

LEAD INDUSTRIES ASSOCIATION

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NEW YORK 17, N. Y.

METALLIC LEAD PRODUCTS DIVISION

... in Lead Pencil Construction Bull. No. 12

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CHEMICAL CONSTRUCTION BULL. (2)

SUBJECT: LEAD REFERENCE SHEET

To Members of the Metallic Lead Products Division:

Attached is a reprint entitled "Lead Reference Sheet" (part 1 and part 2) from the January, 1955 and February, 1955 issues of "Chemical Engineering Progress."

Part 1 covers grades and alloys of lead and their characteristics with special emphasis on their use as materials of chemical construction. Part 2 covers the corrosion characteristics of lead and lead alloys.

This reprint is also being mailed, as one of our series of Chemical Construction Bulletins, to our mailing list of approximately 1300 chemical construction companies, chemical engineers, chemical engineering professors, and others interested in chemical construction.

Additional copies are available as long as our supply lasts.

Yours very truly,

[Signature]
Secretary.



N 3055

Reprinted from CHEMICAL ENGINEERING PROGRESS, January, 1955

lead reference sheet (part I)

Kempson H. Roll Technical Director, Lead Industries Association, New York

Grades of Lead

Chemical lead, acid lead, and copper lead are the A.S.T.M. grades of lead most commonly used for corrosion resistant chemical construction. These three grades are distinct from antimonial lead (hard lead) and tellurium lead, used in chemical construction.

Antimonial Lead

Is ordinary lead to which has been added up to 12% antimony. Through this hardening and improves the mechanical properties, increases the melting point and does not reduce corrosion characteristics. At temperatures below 240°F., 6% antimonial lead has more abrasion resistance than chemical lead. At room temperature it has lost the hardness and tensile properties, but at about 240°F. the mechanical strength of antimonial lead is no better than chemical lead and above this temperature chemical lead actually possesses equal or better mechanical characteristics.

Tellurium Lead

Is chemical lead to which has been added approximately 0.02% tellurium to improve resistance to fatigue due to vibration. Tellurium retards grain growth and allows lead to work harder or stronger under strain.

Applications

Lead has long been widely used in the construction and protection of equipment for the production, transmission, storage, and use of corrosive chemicals. It is especially useful with all concentrations of sulfuric acid, sulfuric acid, chromic acid, phosphoric acid, and salts of these acids.

Forms

In chemical construction lead is used chiefly in the form of rolled sheet, pipe or other extrusions, castings, or as a lead cladding on steel or copper. Either casting or specially constructed vessels of concrete, wood, or steel can be readily lined with sheet lead to make them suitable for handling corrosives. A thick layer of lead can be bonded to steel or copper as a cladding to combine the corrosion resistance of lead with the working strength of the base metal.

Valves and Castings

As lead has a low melting point in combination with high density and corrosion resistance, it has had extensive use, particularly antimonial lead (4 to 6% Sb), in castings. Cast hard lead valves are standard items for handling liquid corrosives and include gate, check, diaphragm, standard Y, and split Y body styles. In addition to cast hard lead valves, lead lined cast-iron and lead lined cast-steel valves are available commercially for use at higher pressures and temperatures. Lead castings are used in the chemical industry in the form of reaction vessels, exchangers, etc., usually made from 4% hard lead.

Mechanical and Physical Properties (All data apply to chemical lead)

Tensile strength	7200 to 20000 lb./sq. in.
Elongation	25 to 37%
Brinell hardness	49 to 60
Density, rolled, g./cc.	11.35 to 11.39
Melting point	618°F.
Mean specific heat (Btu./lb./°F.)	
60°F. to 618°F.	0.030
Thermal expansion (x 10 ⁻⁶ in./in./°F.)	
32°F. to 312°F.	16.2
Thermal conductivity (cal./sq. in./in./°C. at 100°F.)	0.000
Coef. of expansion (x 10 ⁻⁶ in./in. at 200 lb./sq. in.)	0.4
Thermal diffusivity (sq. cm./sec.)	
60°F.	10.640

Heat Treatment

Lead is a self-annealing metal, and therefore never needs heat treatment.

