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CONTROL OF METALLURGICAL AND MINERAL DUSTS AND FUMES IN LOS ANGELES COUNTY, CALIF

SECONDARY ZINC SMELTING
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lead and zinc are purposely volatilized to separate them from worthless material in a primary extractive operation, baghouses are used to recover particulate matter for further treatment to separate the lead and zinc.

The larger secondary-lead works in the Los Angeles area have adopted, on a greatly reduced scale, modified designs for their baghouses similar to those used by the much larger primary-lead smelters elsewhere. At one of these works, gas and fumes collected from small lead-blast furnaces, from lead-refining pots, and from reverberatories are first passed through large spray chambers where the gas temperature is reduced to about 230° F., and the coarse particulate matter is collected. The volume, temperature, and humidity of the gases leaving the cooling chamber are closely controlled by automatic instruments. The baghouse is a well-designed gunite structure divided into compartments containing long woolen bags similar to those used in baghouses at the primary-lead smelters. The bags are automatically rapped when the bag resistance builds up to about 4 inches water pressure. Dust removed from the hoppers beneath the bags is briquetted and returned to the blast furnace for re-treatment.

Another concern, operating a small blast furnace, drossing kettles, and reverberatories on lead scrap, battery plates, dross, and lead residues, has collected its furnace fumes for over 2 years in a five-cell baghouse designed to treat 9,000 c.f.m. of gas. The gas is first cooled to about 500° F. in a settling chamber and a series of water-jacketed, steel U-flues, 12 inches in diameter. This gas-cleaning plant, similar in design to that illustrated in figure 15, was designed to utilize, as far as possible, the existing structures, so the plant is somewhat improvised. The investment in recovery equipment has been repaid by the value of the metal recovered. A ratio of 3.5 c.f.m. per square foot of bag area was used in designing this installation because of the extremely small particle size of the lead fumes.

Zinc Smelting

Introduction

The zinc metallurgical operations in the Los Angeles area, like those of lead, consist essentially of metal reclaiming and refining. For this reason their raw materials are mostly scrap and zinc residues, such as zinc fume and dross, often containing lead, copper, and other metals. No zinc sulfide ore and only limited tonnages of carbonate ore are smelted, hence, sulfur fumes, which sometimes plague the primary zinc smelters, are no problem. The number of secondary zinc smelters operating in Los Angeles has never been large, probably not over three. A description of the method of operation and the recovery equipment used in one of these establishments follows.

Metallurgical Practice

Mixed scrap is hand-sorted as completely as practicable to reduce the amount of copper and other metallic scrap, also fabrics, rubber, and other combustibles. The selected scrap is charged into the open end of a hooded, rotating, oil-fired, sweating furnace. The temperature of the furnace is maintained just above the melting point of lead and below that of zinc. Thus, most of the lead is melted out and cast into pigs. Zinc is removed in a similar way, leaving unmelted copper, aluminum, and iron scrap. The zinc is cast into pigs, which are remelted in an oil-fired reverberatory holding furnace along with clean zinc scrap and held for further refining by distillation.

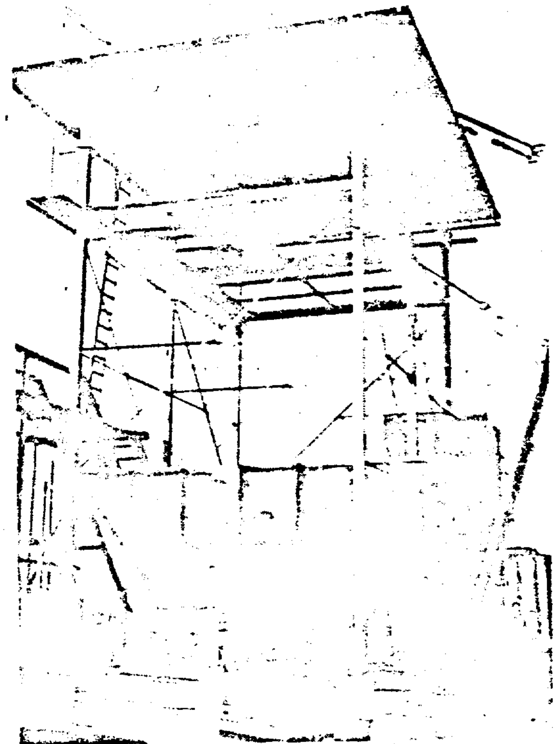

Figure 19. - Pressure-type baghouse (under construction).

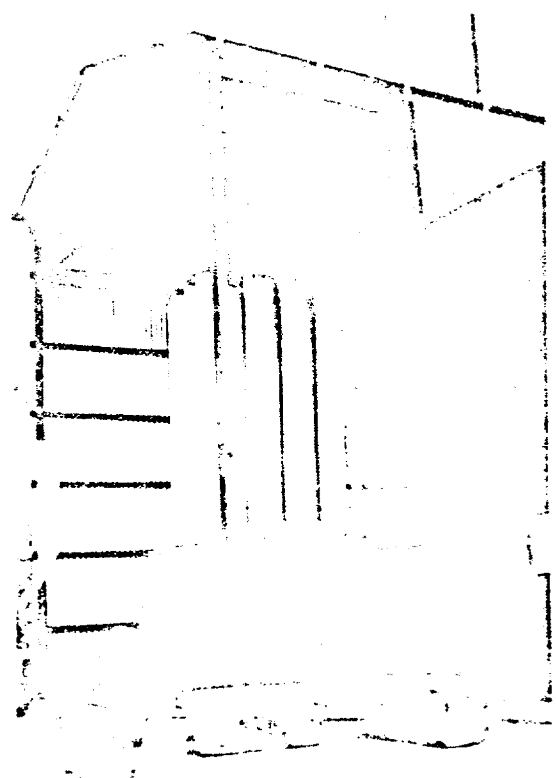

Figure 20. - Small unit of pressure-type baghouse in operation at a zinc smelter.

