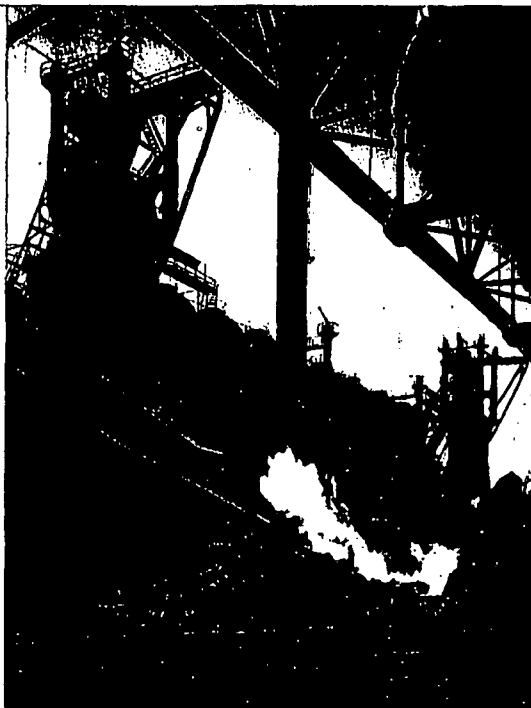


Steel Mills Fight Their Pollution Problems



BLAST FURNACES, important producers of pig iron, can cause air pollution

► INDUSTRY AND LOCAL ENFORCEMENT agencies today recognize the full import of air- and stream-pollution problems. As a result, the emphasis on clean-up is shifting from the power field with its relatively high performance level, *Powern*, April, p 73, to the manufacturing and process industries. Studies and experiments these industries are carrying out point the way to many advances of vital interest to power services engineers.

Take the steel industry as an example. In one year its fuel requirements run over a billion gallons of fuel oil, several hundred billion cubic feet of natural gas, 17 million tons of coal for power boilers, 94 million tons of coal for coke to blast furnaces.

The problems of air-pollution control facing this industry have been tremendous.¹ Out in the Allegheny County area of Pennsylvania a Smoke Control Ordinance, passed June 1, 1949, provided for a research program to be undertaken by the steel industry on its individual difficulties. So the Jones & Laughlin Steel Corp, Pittsburgh Coke & Chemical Co, U.S. Steel Co combined in a joint research program committee. That committee reflected a very practical outlook by a membership made up of operations, research and technology people.

Their over-all assignment was to determine practical methods for controlling emissions caused by blast-furnace slips, open-hearth furnaces, bessemer converters. This committee has done a lot. Some of its findings are being put into

operation. In fact, beginning on the facing page a case history report tells how one company has tackled a single phase of these special problems with considerable success. But first let's look at the available reports on the steel industry's pollution-control progress.^{2, 3}

Open Hearths. Most of the reported work on open-hearth problems occurred on oil-fired furnaces. Dust loadings, they found, varied widely from almost zero to peak loads as high as 2 gr per cu ft. These loadings stretched over the six major periods of open-hearth operation—the melt down, hot-metal addition, ore boil, lime boil, working heat and empty furnace—with the peaks developing at hot-metal addition, ore-boil, lime-boil periods, and when working with oxygen.

Particle size broke down into about 50% by weight running smaller than 5 microns (one micron = 1/25,400-in. dia), and only a few percent 20 microns or above. Many particles run less than one micron. The chemical analysis showed an iron oxide content of about 90%. Incidentally one point of particular interest was a complete lack of correlation between color of open-hearth discharge and its dust loading, so the Ringelmann Chart made no sense here at all.

¹Some Experiences With Air Pollution Abatement in the Steel Industry, C. A. Bishop, Research Associate U.S. Steel Co, before the Air Pollution Prevention Assn, Cleveland, Ohio, June 1952.

²Open Hearth Dust Control, by S. Valda, Office of Chief Engineer, G. M. Dreher, General Technical Dept, Jones & Laughlin Steel Corp, before the Air Pollution Prevention Assn, Cleveland, Ohio, June 1952.

To render the stack virtually clear means a 95 to 98% reduction in the stack emission. (Ed. note: Up in the range of today's power plant collectors, *Powern*, April, p 73). But the cost of installing and operating the available dust-collecting devices² to give this dust-removal performance is so high as to be prohibitive for practical purposes.

Out in Los Angeles County, where, to our knowledge, you'll find the only open-hearth gas-cleaning installation now being used in the country, you run into a different set of conditions. There dust loadings average 0.8 gr per cu ft, all the metal charge enters the furnace as scrap, as against blast-furnace iron supplies in the Pittsburgh area, and the fume contains large amounts of zinc and relatively little iron oxide.