Weldability

Facile joined in the shop or field by fusion welding, known as lead "burning." Method uses no materials other than lead and thus insures that no metal less resistant than lead will be exposed to the corrosive. Eliminates the possibility of galvanic action between dissimilar metals. Should require no assembly, they are easily effected in the field.

Thickness

Thickness of sheet lead linings depends largely on the degree of corrosive attack or erosion anticipated. Hardly is sheet lead lighter than 3/16 or 1/4 in. thick used in chemical equipment, thickness usually ranging between 10 and 20 lb. (4 in. and 5 in.). Frequently different thicknesses are used for different parts of equipment.

Type of Construction

Lead sheet supported either in (1) a framework of steel or wood or (2) as a lining to a steel, concrete, or wooden vessel, are the two principal types of sheet lead construction. They are generally termed (1) strap construction, and (2) lead-lined construction. In the latter, strap or spot bonding or lead-covered steel strapping are usually used to support the lead.

Operation at high temperature or the handling of corrosive slurries which both erode and erode most materials of construction has led to the development and practical acceptance of brick and lead linings, i.e., a steel shell lined with lead, with or without a layer of asbestos slurring, followed by a layer or two of brick-lined lead or an suitable shaped of concrete.

A lead clad or bonded lead lining, in effect, combines the corrosion resistance of lead with the working strength of steel. Lining consists of a layer of lead bonded to steel plate to form a homogeneous or integral metallic structure which permits operation at higher temperatures and in vacuum.

Lead pipe casting such are commonly used. For heating coils, copper pipe is covered usually with a lead cladding with wet lead pipe above may be used up to 50 lb. steam pressure. Flanking a layer of lead in pipes reduces the corrosion resistance of the former with the heat transfer and higher strength of the latter. Steel pipes available with internal lead linings. Corrosive gases conducted usually in ducts fabricated from sheet lead supported in a strap iron framework.

Temperature Limitations

Chemical lead melts at 618°F. At 240°F. its pressure strength half its normal strength. Operating out the low temperature cycle in periodic operations substantially improves performance. Bonding lead directly to steel as in lead clad vessels or to copper as in lead covered copper coils permits operation at higher temperature ranges. By providing an insulating layer of masonry or brick over the lead, still higher temperatures may be successfully tolerated, 300°F. being not uncommon.

Chemical Composition

A.S.T.M. Pb Lead Specifications* for Chemical, Acid and Copper Lead

	Chemical lead	Copper lead	Acid lead
Ag, Maximum	0.005	0.000	0.000
As, Maximum	0.005	0.000	0.000
Co, Maximum	0.005	0.000	0.000
Cu, Maximum	0.005	0.040	0.040
Al, Sn, Fe, Maximum	0.005	0.000	0.010
Zn, Maximum	0.004	0.004	0.000
Pb, Maximum	0.000	0.000	0.000
Bi, Maximum	0.000	0.000	0.10
Lead, by diff., Minimum	99.90	99.90	99.90

* A.S.T.M. Standard Specification B 20-49.

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load reference sheet (part 2)

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Corrosion Characteristics of Lead:

Lead relies for its resistance to corrosion upon a thin protective coating which forms on its surface. When the coating is one of the highly insoluble lead salts such as sulphate, carbonate or phosphate, resistance to corrosion is high and the environment generally promotes self-healing of the coating upon mechanical injury. On the other hand, if soluble salts form such as the nitrate, acetate, or chloride, little protection is afforded and the lead may corrode further. Likewise, if insoluble pro-

Protective coatings are removed mechanically, as by abrasion, or erosion, or dissolved chemically as in the case of some mixed corrosives, corrosion resistance is similarly reduced.

The manner of installation, proper design, and awareness of the exact service conditions are all important in lead chemical construction in order to minimize the mechanical limitations of lead and to take advantage in the best way of its superior corrosion characteristics.

CORROSION RESISTANCE:

[illegible]

* Data applies to A & M Chemical Grade level
 B - Excellent resistance Corrosion as slight as to be noticed
 C - Good resistance Satisfactory service expected

9 - For resistance. Satisfactory service under specific conditions.
 10 - For resistance. Satisfactory for temporary service only.
 11 - No resistance. Duty of subject too great for any use.

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