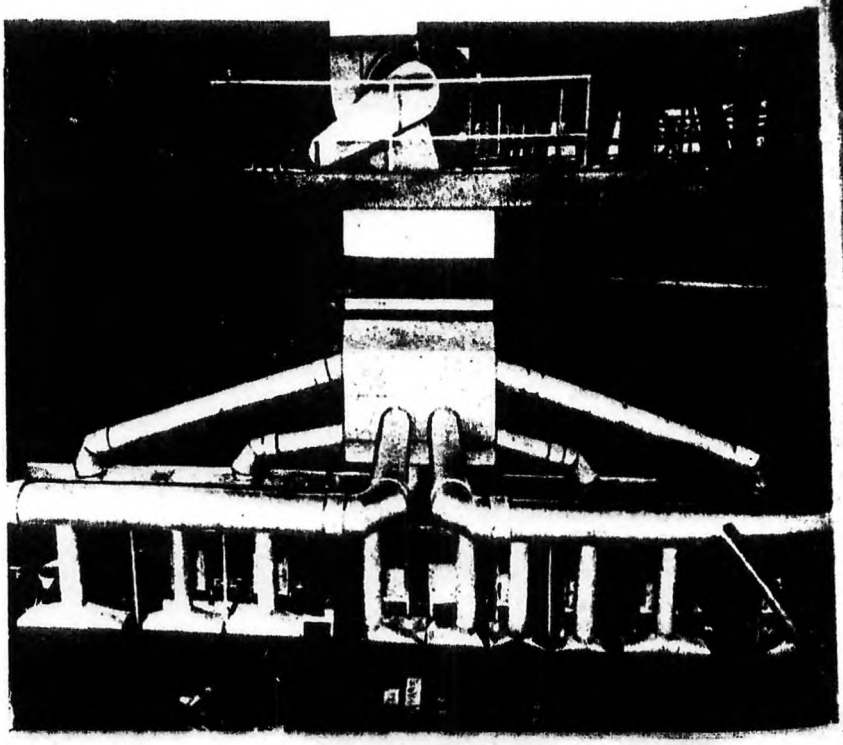
Industrial operations require the use of many materials, some of which are toxic and produce harmful effects on individuals who are exposed to them. In addition, there are certain physical conditions which exercise harmful effects on the worker. The deleterious effects produced by these materials and conditions may, in a broad sense, be termed occupational diseases.

In some states, industry has been legally responsible for the effects on the worker which is brought about from such exposures. Where legal responsibility has been designated, codes or schedules have been established for a rate of compensation covering occupational diseases. Such codes vary from all inclusive loss to those which cover only specific occupational diseases.

BEFORE AND AFTER INSTALLATION OF VAPOR ABSORPTION SYSTEM IN MERCERIZING DEPARTMENT OF BLEACHERY AND DYE WORKS.



In considering the potential development of occupational diseases and the responsibility and cost incident, management cannot escape the fact that the condition of the working environment is an economic factor expressed in terms of the overall cost of production. Proper consideration to the status of the environment, in many cases, will directly lower the cost. Recognizing these facts, management should take every possible means of improving and controlling the working environment. For many occupational diseases there is no known medication and the logical method of control is the adjustment of the working environment in order that the exposure from which occupational diseases result may be removed.



FUME REMOVAL SYSTEM FOR EXHAUSTING FUMES FROM PICKLING TANKS.

