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LEAD AS AN ENGINEERING MATERIAL

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Lead Industries Associations

About one-third of the lead used each year in America is made into chemical compounds such as red lead, white lead, litharge, tetraethyl lead, etc. How the rest of it is used as metallic lead and where it goes in industry is described briefly below.

Historical Background

Because of its ease of reduction from ores, lead was one of the first metals used by man. Lead pipe manufactured by curving sheet lead together and soldering the seam was used by the early Romans for conducting drinking water. Architecturally, lead served as a roofing material for public buildings and churches. The famous dome of St. Sofia in Istanbul is lead covered. The floors of the Hanging Gardens of Babylon were lead covered to retain the moisture necessary for the vegetation. Lead was used in the construction of the first commercial sulphuric acid box chambers built in 1746 in England.

Production

Lead is mined primarily as the sulphide, the bulk of the domestic ore coming from southeastern Missouri and the Northwestern States. Lead ore is usually associated with zinc ore. The ore mixture is crushed and ground to fine powder and separated by the flotation process.

Lead is recovered by smelting in a blast furnace. A lead blast furnace is similar to an iron blast furnace but constructed on a smaller scale and, of course, operates at lower temperatures. Ore, coke and limestone constitute the normal furnace charge. Oxygen-enriched blast is one of the latest developments in lead smelting.

Lead bullion or unrefined lead containing other metallic constituents is normally fire refined in large kettles where it is heated under controlled conditions. Here, silver, gold, copper, zinc and some other metals are removed and, in most cases, recovered. For example, gold and silver are recovered by taking advantage of the fact that these two metals have a greater affinity for zinc than for lead.

By deliberately adding zinc to lead bullion containing gold and silver, these two valuable elements form a zinc-silver-gold mixture which subsequently floats to the top of the bath and is removed by skimming. Any zinc remaining in the lead is removed by creating a vacuum over the molten metal so that the zinc will vaporize out and condense as crystals on the cold top of the vacuum dome. The latter technique has been recently perfected and is known as the Vacuum Dezinking Process.

Fire refining does not remove bismuth and some other rare elements which are close to lead in their characteristics. In order to refine bullion high in these metals, the electrolytic refining process is used. Only one such plant, however, is in existence today in this country.

Grades of Lead

Specifications have been established by the American Society for Testing Materials for the various types and grades of lead that are available commercially.

The purest grade is referred to as corroding lead, simply because it was used originally in the manufacture of white lead where the presence of metallic impurities would discolor the product.

The most commonly used primary lead is chemical grade. This is obtained chiefly from southeastern Missouri ores which retain a small percentage of silver (0.002 to 0.02%) and copper (0.04 to 0.08%) in the refined metal. This grade is referred to in the trade as chemical lead because it is used primarily by the chemical industry. The presence of silver and copper were found to add to the corrosion resistance and improve creep and fatigue resistance.

Common lead is the type most often encountered outside of the chemical industry and consists essentially of secondary lead, that is, lead recovered from scrap sources.

Antimonial or hard lead is ordinary lead to which has been added anywhere from 1 to 12 per cent antimony. This serves to harden the lead and improve the physical characteristics. However, it must be remembered that the presence of antimony lowers the melting point and does not enhance lead's corrosion characteristics.

Tellurium lead is chemical lead to which has been added approximately 0.04 per cent tellurium. Tellurium retards grain growth and thereby increases the fatigue resistance.

Fabrication

Lead is cast into slabs about 5 feet by 10 feet by 4 inches and rolled into sheet on special rolling mills. Because of its softness, lead is relatively easy to roll into sheets from foil thickness up to 2 inches. Average sheet length is 20 feet.

An unusual system of sheet size measurement has developed through the years that is rather unique to the lead industry. Thickness of lead sheet

[illegible] as an [illegible]

[illegible]

[illegible] corrosion resistance is required.

Lead melts at 621° F so it is [illegible] easy to join together by welding. For this process oxy-hydrogen is used with a very small burner tips. Joining lead to lead in this manner without solder is [illegible] as "lead burning." Actually however, the lead is not burned but merely melted and fused together.

Soldering is a process familiar to everyone. Solder itself is usually an alloy of 40 per cent tin and 60 per cent lead. Very often lead is joined together by means of solder. Lead wiping is a special method of joining lead that has been used for years by plumbers and cable splicers. As the term implies, lead wiping consists simply of wiping solder (usually 40-60) while it is in the plastic or pasty range around the pieces of lead to be joined.

Why Lead is Used in the Chemical Industry

Lead has played an important role in the chemical industry since the time when [illegible] were practiced by the alchemist. The chief reason for the use is [illegible] (1) excellent corrosion resistance, especially to sulphuric acid from dilute up to 80% H2SO4 acid. Since sulphuric acid is the work horse of the chemical industry, it is easy to understand why lead is [illegible] material of chemical construction. In addition to sulphuric [illegible] lead is noted for its resistance to phosphoric acid, chromic acid, hydrofluoric acid, sulphur dioxide and salts of these compounds. Another reason for leading use in the chemical industry is its (2) low cost compared to other corrosion resistant materials. Adding to its economic advantage is that (3) it can be calendered easily and [illegible] while (as much as 75 per cent of the original [illegible]). [illegible] which lead may be replaced also [illegible] industry.

How Lead Is Used [illegible]

Lead is naturally soft [illegible] alone, more often it is supported by an [illegible]. Usually, steel or wooden vessels are [illegible] lead fastened at intervals with lead covered steel straps.

[illegible]

[illegible] as lining.

