LEAD INDUSTRIES ASSOCIATION
420 LEXINGTON AVENUE
NEW YORK 17, N. Y.

METALLIC LEAD PRODUCTS DIVISION

February 2, 1950

[redacted]

To Chemical Construction Companies:

Accompanying this letter is a series of reprints from CHEMICAL ENGINEERING magazine. They are concerned with the performance and corrosion characteristics of lead as a material of chemical construction in contact with a variety of important industrial chemicals.

We are sending these reprints to you because we feel that the subject covered is of direct interest to those who are dealing directly with the chemical industry. As long as our supply lasts, we will be pleased to send additional copies to you for distribution to others whom you feel may benefit.

As additional reprints become available, we will send them to you so that they may be added to the series.

Very truly yours,

Secretary

Sulphuric Acid versus Lead

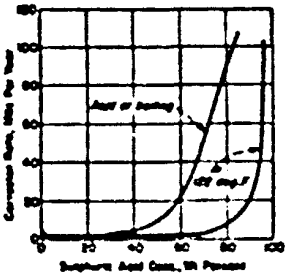
ELIPTON H. POLL
Lead Industries Assn.
New York, N. Y.

LEAD'S BIGGEST USE in connection with sulphuric acid, the chamber process, is exemplified in these two Mills-Packard chambers (only upper third is visible)

Sulphuric acid is lead's forte, providing by far the bulk of its application as a construction material in the chemical industry. Lead's resistance to dilute acid, in fact to all but concentrated acid, is probably known to more people than any other metal versus-acid combination. At room temperature it resists all concentrations up to 96 percent, at resists 85 percent acid up to 425 deg. F. Satisfactory use is sometimes obtained up to 480 deg. F. The graph shows the corrosion resistance of lead to sulphuric at 122 deg. F. and at the boiling point. In obtaining data for this graph specimens were removed daily for 14 days and the protective sulphate coating dissolved in an acidified ammonium acetate solution (5 percent, hot). The corrosion rates are consequently maximum for total immersion in sulphuric acid. Although these values are excessively high, they serve as a guide for commercial practice.

Since lead's resistance to sulphuric acid is due to a sulphate film it follows that high velocities or excessive turbulence can increase the rate of corrosion by removing the film. In pipelines this may be remedied by redesigning to reduce flowrates. In the table below the corrosion rate appears to fall as velocity increases but increases markedly at a velocity of 300 fpm. (Data are for 20 percent acid at 75 deg. F.)

The biggest use for lead in connection with sulphuric acid is in the manufacture of the acid, especially by the chamber process. From the introduction to the Glover tower the entire chamber process takes place within a series of chamber towers and ducts constructed entirely of sheet lead with supporting structures of wood, steel, brick or concrete. (When in direct contact with "green" concrete, lead should be protected by asphaltum or tar paper.) Lead pipe is used in handling the dilute sulphuric acid product. Most of the lead chamber plants throughout industry can show great length of service of sheet lead in use with the constituents of sulphuric acid in their most corrosive conditions, hot and moist. Some old box type chambers were examined and it was found that virtually no corrosion had taken place after some 30 to 50 years in contact with the acid. The newer Mills-Packard chambers, which are shaped like truncated cones (see photo), are cooled by water flowing down the sloping sheet lead sides, cooling the lead in this manner results in still longer life for the lead chambers even though interior temperatures are comparatively high.



Sulphuric Acid Conc., Wt Percent

From "Corrosion Handbook," John Wiley & Sons

Lead's importance in the manufacture of sulphuric acid by the contact process is not as great as in the chamber process because the concentrations of the acids are higher and the temperatures generally exceed those at which lead may be used. However, the processing of hot, corrosive gas mixture from sulphide ore roasters prior to conversion to sulphuric acid is carried out in equipment fabricated from sheet lead with external steel supports. In a typical byproduct acid plant using the contact process large 40 and 50 ft. settlers, as well as a sulphur dioxide scrubber and cooler, are protected by lead against a sulphuric acid coolant solution, there has been no appreciable action on the lead in nine years. For over 15 months the coolant in this particular installation contained, in addition to 56 g. per l. of sulphuric acid, 1.5 g. per l. of fluorine with still no apparent effect on the lead linings and equipment. Other lead lined apparatus—ducts, pipes, valves and pumps—have given at least 16 yr. service handling roaster and sulphuric acid gases and solutions at various temperatures. Similar longevity is recorded for the lead pipes in the plant's Cottrells, these are the pipes on which dilute sulphuric acid is electrostatically precipitated, temperature ranges from 77 to 164 deg. F.

