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SMOKE, DUST, FUMES

Closely Controlled In Electric Furnaces

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◆ Better working conditions, improved community relations, lower maintenance costs have resulted from use of improved smoke control equipment on electric furnaces operated by Bethlehem Pacific Coast Steel Corp. at Los Angeles . . . From 12,000 to 20,000 lb of dust are collected daily.

◆ About 75 pct of all dust by weight is generated in the first half of heat time . . . This high load, plus temperatures and physical characteristics experienced, led to selection of electrostatic precipitation equipment.

◆ Local regulations require high operating efficiencies . . . Amount of dust emitted varies with cleanliness of the scrap charge . . . Negative pressures at the furnaces help keep plant clean.

◆ A BETTER PLACE TO WORK and a cleaner community to live in have resulted from successful control of smoke and fume from three electric steelmaking furnaces operated at the Los Angeles plant of Bethlehem Pacific Coast Steel Corp. From 12,000 to 20,000 lb of dust are collected daily. The equipment, designed to operate within stringent local regulations, required 4 years to develop.

Dust generation may run as high as 1125 lb per hour and 30 lb per ton of process weight in large electric furnaces. Temperatures and other characteristics of dust and fume led to selection of the electrostatic precipitation method of collection. A controlled negative furnace pressure, maintained by means of exhaust fan, vents and dampers, has eliminated all dust and fume emissions from electrode openings, paving the way for fewer maintenance delays and other benefits.

Three top-charged arc electric basic furnaces are used to make plain carbon and low alloy steels in a single-slag process. Two are rated at 75 tons capacity and one at 50 tons. The plant, in Los Angeles County, is subject to regulations of the County Air Pollution Control District. In limiting dust and fume emissions local law requires qualitative as well as quantitative results.

The amount and physical character of charged materials as well as the speed of melt-down influence the rate of generation and character of the dust and fumes. Provision must be made to capture particulate emissions corresponding to the worst or dirtiest condition of scrap charge melted and shaped. Approximately 75 pct of total dust, by weight, is generated in the first half of heat time.

Dust emissions averaging as high as 30 lb per ton of total charge weight have been recorded. This, however, is for heats in which charges were particularly dirty and the quality of scrap less than good. A typical furnace charge, and composition of the dust emitted, are shown in the table. Particle size varies with chemical analysis. With cleaner charges of selected scrap, dust generation will be under 30 lb per ton of charge.

To collect the composite material in these amounts and in compliance with local air pollution laws, posed a problem. With operations of this magnitude the law limits the maximum weight of particulate matter from any one source in any hour in accordance with the equation.

W = KP + 4.

Where: W = allowable weight of particulate matter discharged to atmosphere per hour in pounds.

K = constant having a numerical value of 0.0006 for average hourly process weights between 4500 and 60,000 lb per hour.

ELECTRIC FURNACE OPERATION

Typical Charge	Pct
Fluxes, Carbon and Ore	5
Turnings and Borings	7
Home Scrap	20
No. 2 Baled Scrap	25
Miscellaneous Scrap (auto., etc.)	43
Typical Dust Emissions	**Pct**
Silica	2
Alumina	3
Iron	25
Lime	6
Zinc Oxide	37
Magnesium Oxide	2
Copper Oxide	0.2
Manganese Oxide	4
Phosphorus Pentoxide	0.2
Sulphur Trioxide	.3
Particle Size, microns	**Pct**
0 - 5	71.9
5 - 10	8.3
10 - 20	6.0
20 - 44	7.5
Over 44	6.3
Specific Gravity	3.93

P = Average hourly process weight in pounds.

High collection efficiencies are needed to comply with the air pollution laws. Assuming a furnace charge weight of 100 tons of metallics, fluxes and additions making a heat in 4 hours maximum allowable discharge of dust and fume in any one hour would be:

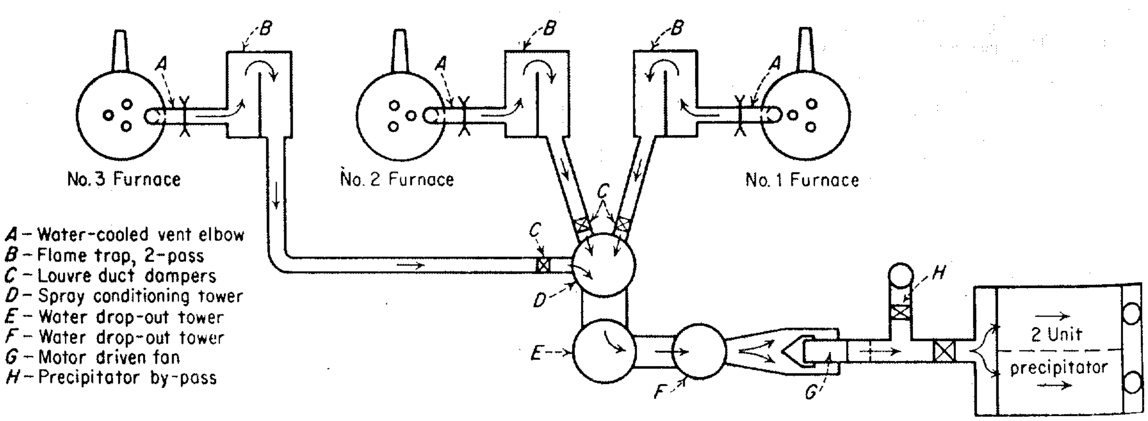
$$\frac{0.0006 \times 100 \times 2000 + 4}{4} = 34 \text{ lb}$$

