

Lead

Lead is a transitional element with a symbol **Pb**. Lead has the atomic number 82. Lead is a soft and heavy toxic and malleable poor metal. Lead has bluish white color when freshly cut, but tarnishes to dull grayish color when it is exposed to air and is a shiny chrome silver when melted into a liquid. Lead is used in building construction, lead-acid batteries, bullets and shot, weights, and is part of solder, pewter, and fusible alloys. Lead has the highest atomic number of all stable elements, although the next element, bismuth, has a half-life so long (longer than the estimated age of the universe) it can be considered stable. Like mercury, another heavy metal, lead is a potent neurotoxin that accumulates in soft tissues and bone over time.

Notable characteristics

Lead has a dull luster and is a dense, ductile, very soft, highly malleable, bluish-white metal that has poor electrical conductivity. This true metal is highly resistant to corrosion, and because of this property, it is used to contain corrosive liquids (e.g. sulfuric acid). Because lead is very malleable and resistant to corrosion it is extensively used in building construction, e.g. external coverings of roofing joints. Lead can be toughened by adding a small amount of antimony or other metals to it. It is a common misconception that lead has a zero Thomson effect. All lead, except ²⁰⁴Pb, is the end product of a complex radioactive decay (see isotopes of lead below). Lead is also poisonous.

History

Lead has been commonly used for thousands of years because it is widespread, easy to extract and easy to work with. It is highly malleable and ductile as well as easy to smelt. In the early Bronze Age, lead was used with antimony and arsenic. Lead was mentioned in the Book of Exodus (15:10).

In alchemy, lead was thought to be the oldest metal and was associated with the planet Saturn. Lead pipes that bear the insignia of Roman emperors are still in service and many Roman "pigs" (ingots) of lead figure in Derbyshire lead mining history and in the history of the industry in other English centres. The Romans also used lead in molten form to secure iron pins that held together large limestone blocks in certain monumental buildings. Lead's symbol Pb is an abbreviation of its Latin name *plumbum* for soft metals; originally it was *plumbum nigrum*, where *plumbum candidum* was tin. The English words "plumbing" and "plumb-bob" also derive from this Latin root.

Lead also refers collectively to the organic and inorganic compounds of lead, which are toxic. Lead poisoning was documented in ancient Rome, Greece, and China. In the 20th century, the use of lead in paint pigments was sharply reduced because of the danger of lead poisoning, especially to children.^{[1][2][3]} By the mid-1980s, a significant shift in lead end-use patterns had taken place. Much of this shift was a result of the U.S. lead

consumers' compliance with environmental regulations that significantly reduced or eliminated the use of lead in non-battery products, including gasoline, paints, solders, and water systems. Lead use is being further curtailed by the European Union's RoHS directive. Lead may still be found in harmful quantities in stoneware, vinyl (such as that used for tubing and the insulation of electrical cords), and brass manufactured in China. Around 2006-2007, many children's toys made in China had been recalled due to lead in paint used to color the product.

Processing of metal from ore



Lead ore

The principal ores of lead are galena (PbS), anglesite (PbSO_4) and cerussite (PbCO_3). Most ores contain less than 10% lead, and ores containing as little as 3% lead can be economically exploited. Ores are crushed and concentrated by froth flotation typically to 70% or more. Sulfide ores are roasted, producing primarily lead oxide and a mixture of sulfates and silicates of lead and other metals contained in the ore.^[6]

Lead oxide from the roasting process is reduced in a coke-fired blast furnace.^[7] This converts most of the lead to its metallic form. Three additional layers separate in the process and float to the top of the metallic lead. These are slag (silicates containing 1.5% lead), matte (sulfides containing 15% lead), and speiss (arsenides of iron and copper). These wastes contain concentrations of copper, zinc, cadmium, and bismuth that can be recovered economically, as can their content of unreduced lead.^[6]