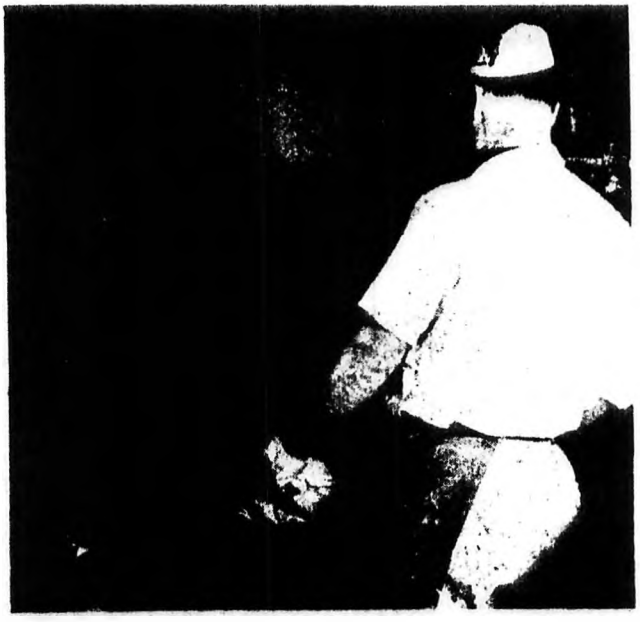
Processing And The Environment

The working environment in any plant will be dependent on these factors: (1) materials, (2) processing methods, and (3) process equipment. Many of the raw and processing materials used in industry are specifically toxic and toxic compounds are often liberated as by-products of certain operations. In any case, the type material and its presence in the working atmosphere will determine the existence of a hazard. Fortunately most processing materials are non-toxic. However, with many industries it is impossible to avoid the use of certain specific compounds which are known to produce harmful effects on individuals exposed to them.

The method of processing is important as it will determine the extent to which materials are dispersed into the working atmosphere. Important factors associated with process methods include: (1) temperatures required for various operations, (2) agitation and other mechanical details, and (3) specific operations where by-products are formed and liberated.

Equipment plays an important role in determining dispersion since the design of such units may call for open or closed operations, rotation at high speed or close or frequent observation on the part of the operator. Specific design would determine the extent to which certain control installations such as local exhaust ventilation might be applied.

OPERATOR EMPTYING BAG OF CARBON BLACK INTO BANBURY MIXER BEFORE AND AFTER INSTALLATION OF DUST AND FUME REMOVAL SYSTEM.



Environment Problems

Of importance to industry is the matter of controlling dust. Fortunately, there are relatively few types of dust which are specifically toxic. The more important from an industrial standpoint are silica, asbestos and finely divided salts of toxic metals, such as lead.

Silica and Dust

Exposures to free silica are more important from the standpoint of population exposed and deserve more consideration than those to asbestos dust. However, asbestos dust is just as toxic as free silica. Wherever sand or materials containing free silica are processed, exposure to the dust is likely to result. This is especially true in foundry operations, abrasive cleaning, blasting, and the like. Sufficient exposure to concentrations of free silica often results in the production of fibrotic growths in the lungs of the exposed individual. This condition is known as silicosis and is one of the prime disabling occupational diseases and has cost industry considerable sums of money for compensation.

Asbestos dust although specifically toxic, does not result in a numerically great number of exposures due to its infrequent industrial applications. However, in the production of asbestos cloth and other products, a serious problem of dust control is presented.

Certain heavy metals and their salts produce specific toxic reactions. Many industries employ lead and cadmium, and their application to plant operation usually results in the creation of an actual or potential exposure. Lead compounds are particularly important in such operations as the manufacture of storage batteries, printing industries, and the production of paints or pigments.

Gases

Gases are usually classified as either asphyxiant or irritant. Industrially the more important asphyxiants include carbon monoxide, hydrogen sulfide and hydrogen cyanide. Of these, carbon monoxide occurs more frequently. This gas is associated with the combustion of carbonacious materials and is extremely toxic. On entry into the body it exerts an affinity for hemoglobin which is about 300 times the affinity of oxygen resulting in a tremendous decrease in the ability of the blood to carry oxygen and produces a condition of asphyxia.

The more common irritants found in industry include sulfur dioxide, chlorine, ammonia, and the oxides of nitrogen. Although these gases are extremely toxic, they are sufficiently irritating so that the individual exposed usually has some warning as to their presence. Under these conditions the worker can normally remove himself from the exposure before too much damage is done. However, these materials do occur frequently in industry and the importance of exposures to them should not be minimized.

Vapors

Vapors come from organic compounds both of the aliphatic and aromatic series. They play a tremendously important part in modern production and their number and use is limited only by the ingenuity of the chemist. They are used widely as degreasing agents, intermediates, solvents and cleaning compounds.

