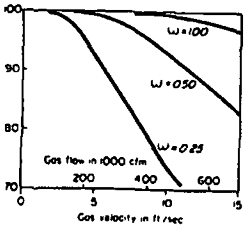
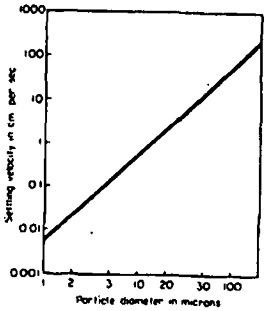
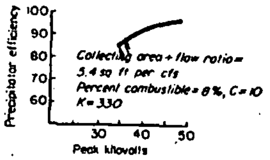


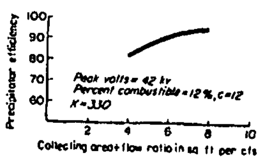
1 Gas-flow rates, plus drift velocity of particles, influence final results



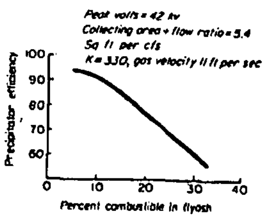
2 Settling velocity of particles has long been used to rate precipitators



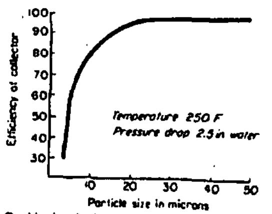
3 The higher the applied voltage, the more efficient will dust collection be



4 Ratio of effective collecting area to gas flow affects unit efficiency



5 Combustible content of flyash above 10% destroys precipitator results



6 Mechanical dust collectors show good results for certain particle ranges

Constant Study ... And Field Research Have Upped Performance of Dust Collectors

► COMBUSTION OF FUEL of any k... solid, liquid or gaseous—alway... off waste products that could be... tion problems. Some, like carbo... ide and water vapor, vented to th... air and adequately *diffused*, prove... less. But to the untrained eye the... plume they form appears threa... This public reaction to stack disch... makes the job of removing the ... tionable elements that much tough...

One of the biggest *targets* for ... reaction to air pollution is the ... central-station power plants. Yet... class, they usually prove willing to... more in solving power-generating... allied problems than other indus... And this instance proves no excep... What, then, is the case* for air ... tion today? On the whole it's ... encouraging.

Air-Borne Solids. The major prob... as the utility industry sees it, is and... been control of air-borne *solids*... member, they burn tremendous qua... ties of pulverized coal—over 105,000... tons in 1951 alone. Assuming an ... age ash content of 10% this could ... out due precautions, show up as ... 10,000,000 tons annually of flyash.

But to get the problem *down to* ... practical proportions—the single ... —consider a large modern boiler ... 000,000-lb-steam-per-hr capacity. ... hausts flue gas at about 500,000 c... a temperature of 300 F or so. With... typical, average figure for flyash ...centration of 2 gr per cu ft, dust leaving ... furnace amounts to about 140 lb ... minute, or 100 tons per day. A siz... control problem for any plant. Yet ... is equipment today that does a ... efficient *clean-up job of this stack* ...

Particle Size. Solid particles, making ... stack dust can and do range in size ... the tiniest specks, too small to be ... in a powerful optical microscope, ... particles large enough to pick up ... the fingers, Table II, p 76. The ... small particles represent no prob... except under most unusual condi... of concentration. The large ones can be reduced in quantity both at fur... and at *stack* level. Upper limit of ... reduction has been set in many ... by ordinances regulating smoke ... dust.

A large percentage of these ordinances ... on *ASME* Test Code PTC 21-1941, which states a maximum figure of ... lb per 1000 lb gas (equivalent to about 0.3 gr per cu ft at 300 F) adjusted to 50% excess air. If left to a clean-up at stack level alone, this would require a collector of 85% efficiency for the av... flue-dust load—well within cur... design limits (see below).

Furnace Performance. But the utility industry does not leave the clean-up job to the stack alone. They've thoroughly investigated furnace conditions and per... formances with an eye to reducing the problem before it gets a start.

Complete combustion is a basic re... quirement with the large, better-run central stations. They take every precau... tion for obvious reasons of economy: to assure (1) proper fuel preparation (2) intimate mixture of air with fuel (3) correct introduction of fuel to furnace (4) furnace of adequate design for fuel in question (5) ample fan capacity for required *excess* air (6) *constant* maintenance of proper fuel-air ratios (7) mechanical or electronic aids to correct and signal faulty furnace conditions to operation. These seven steps represent the best engineering practices in assuring complete combustion.