Metallic lead that results from the roasting and blast furnace processes still contains significant contaminants of arsenic, antimony, bismuth, zinc, copper, silver, and gold. The melt is treated in a reverberatory furnace with air, steam, and sulfur, which oxidizes the contaminants except silver, gold, and bismuth. The oxidized contaminants are removed by drossing, where they float to the top and are skimmed off.^{[6][4]}

Most lead ores contain significant concentrations of silver, resulting in the smelted metal also containing silver as a contaminant. Metallic silver as well as gold is removed and recovered economically by means of the Parkes process.^{[8][6][4]}

Desilvered lead is freed of bismuth according to the Betterton-Kroll process by treating it with metallic calcium and magnesium, which forms a bismuth dross that can be skimmed off.^{[6][4]}

Very pure lead can be obtained by processing smelted lead electrolytically by means of the Betts process. The process uses anodes of impure lead and cathodes of pure lead in an electrolyte of silica fluoride.^{[6][4]}

Production and Recycling

Worldwide production and consumption of lead is increasing. Total annual production is about 8 million tonnes; about half is produced from recycled scrap. The main countries are Australia, China and the US, which account for more than half of primary production. The most common lead ore is galena or lead sulfide.^[9]

At current use rates, the supply of lead is estimated to run out in 42 years.^[11] Environmental analyst, Lester Brown, however, has suggested lead could run out within 18 years based on an extrapolation of 2% growth per year.^[12] This may need to be reviewed to take account of renewed interest in recycling, and rapid progress in fuel cell technology.

Applications

- Lead is a major constituent of the lead-acid battery used extensively in car batteries.
- Lead is used as a coloring element in ceramic glazes, notably in the colors red and yellow.
- Lead is used to form glazing bars for stained glass or other multi-lit windows. The practice has become less common, not for danger but for stylistic reasons.
- Lead is used as projectiles for firearms and fishing sinkers because of its density, low cost compared to alternative products and ease of use due to relatively low melting point.^[20]
- Lead or "sheet-lead" is used as a sound deadening layer in such areas as wall, floor and ceiling design in sound studios where levels of airborne and mechanically produced sound are targeted for reduction or virtual elimination.
- Lead is used in some candles to treat the wick to ensure a longer, more even burn. Because of the dangers, European and North American manufacturers use more expensive alternatives such as zinc.^[21]
- Lead is used as shielding from radiation, e.g. in x-ray rooms.
- Molten lead is used as a coolant, eg. for lead cooled fast reactors.
- Lead glass is composed of 12-28% lead oxide. It changes the optical characteristics of the glass and reduces the transmission of radiation.
- Lead is the traditional base metal of organ pipes, mixed with varying amounts of tin to control the tone of the pipe.
- Lead is used as electrodes in the process of electrolysis.
- Lead is used in solder for electronics, although this usage is being phased out by some countries to reduce the amount of environmentally unfriendly waste.
- Lead is used in high voltage power cables as sheathing material to prevent water diffusion into insulation.

- Lead is used for the ballast keel of sailboats. Its high weight-to-volume ratio allows it to counterbalance the heeling effect of wind on the sails while at the same time occupying a small volume and thus offering the least underwater resistance.
- Lead is added to brass to reduce machine tool wear.
- Lead has many uses in the construction industry, e.g. lead sheets are used as roofing material, cladding, flashings, gutters and gutter joints, and on roof parapets. Detailed lead mouldings are used as decorative motifs used to fix lead sheet.
- Lead is frequently used in scuba diving weight belts to counteract the diver's natural buoyancy and that of his equipment.
- Lead is often used to balance the wheels of a car; this use is being phased out in favor of other materials for environmental reasons.
- Lead is still widely used in statues and sculptures.

Contrary to popular belief, pencil "leads" have never been made from lead. The term comes from the Roman stylus, called the *penicillus*, which was made of lead.^[24] When the pencil originated as a wrapped graphite writing tool, the particular type of graphite being used was named *plumbago* (lit. "act for lead"; "leadmocku").