Most of these materials are excellent fat solvents, and on entry into the body tend to go to the nervous system. This is true of the aliphatic series, including distillates and petroleum. From the standpoint of pure toxicity, probably the most important of these materials would include benzol, its homologues and the chlorinated compounds. Sufficient exposure to these compounds results in chronic disturbance and in some cases disability.

Mists

Acid and alkaline mists are associated with plating, stripping and cleaning. Chromic acid mist is probably the most important of this class of material and results from electroplating, anodizing and similar operations. Exposure to such mists may result in perforation of the nasal septum, and if cuts or abrasions are present on the exposed parts, ulcers may develop.

Fumes

Fumes are usually associated with welding, cutting, or other operations where metals are heated to high temperatures. From an industrial standpoint, lead, zinc, and cadmium are probably the most important. Atmospheric fumes of this type are often found around pouring of brass, welding or burning of galvanized metal or on high temperature operations involving surfaces coated with lead bearing paint.

The physiological response to the inhalation of these materials may vary considerably. The less serious condition is known as metal fume fever which carries symptoms of zinc oxide. It is of short duration and no permanent tissue damage is done. The more serious conditions arise from the exposure to fumes or metals which are specifically toxic.

Physical Conditions

Physical conditions such as working positions, temperature, humidity and abnormal pressures play an important part in the ability of the worker to produce. The correction of such conditions is primarily a problem of engineering and when given proper consideration will do much toward increasing production and lowering costs, through improvement of quality of the final production, reduction of spoilage, and increase in the final plant safety.

Evaluation of Environment

In order to properly evaluate the exposures in an industrial plant, a detailed engineering study and analysis is required. Such a study in the form of an industrial hygiene survey is a mechanical means by which the plant is observed department by department for the purpose of noting occupational hazards and unsafe practices so that they may be appraised. Such a survey should include a work analysis, analytical procedure rating of hazards, analyses of the hazards and recommendations for control.

The work analysis should be made by noting each and every job carried out in the plant, method of process, and hazardous conditions to which each worker