Each distillation furnace contains a graphite retort large enough to hold a charge of 3,200-3,500 pounds. In a typical furnace cycle, the cold retort is charged with clean scrap and metallic skimmings, then closed and heated. Molten remelted pig metal, making up the remainder of the charge, is pumped from the holding furnaces into the closed, hot, oil-fired retort. The retort is driven at about 2,000° F. for 10 to 12 hours. During this time the zinc is vaporized and condensed in large, water-chilled, cast-iron condensers. Temperatures are closely controlled during the entire cycle. Prime Western grade zinc is tapped from the condensers into molds. The retort is cooled, the residue (containing copper, iron, and some lead) is removed, and the retort is readied for another charge. Retorts are hooded during charging, and any escaping dust and fume are sent to the baghouse.

This concern operates a block of conventional-type retort furnaces to reduce oxidized zinc ores, fume, and residues. Materials to be smelted are mixed with crushed coal; and plant secondaries, such as blue powder, are charged into horizontal, cylindrical clay retorts provided with conventional, truncated, cone-shaped clay condensers. Molten zinc is periodically scraped from the condensers during the active distillation and cast into slabs for market. Oil is used for fuel, and all combustion gases are exhausted to a stack.

Stack Effluents

The dust load carried by the metallurgical gases varies with the method of metal drawing, retort charging, and the distillation cycle inherent in the retort-reduction process. An average of four samples of the dirty gas entering the baghouse gave dust loading of 0.78 grain per cubic foot, 90 percent of which was zinc oxide. During about two-thirds of the distillation periods the blue-green tinge of burning zinc can be seen escaping from the condensers. This and other losses entering the atmosphere may amount to 1.0-2.5 percent of the metal charge.

The physical nature of nascent zinc oxide fume, characterized by its extremely small particle size from 0.5 down to probably 0.03 micron diameter, and its quite typical star-shaped crystal, is illustrated in figures 11 and 13. The sample in figure 11 was taken from the gas stream entering the baghouse described below.

Recovery Equipment

At this zinc smelter, recovery equipment for collecting dust and fume consists of closets and hoods placed over the condensers during the charging and metal drawing. Large volumes of fresh air are admitted into the vent system at the hoods to collect any escaping fumes and dusts and cool the gases. The diluted gas is drawn by exhaust fans through a long system of horizontal, steel flues in which the gases are cooled down to about 150° F. The gases then enter the baghouse, a simple steel frame structure supporting a roof over a series of closed steel hoppers. The sock-type bags are of cotton drill, 12 inches in diameter and 15 feet long and closed at the top. They are suspended from a simple steel rapping mechanism at the top, which is operated periodically by hand, and the open ends of the bags are clamped to 15-inch-diameter collars welded to the top of the hoppers in rows or in a manifold arrangement. The simple design of the pressure-type baghouse is shown in figures 19 and 20.

Despite some inconveniences of semimanual operations, the simple pressure-type baghouse is well-suited for dust collecting at such plants as that just described. It is extremely simple to construct and operate, and its first cost is low in comparison to some of the fully automatic custom-made equipment supplied by many manufacturers of dust-collecting systems. With the exception of the exhaust fans and a few simple castings, the baghouse illustrated was designed and constructed by the company's small staff.

Light Metals

Introduction

The term "light metals" as used here includes aluminum, magnesium, and alloys in which they predominate. The light-metal industry comprises some 75 establishments engaged mostly in the production of gravity castings. Some of the larger concerns, however, cast billets for working into sheet, tube, and many other wrought products as well. In addition there are some 25 concerns whose principal operations consist of reclaiming and refining aluminum- and magnesium-alloy scrap, skimmings, and dross.58/ No strictly primary light metals are produced in the area.

Large and increasing tonnages of aluminum- and magnesium-alloy products, however, are used in the manufacture of airframes, in structural work, in transportation, and in other major Los Angeles industries. As much as 25 to 40 percent of the metal fabricated may be returned eventually to the remelting furnaces as plant scrap. Whenever feasible, such scrap is carefully segregated and may often be remelted in the furnace making the original alloy. Otherwise, the remelt scrap may have to be brought to specifications by the addition of pure metals or alloying constituents.

The national aggregate of fresh plant scrap, together with the obsolete scrap, such as old cable and pistons, is approximately 330,000 tons annually. This represents some 25-35 percent of the normal total aluminum consumption in the United States. Secondary-aluminum processing is, therefore, an important metallurgical industry. Secondary magnesium is relatively unimportant but is growing. Production, stocks, and movements of some 30 or more classifications of light-metal scraps are reported monthly.

The consumption curve for light metals in this country continues sharply upward year after year, and there is little doubt that the Los Angeles area will continue to process and consume increasing amounts. Aluminum, which constitutes the major portion of light-metals tonnages, fortunately does not volatilize readily at the temperatures required in processing the alloys. Some fume, of course, is produced from the low-boiling-point alloying metals and from the fluxes used. Control of fume from carefully operated, small, indirect-fired furnaces is comparatively easy. Handling of dross and reclaiming of dirty scrap usually produce more fume, as does operation of the large open-flame reverberatory-type furnaces. Serious efforts extending over many months have gone into the matter of controlling these fumes in the Los Angeles area and with some very good results, which are described later.

58/ Dross refers to the oxidation products formed during melting, usually containing some metal mechanically entrained during skimming.