In many processes, lead pipe coils [illegible] are used for cooling purposes and occasionally for heating [illegible] hot water. For use with steam pressures exceeding 40 and up to 200 [illegible] steam pressure, lead covered copper coils are preferred. Here again, [illegible] a bonded lining, the greater strength of copper is combined with the corrosion resistance of lead.

Lead pipe and conduits are used to a great extent for conducting corrosive liquids and fumes. Where the lead pipe is surrounded it is common practice to either lay it in trough or better [illegible] lead lined cast iron or steel pipe. This consists of [illegible] pipe in which is placed a lead pipe expanded by hydraulic pressure to fit snugly.

Lead in Plumbing

Lead for many years has been used in household and industrial plumbing. It is used to conduct drinking water from the cast iron water mains in the street to the house. Inside the house it is used in the form of pipe for wastes, lead traps beneath basins, tubs and showers, lead bends on water closets and occasionally as vent pipe. In practically all cases, the lead pipe is joined by wiping.

A surprisingly large amount of lead is also used in conjunction with cast iron water mains and soil pipe which is used to conduct waste to the sewer or for venting purposes. Here it serves as a [illegible] material to form a water-tight [illegible] joint between sections of pipe. [illegible] the lead is melted and poured into the [illegible] using special [illegible] tools. Sometimes if it is [illegible] lead wire is used instead. Because of its [illegible] and wool is easily consolidated or caulked into [illegible] water-tight joint.

Architectural [illegible]

Architecturally, lead also [illegible] considerable service, most prominently as a roofing [illegible] material. [illegible] its corrosion resistance and pleasing grey color are the chief advantages. It is also used for gutters,

[illegible] lead [illegible]

[illegible] are used [illegible] have plated [illegible] and on [illegible] and by dump- [illegible] [illegible] of lead's lubricating characteristics.

Electrical Applications

In the electrical industry, the chief use for lead and also the greatest consumer of lead in the [illegible] industry. Storage batteries consist on the average, 8% parts of [illegible] [illegible]. This includes both the lead alloy used for making grids as well as the lead oxides used on the battery plates.

Also in the top third of the lead consuming industries is the manufacture of cable sheathing. A cable for cable whether telephone or power, must be (1) corrosion resistant to the atmosphere and soil waters, (2) flexible enough to be coiled on reels and drawn through conduits and, (3) it must be able to be extruded to form a continuous sheath around the wires in a cable.

In certain applications copper wire is coated with lead before being covered with rubber insulation because the sulphur compounds in some rubbers attack copper and, vice versa, copper effects some insulating materials adversely. The presence of a lead coating eliminates any reaction between the copper and rubber.

Plating

In the plating industry particularly chromium, copper and nickel [illegible] plated, as an anode, and for heating [illegible] because lead is normally re- [illegible] used in plating these metals [illegible] be plated do not affect [illegible] of the plate. A more recent [illegible] plating process is in which a cold [illegible] are used to cool the anodizing solutions [illegible] of circulating them to or from and the tanks themselves are lead [illegible].

[illegible] cutting operations [illegible]

[illegible]

[illegible]

Most freight cars run on bearings consisting of a layer of [illegible]-antimony alloy [illegible] copper-10 tin-10 lead bronze. [illegible] bearings are used in [illegible]. Composite bearings consisting of thin lead babbitt on a matrix of copper and nickel powders sintered on a steel backing have been used in automobiles. An average of 2 to 4 per cent lead powder is used in sintered metal powder bearings of the self-lubricating type.

Radiation Protection

Lead is used universally for protecting patients and operating personnel from harmful exposure to X-rays and gamma rays emitted by Crooke's tubes, betatrons, and radium as well as cobalt 60, tantalum 182 and other radioisotopes. While the total quantity of lead used for this purpose is small compared to the overall lead consumption figure, its importance should not be minimized insofar as lead does not itself become radioactive and hence can be used as long as required and moved to other locations without fear of radioactive contamination. For very large atomic energy installations, particularly those being designed from the ground up, shielding is accomplished by using thick concrete walls sandwiched with relatively thin sheets of lead. Probably the bulk of the lead used for protection against atomic radiation is in the form of bricks about the size of common building bricks. In this way barriers can be constructed in practically any location and to protect against any degree of radiation.

How Much Lead Is Used

To round out the industry-wide picture, it may be interesting to know how many tons of lead are actually consumed by American industry in a year. In 19[illegible] this figure was more than 1,212,000 tons. Last year we produced from our own mines [illegible],000 tons and 395,000 tons were recovered from secondary sources such as old storage batteries and cable sheathing. From this it is obvious that this country consumes more lead each year than it produces. To account for this about [illegible] tons were imported from other countries like Mexico, Canada and South America with minor tonnage coming from overseas sources. The difference between consumption and production is made up of changes in stock and government stockpiling.

[illegible]

[illegible]

[illegible]

[illegible]

Lead in [illegible]

As an engineering material, Lead's characteristics are so diverse that as old uses diminish, new ones such as those described earlier are developed. In addition to new applications, new alloys having improved properties have enhanced the use of lead for many old applications. The new F3 alloy for cable sheathing has demonstrated greatly improved fatigue and creep characteristics. Calcium-lead grid metal has lengthened the service life of storage batteries for stand-by "float" service. Other alloys have improved the performance of storage batteries for automotive use, tank linings for chromium plating, etc.

Lead's applications cover a multiplicity of industries which utilize one or more of its many characteristics. It is a metal that has been around for a long time and one which will certainly continue to find considerable use in the changing technology of modern times.

The Lead Industries Association is always willing to cooperate without obligation in the solution of problems involving lead. Inquiries should be addressed to 420 Lexington Avenue, New York 17, New York.