How about gas-fired open hearths? The American Steel and Wire Co at Donora, Pa. uses natural gas and reports dust loadings down around 0.02 to 0.07 gr per cu ft against a 0.43 gr per cu ft average with oil. The dust loading ranges from 0.1 to 0.4 gr per cu ft on an average when natural and coke-oven gases are employed.

But while the loading drops, the particle-size distribution gets tougher. About 90% by weight run smaller than 5 microns. Stack gas seems particularly dirty with this size distribution and makes color comparisons completely unrealistic as far as total dust-loading judgment goes.

Blast Furnaces. Cleaning blast-furnace gas has long been an established art. Today, more than 7,000,000 cfm are being cleaned in the blast furnaces in this country. Results have been excellent, *Powern*, Sept 1951, p 96. The quantity of gas scrubbed and the waste waters involved, though, have led to still another problem, that of stream pollution. One solution we present just below.

Over and above the well-understood problems of cleaning gas from those furnaces that produce basic pig iron are the relatively fewer, but more stubborn, ferromanganese blast furnaces whose difficulties prompted special treatment.

The gas-cleaning equipment differs sharply because the gas loading is so different. What's more, there are two types of dust coming off a ferromanganese blast furnace. One, comprising about 20% of the dust present, consists of particles of about 20 microns that seem to develop when the coke and ferromanganese burden disintegrate. A conventional dust catcher can remove this fraction. But the other 80% is a different story. It is a typical fume with particle sizes ranging from 0.10 to 1.0 micron and dust loading, averaging about

7.5 gr per cu ft. It forms as a result of vaporization and condensation.

High-energy wet washers will clean this type fume. But maintenance costs run high since the collected ferromanganese has very definite cementing properties. Over and above this consideration was the fact that a rather elaborate water-treating plant would have to go in (see the case history following).

Sonic coagulators for agglomerating the fume had been studied in a preliminary fashion by others. Their findings indicated a required gas-retention time in the sound chamber of over three seconds at a sound-pressure intensity of above 160 decibels. Converted to economic terms, sonic agglomeration at its present state of development lacked definite appeal.

What U.S. Steel elected to install was a dry electrostatic precipitator that handles a specially conditioned gas. They set up a pilot plant to study the various steps involved, and as a result of these studies a plant has been designed and is under construction to clean 135,000 cfm of ferromanganese blast-furnace gas.

The major operating considerations were (1) a spray tower for conditioning the gas, (2) an electrostatic precipitator, (3) a special briquetting process involving a pyrophoric kiln.

The dirty gas, to be treated, first enters a spray cooler at an average temperature of 700 F. This cooler operates without any water effluent to cool and humidify the gas with a 350-F exit-gas temperature. It is absolutely essential that all spray water be evaporated in this unit. Any bottom drip causes the fume to form a hard-setting cement. Incidentally, somewhere around 10% of the solids in the gas leave this tower as a dry material.

From here, the gas passes through a 98%-efficient plate-type electrostatic precipitator, and then to power boilers for duty as a fuel. The visible effect of gas cleaning from the pilot unit on the boiler stack was impressive indeed. No discernible fume was emitted at all, while other boilers handling an untreated gas did give off a noticeable fume. Stack-effluent loadings measured only 0.05 gr per cu ft. The cleaned gas burned with a short, bright blue flame.

But now how about the basic blast-furnace gas furnaces? Since they produced in 1952 some 61,530,000 tons of pig iron against the 630,000 or so tons from the ferromanganese furnaces, their handling seems most important.

...Here's How the J & L Steel Corp Makes Its

Blast-Furnace Gas Yield Rich Iron Ore

By W A WALTON, Apparatus Dept, Dravo Corp

Out of the blast-furnace gas discharged in the process of making 62,000,000 tons of pig iron by the basic method, some 3,000,000 tons of iron ore were recovered last year. Collection and removal of all forms of dust from blast-furnace gas has long been carried out. But only of recent years with the heavy pressure of stream-pollution laws has much attempt been made to recapture the important iron ore in this dust.

Jones & Laughlin Steel Corp recently completed a modern blast-furnace flue-dust-recovery plant for its Aliquippa Works, Aliquippa, Pa. The last word in dust collection, the system not only provides complete recovery of high iron-content dust, but also conforms to the Pennsylvania State Department of Health's Clean Streams Program.

The plant handles a flow of 16,000 gpm of washer water containing about

100 gr per gal of fine dust with an iron content of about 45% (dry basis). The fine dust is removed from the water in special thickeners in a slurry form consisting of about 50% solids. Overflow from these thickeners, with more than 95% of the solids removed, discharges to the Ohio River. The thickened slurry is pumped to a filter house, and then fed to one of two disk-type filters. Here it is filtered and the final cake, pro-