Outside the manufacture of sulphuric acid, the uses for lead in handling the acid are legion—either as sheet as applications of the acid itself. Lead sheet ⅛ to ¼ in. thick is used to line vacuum concentrators where di-

Sheet lead is available in any thickness from 1/80 in. to 2 in., or, in lead parlance, from 1 lb. to 120 lb.

Hard lead, containing an average of 6 percent antimony, is used when greater rigidity than chemical lead is demand, provided concentrations are

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Caustic Soda versus....

Lead

Kenneth H. Ecel, Lead Industries Association, New York, N. Y.

Lead is amphoteric and reacts with aqueous solutions of caustic soda to form plumbites. Because the plumbites formed are soluble in the caustic solution they cannot provide a protective surface film on the lead. However, for certain purposes or under special conditions corrosion rates are tolerable with sodium hydroxide up to 30 percent concentration at 25 deg. C. and up to 10 percent concentration at 90 deg. C. For example, lead has proved useful in the refining of petroleum where a sulphuric acid treatment is followed by an alkaline solution treatment in the same lead-lined vessel. Below are shown the results of tests by Calcott and Whetzel in which lead was exposed to a 25 percent solution of caustic soda at various temperatures:

Temperature, Deg. C.	Corrosion Rate, Mg. Per Sq. Dm. Per Day
[illegible]	0.4
[illegible]	0.4
[illegible]	0.4
[illegible]	0.4
100	1.4

The table below illustrates the effect of varying concentration and temperature of caustic soda to which lead is exposed:

	Corrosion Rates, Mg. Per Sq. Dm. Per Day, at 30 Deg. C.	Corrosion Rates, Mg. Per Sq. Dm. Per Day, at 100 Deg. C.
[illegible]	1.1	1.1
[illegible]	0.1	0.1

The results of these tests show that cold, concentrated solutions of caustic soda have far less effect on lead than hot, dilute solutions. Except for the latter conditions, some of the results indicate that lead could not be used for handling the solutions tested.

Other tests have been recorded to show the effects of aeration on the corrosion rate of lead in a 1 N solution of sodium hydroxide at room temperature. Tests were run for two days following a previous two-day exposure. Here are the results:

Test Immersion	Corrosion Rate, Mg. Per Sq. Dm.
Open [illegible]	0.2
Aeration Immersion	
[illegible]	0.2
Open 30 days	1

In a series of comprehensive tests conducted by Watts and Whipple lead was exposed to a 1 N solution of sodium hydroxide and results compared with lead exposed to the same solution but containing additional small amounts of such salts as sodium arsenate, potassium permanganate, potassium nitrate and sodium chlorate. It was found that all of these oxidizing agents reduced the rate of corrosion instead of accelerating it. While the test data reported here are not wholly consistent, the trends appear clear.

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SODIUM CHLORIDE versus....

LEAD

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Excellent service records are characteristic of metallic lead products when used to resist corrosion by salt water, spray or seacoast atmospheres. There is little corrosion of lead from sodium chloride but this is so slight that years of useful life are obtained from lead pipe, valves, boat keels, anchors, and sheet lead in various forms. The latter serves as trunk linings, protective roofing, caps for wood piling, and a host of other uses where the low corrosion rate of lead means a long life of protective service.