Total generation of dust and fume from a dirty charge, as given above, has averaged as high as 30 lb per ton of process charge weight, or for this example 3000 lb total. If 75 pct of this is generated in one-half the heat time, we would have a maximum hourly generation of 1125 lb with an allowable discharge of only 34 lb. To comply with the law, collection efficiency would have to be close to 97 pct.

Equipment choice was narrowed to two types: electrostatic precipitators and bag houses. The latter type was eliminated due to the temperatures involved. A 24-hour chart shows typical temperatures of gases and particulate matter issuing from annular openings around the furnace electrodes. These temperatures have been modified somewhat by dilution with considerable quantities of infiltration air at atmospheric temperature. Initial volumes were too large to consider further air dilution to effect a temperature low enough for bag house operation.

Cottrell type electrical precipitation equipment was selected after pilot plant tests on this and other types of collectors, including washers and scrubbers. Dry type electrical precipitation was originally installed principally because of the shortage and expense of water and lack of space for installation of sludge thickeners and filters.

Gases and dusts originating in the furnaces are drawn off through a water-cooled vent elbow, one end of which coincides with an opening in the furnace roof. Gases are then drawn through a two-pass flame trap, individual duct and louvre damper, a series of towers, and a motor-driven



SCHEMATIC LAYOUT of components used to trap electric furnace smoke, dust and fume.

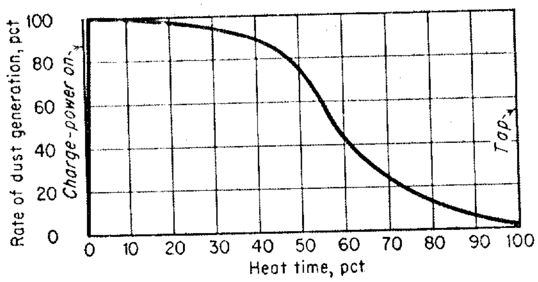
fan which pushes the gas and dust into the single two-unit precipitator serving all three electric furnaces.

The flame trap lowers peak temperatures of gases (by water sprays), to a point safe for the unlined steel ductwork. These traps are refractory-lined and two-pass to conserve space and provide sufficient time for evaporative spray cooling of gases. Temperature peak limits are automatically controlled by adjustable-range instruments generally set for 800°F maximum to operate a series of water fog sprays.

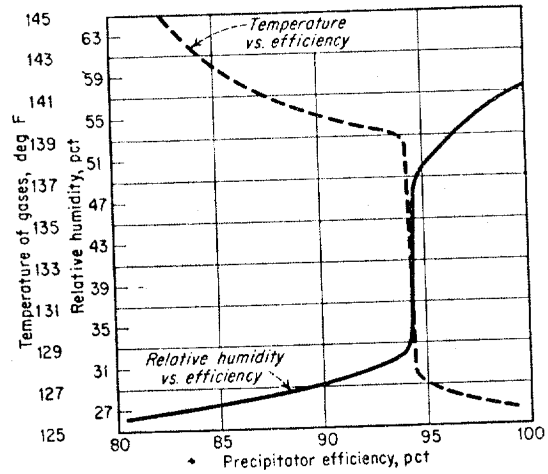
Louvre dampers in ducts permit automatic and/or manual push-button control of individual furnace pressure. Furnace pressures are controlled to provide a slight inward flow of air through the annular spaces around the electrodes at all times. To produce this effect required a pressure of minus 0.02 in. water column at inside crown elevation. The automatically controlled dampers prevent escape of dust, fume and flame from the electrode openings even when the working doors of the furnace are open.

The spray conditioning tower adds moisture to and cool the gases to a point where the electrical resistivity of the dust particles assumes a minimum value. Low temperatures and high moisture content are equally necessary for high precipitator efficiency. Acceptable precipitator efficiencies are not produced until gas temperatures fall below 127° with a critical point at 139°F. Relative humidity must be kept above 49 pct with a critical point at about 32½ pct.