COMMON PROCESSING MATERIALS WITH SAFE CONCENTRATION AND PHYSIOLOGICAL SYMPTOMS

TOXIC MATERIAL	INDUSTRIAL USE	SAFE CONCENTRATIONS	PHYSIOLOGICAL RESPONSE
Acrolein	Organic synthesis; mfg. military gases; soap and varnish; fertilizer.	1.0 ppm	Irritation of skin and mucous membranes of eyes and respiratory tract, dyspnea, bronchitis.
Ammonia	Organic preparations; refrigeration; bronzing; dye and color mfg.; sugar refining.	100 ppm	Irritation of respiratory passages, cough, pulmonary edema, severe eye irritation, caustic action on skin.
Aniline	Organic synthesis; dye mfg.; paint and varnish; disinfectants; explosives.	5.0 ppm	Muscular weakness, vertigo, cyanosis, fainting, nervous symptoms, loss of equilibrium, nausea, vomiting, diarrhea.
Arsenic Compounds	Paint and pigments; leather industry; insecticides; mining and smelting; dye and varnish mfg.	0.5 mg/M³	Pains in stomach, vomiting, diarrhea, headache, gastric disturbances, skin diseases, loss of hair, weakness.
Bromine	Organic synthesis; dyes; bromides; explosives.	1.0 ppm	Irritation of air passages, bronchitis, conjunctivitis, skin eruptions, discoloration of skin.
Benzol	Solvent; paint and varnish removers; dye; varnish mfg.; rubber industry.	100 ppm	Headache and vertigo, gastro intestinal disturbances, hemorrhages, injury to blood forming organs with changes in blood picture, injury to blood vessels, heart, liver, kidneys, etc.
Cadmium	Alloys; cadmium salts; electro-plating; storage batteries; lead and zinc smelting.	0.1 mg/M³	Loss of appetite, weakness, nausea, inflammation of the lungs, cough, soreness of chest.
Carbon Disulfide	Solvent; mfg. viscose rayon; varnishes; insecticides; carbon tetrachloride.	20 ppm	Headache, vertigo, weakness, mental disturbances, irritation of skin.
Carbon Monoxide	Mfg. iron and steel; enamel; illuminating gas; kiln operations; smelting.	100 ppm	Headache, painfulness of eyeball, throbbing of temples, weakness, nausea, vomiting, increased respiration and pulse, collapse.
Carbon Tetrachloride	Solvent; mfg. cleaning compounds; dye; paint and lacquer industries.	100 ppm	Irritation of nose, throat and eyes, nausea, headache, vomiting, confusion, narcosis, injury to liver, dermatitis.
Chlorinated Diphenyls	Electrical equipment; lacquer mfg.; paints, wax mfg.	1.0 mg/M³	Acneform skin eruptions, jaundice and atrophy of liver.
Chlorine	Organic synthesis; textile bleaching; water purification; chlorination.	1.0 ppm	Acute cardiac paralysis, burning, blistering, cough, bronchitis, chronic anemia, nasal and bronchial catarrh.
Chlorobenzene	Solvent for cellulose acetate, resins, oils, fats; dry cleaning.	75 ppm	Headache, giddiness. Blood changes.
Chromium Compounds	Dyeing; metallurgy; electroplating, printing; tanning.	0.1 mg/M³	Bronchitis; bronchopneumonia, anemia, nephritis, ulcers of skin and membrane, perforation of nasal septum.
Ethylene Dichloride	Organic synthesis; solvents; thinner for lacquers.	100 ppm	Irritation of eyes and nose, vertigo, unconsciousness and death if exposure is prolonged.
Formaldehyde	Organic synthesis; dyes; rubber goods; leather; synthetic resins and lacquers.	20 ppm	Irritation of mucous membranes, conjunctivitis, severe dermatitis, degeneration of liver.
Hydrochloric Acid	Leather industry; organic synthesis; dye stuffs; mfg. chlorides.	10 ppm	Coughing, bronchitis, destruction of teeth, contraction of throat, caustic action on skin.
Hydrogen Sulfide	Reagent; analytical chemistry; viscose rayon spinning; leather tanning, mining and smelting; paper mfg.	20 ppm	Conjunctivitis, exhaustion, pallor, pain in eyes, nose and throat; headache, convulsions, paralysis.
Lead	Chemical equipment lead pigments; alloys; storage battery mfg.; insecticides.	0.15 mg/M³	Weakness, pallor, loss of appetite, lead line, anemia, constipation, cramps, colic.
Mercury	Prep. mercury salts, scientific instruments, chemical processing.	0.1 mg/M³	Inflammation of gums and mucous membrane of the mouth, necrosis of the jaw, enteritis, anemia, tremors of the hands and face.
Silica Dust (Free)	Foundries; stone industry; abrasive cleaning; blasting.	5,000,000 p.p.c.f.	Fibrotic lung tissue, development of silicosis.
Sulfur Dioxide	Refrigeration; bleaching; cellulose; paper; mining and smelting.	10 ppm	Bronchitis, coughing, laryngitis, bronchopneumonia, digestive disorders.
Sulfuric Acid	Fertilizers; refining, explosives; organic synthesis; leather; textiles; chemicals.	2.0 ppm	Acute and chronic bronchitis, bronchopneumonia, decay of teeth. On the skin, pain, edema and ulceration.
Toluene	Solvent; paint and varnish; organic preparations; dye and varnish; rubber industry.	200 ppm	Narcotic effect, headache, vertigo, gastro-intestinal disturbances, injury to liver and nervous system.
Zinc	Metallurgy; galvanizing, brass foundries smelting.	15 mg/M	Metal fume fevers; irritation of respiratory tract, headache, nausea, chills, pain in limbs.