Over and above instituting these correct operating steps the role of individual fuels and furnace designs have received similar intensive study. The more progressive companies take every advantage of facts like these—slag-tap furnaces can drain off a portion of the fuel ash in a fused form; other furnace designs may separate out varying proportions of ash from the flue-gas stream; fuels of low *solid* residue *result in* lowest gas dust-loading. Just about every known way of holding down dust loading at the furnace level can be found in use or under study. A reduction in the carbon percent in flyash (preferably below 10%) is very desirable for cleaning both at furnace and stack level.

Stack Level Clean-up. The same attention to performance details carries over into the methods for collecting flue dust after it leaves the furnace. Hence, dust-collector manufacturers have been steadily raising their equipment's performance levels in response to this demand, POWER, special reprint, *Clean Air*.

Both mechanical and electrical designs report efficiencies up to 90% and, in some instances, better. A recent electrostatic precipitator design installed at Goudey Station of New York State Gas and Electric Co is said to give 98% efficiency handling 253,000 cfm of 264-F gas from a 560,000-lb-per-hr generator. *Dust loadings* run from 3.43 to 2.33 gr per standard cubic ft. Moreover, this unit features a new method for continuously cleaning off the collecting electrodes. But let's review precipitator theory first, to better understand these improvements.

Theory. In practice, gas containing particles of dust in suspension passes between highly charged electrodes of the typical electrostatic precipitator. While under the influence of these electrodes electric forces act on the particles to force them onto collecting plates or surfaces. Under usual conditions the charge on a 10-micron-dia particle (1/2500 of an in.) is about 25,000 electrons, while the precipitating or collecting field measures about 4500 v per cm. The coulomb force amounts to about 300 times the gravitational force, assuming a spherical particle of unit density. So it is by far the dominant element.

The efficiency of particle removal, though, depends mostly on the effective surface area of the collecting electrodes, the gas-flow rate through the precipitator and drift velocity, w, of the charged particles in the electrical field. In turn, w is directly proportional to the particle radius so large particles collect at a faster rate than do fine ones.

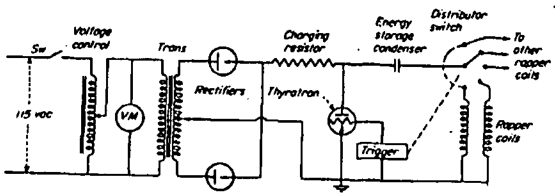
Fig. 1 graphically illustrates the swing of *precipitator* efficiency with gas flow for several values of w. Efficiency runs high at low gas rates for all values of w and falls off with increasing gas flow, slowly for high values of w, more rapidly for low.

The effective theoretical value of w for flyash precipitators is about 0.7 to 1.2 ft per sec as against the practical and field efficiency measurements of 0.4 to 0.6 ft per sec. This 2 to 1 discrepancy can be charged to the loss of precipitator performance caused mostly by uneven gas-flow and loss of particles from collecting surfaces by resuspension.

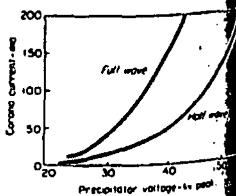
From a practical application point the precipitator manufacturer needs data on the properties of furnace gas and dust. For example, the corona and the sparking characteristics that determine the strength of the electric field, its coulomb force, depend on dielectric properties of the gas and resistivity properties of the dust. A typical pulverized-coal-furnace gas after the preheater consists of 77% nitrogen, 4 to 5% oxygen, 12 to 15% carbon dioxide and 4 to 10% water with traces of sulfur dioxide and trioxide. Table I shows the makeup of a typical dust. From such data, gas properties and resistivity can be determined.

Furnace-gas moisture content and dewpoint are primarily influenced by the amount of volatile matter in coal. They, in turn, strongly influence corona and electrical operating characteristics. Trace quantities of sulfur trioxide are

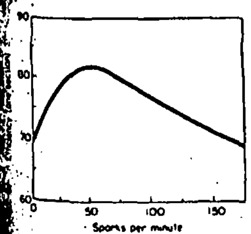
*Abstracted from the following papers: ... *Pollution Prevention in Electric Generating Stations*, H A Bauman, Consolidated Edison, AIEE Paper No. 53-27, and *Electrostatic Precipitators for Electric Generating Stations*, H J White, Research Corp.



7 Continuous rapping of collector electrodes in an electrostatic precipitator by magnetic means removes dust deposit without previously usual objectionable puffs



8 Predicting corona voltage - cur... varies with each different fl...



9 Research shows sparking is good in precipitators but only up to a point

Complete flue-dust data, next page, should accompany specs

Complete flue-dust data, next page