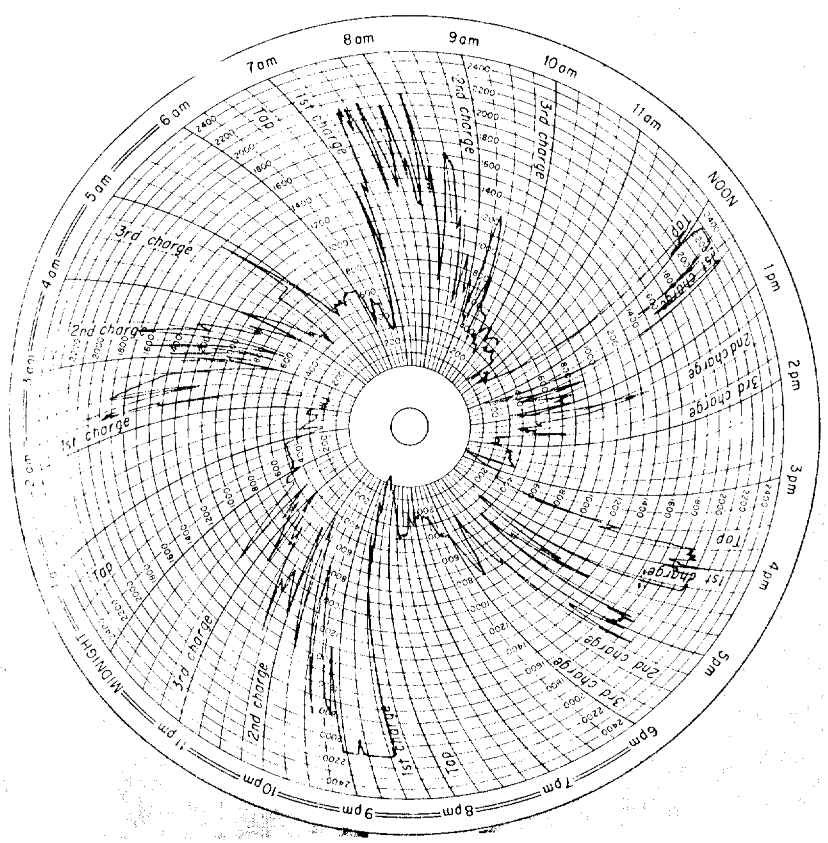
It is believed there is also a higher tempera-



MOST DUST, 75 pct by weight, is generated in the first half of electric furnace heat time.



PRECIPITATOR works best when gas temperature is below 127°F, humidity above 49 pct.



TEMPERATURES taken at annular openings over 24 hours rise and fall sharply during operation.

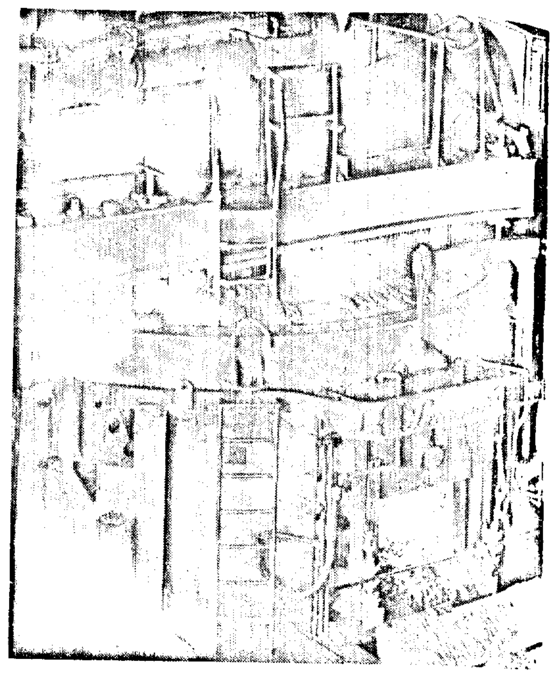
ture point, above 500°F, at which these dust particles again have a minimum electrical resistivity value also in combination with a relative humidity value. For substantial periods, temperatures are below 500°F. To obtain required precipitator efficiency heat would have to be added to the system. The economics of operating at temperatures above 500° or below 127° favored the latter.

Water drop-out towers E and F, see drawing, are simply "wide places in the road." Tower E was installed to slow gas velocity to a point where large entrained water droplets picked up in Tower D would be precipitated and run off through a bottom drain. Tower F, originally installed as a gas mixing and tempering chamber, is now used to slow gas velocity.

The fan is powered with a 250 hp constant speed motor and, at full capacity with all duct dampers wide open, handles 140,000 cfm of moistened dust-laden gases at 127°F and 8 in. water column, static pressures. Normal operation of three furnaces requires an average gas flow of about 35,000 cfm per furnace to insure no escape of dust and fume at the furnace electrode and door openings. The precipitated dust is accumulated in the pyramid-shaped hoppers which are emptied by interconnecting screw conveyors. These lead to a single drop pipe, which discharges into a covered auto truck tank under the platform at yard level. With current production, product mix and grades of scrap, dust catch will average 12,000 to 20,000 lb daily.

In normal operation no visible fume or dust issues from any opening or roof of a 75-ton furnace, even with power on and slag door open. A water-cooled dust collecting elbow communicates with a vent hole in the furnace roof.

The water-jacketed elbow is an effective means for drawing off all potential particle emissions from one central location. The elbow is supported on the furnace-roof superstructure and swings with the roof.



POWER'S ON and slag door open yet there is no visible fume or dust from this 75-ton furnace.

DUST is collected in pyramid-shaped hoppers which are emptied by screw conveyors.