NOTE: P.P.M. = Parts of substance per million parts of air by volume.
m.p.p.c.f. = Millions of particles of substance per cubic foot of air
mg/M³ = Milligrams of substance per cubic meter of air.

is exposed. Toxic materials when present are investigated from the standpoint of the liberation into the atmosphere; physical state, whether or not the employee is required to be in the area where this material is dispersed, and the probable effect on the individual.

Analytical procedures usually include the collection of field samples and their analysis and the completion of other measurements when necessary. Atmospheric samples are collected from the breathing zone of the exposed worker and are taken in such manner as to be representative of average working conditions. Actual sampling and analysis of the atmosphere is the only scientific means by which a known exposure may be accurately evaluated. Some toxic materials make their presence known by odor and other properties, but these do not offer a means of determining their concentrations.

The rating of a hazard or exposure is a measurement to determine the degree of a condition and the effectiveness of existing control methods. Much work has been done in establishing safe permissable concentrations for some of the more common toxic materials These threshold values offer a means of determining the extent of individual exposures. By an analysis of processing methods, rating of hazards and study of efficiency of existing corrective measures, a baseline for adequate **control procedures** may be established. In most cases processing methods will determine the type control indicated.

Application of Data

When the industrial hygiene study has been completed and observations and data analyzed, it is necessary to translate this information into terms of specific control procedures. Unless these data finally result in corrective measures, a great waste of time and effort will take place. Although the plant or process engineer may not be primarily concerned with activities other than strictly processing, this individual should take advantage of information obtained through the industrial hygiene survey. In many cases, a study of environmental conditions under which a job is carried out will offer the production engineer a means of increasing the efficiency of the particular operation.

The plant engineer should also be concerned with the industrial hygiene information because the control procedures applied will be based on an analysis of these findings. The design and installation of such control procedures as local exhaust ventilation should be worked out with the plant engineer in order that the final installation may be entirely consistent with processing requirements.

Control Procedures

Hazards associated with industrial operations can either be eliminated or reduced to harmless limits by the application of public engineering methods. Procedures for the control of such exposures usually consists of one of the following:

Isolation of the process. Frequently a job which is productive of dust or tends to disperse other materials into the work area can be removed and located at a point so that the liberation of such material will not contaminate the general working atmosphere. It is occasionally possible to close off individual operations so as to isolate them from other areas and control the exposure.

Substitution of non-toxic material occasionally offers a good method of alleviating specific exposures. Where toxic materials are used and it is possible to replace them with non-toxic substitutes, the exposure can be removed in the easiest possible way.

Wet methods can sometimes be applied. These are frequently used in the stone industry in drilling, crushing, and grinding. Where materials being processed must be kept in the dry state, this method is obviously eliminated.

Personal protective equipment offers an excellent control procedure where the exposure is infrequent or of a short duration. Where this type of equipment is used, care should be exercised in its selection in order that the equipment used be designed for the particular exposure. Only equipment which bears the stamp of approval of the U. S. Bureau of Mines should be purchased.

Some exposures may be controlled by means of general ventilation. By this procedure a sufficient amount of air is introduced into the work area to dilute the contaminant to a point below the toxic limit. This method has certain disadvantages, such as the handling of excessive amounts of air, and the failure to reduce concentrations of the material at the point of liberation. It is usually at or close to the point of liberation where real exposure occurs. In general ventilation, in most cases does not correct this situation.

Local exhaust ventilation offers the most effective and generally the most efficient means of controlling individual exposures. A hood or similar type of collecting device is located as close as possible to the point of liberation of the contaminant and sufficient air handled in order to remove this material in such a manner that it is not dispersed into the work area. This type control should remove the material before it has an opportunity to come into the breathing zone of either the worker on the individual job or the workers in the surrounding area.

In considering the matter of local exhaust ventilation, it is highly essential that these installations be properly designed and engineered. In too many cases hoods and the entire exhaust systems are installed by mechanics or other individuals in the plant and no thought is given to their design or the principles on which they should operate. Unless such systems are based on good engineering design there is no assurance that the installation will operate in such manner as to control the exposure.

The next article of this series will cover organic solvents and similar industrial materials, their properties and uses as they influence the environment and health of the workers using them.