Lead shows only slight corrosion (4 or 5 mils per yr.) when exposed to 1 normal sodium chloride and practically no corrosion when exposed to salt spray. Corrosion resistance of lead to salt water is well illustrated by the wide use of lead pipe in handling sea water supplies to aquariums throughout the country. Tropical salt water fish were put on display in 1927 in the Miami (Fla.) Floating Aquarium. The original piping was not lead and served only 18 months before requiring replacement. Corrosion in the original pipe so clouded the water that the specimens could not be distinguished. This was completely corrected by the use of lead pipes, cocks and valves throughout.

Among an extensive list of aquariums using lead for salt water corrosion resistance is the Shedd Aquarium in Chicago which was completed in 1929 or 1930. Aquarium authorities recently assured us there is no question but that lead pipe had given satisfactory service. The only physical change observed is that an undisturbed lining of lead oxide or lead oxychloride has formed within the pipes. All the water used for both fresh and salt water fish is handled in lead pipe and valves ranging in size from ¼ in. to 6 in. The water, taken from off the Florida coast, is circulated through literally miles of lead pipe. Unsightly staining of the white Georgia marble building from moisture is prevented by liberal use of lead for roofing and decorative trim. (This practice is especially typical of seashore areas subject to salt spray.)

Over a period of four years lead bars were exposed in Bristol (England) Channel and the corrosion rates for soft lead and 1.6 percent antimonial lead were less than 0.1 mils per yr. There was no localized attack on these bars which were submerged 93 percent of the time.

Another use for lead in contact with sea water is for soil and waste pipes aboard ocean going liners where fresh water must be conserved and salt water is used for flushing with a resulting corrosion problem. In the three 17,000-ton luxury liners built in 1932 for the Cunard Line, extensive use was made of lead for handling salt water. Space is at a premium in shipbuilding and flexible lead pipe is easily bent around obstacles and is less subject to damage from engine vibration and ship movement and buffeting. Abaft ship sheet lead was also used to line refrigerator rooms and for flashing on the upper work on deck for its high resistance to sea air and sea water corrosion.

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Sulphur Dioxide

versus

Construction Materials

Corrosion characteristics [illegible] gas [illegible] are made of lead supported by steel [illegible]

LEAD
H. M. CHESTER, Jr.
Lead Industries Assn.
New York, N. Y.

Since 1746, when the first lead chamber was used in Birmingham, England, for making chemicals, lead has proved its worth in handling sulphur dioxide and related compounds, such as sulphuric acid, sulphurous acid, sulphur chloride and sulphur trioxide. Lead suffers practically no corrosive effects from SO_2 gas, whether cold and dry or in hot, moist conditions up to 390 deg. F. In fact, lead is the standard material for handling the above corrosives.

The magazine, *Lead*, a publication of the Lead Industries Assn., carried an article in its issue of July-August, 1946, on the replacement of a lead duct in the sulphuric acid plant of a southern chemical company. A 28-ft. lead duct, 42 in. in diameter, had given 29 years of excellent service before being replaced. The sheet lead was not appreciably corroded and the only signs of failure necessitating replacement were near the steel supporting bands. Vapors pass through at temperatures of approximately 235 deg. F. at the top where they leave the Glover tower and 225 deg. F. at the bottom where they enter the nitre pot carrying a mixture of sulphur dioxide and sulphur trioxide. To form the new duct, 10-lb. sheet lead was wrapped around mandrels of the proper size, welded longitudinally and supported by lead covered steel bands on 4-ft. centers. This duct, when welded in place and supported by a steel structure was ready to give at least [illegible] years service. Throughout [illegible] corrosion-resistant service has been [illegible] but corrosive vapors while being exposed to the atmosphere on its external surface.

From the roasting of lead, zinc, and iron sulphides large amounts of hot SO_2 vapors with other oxidation products are handled in lead ducts and in lead lined equipment. The actual conversion of the SO_2 to concentrated sulphuric acid is accomplished by the contact process, but extensive use of sheet lead is made in the purification of the hot gas coming from the roasters prior to its conversion. In one plant of this type a corrosive liquor saturated with SO_2 and at 125 deg. F. has been handled in lead equipment with little or no corrosion since 1917. Among other corrosives in the liquor are sulphuric acid, 56.6 g. per L; chlorine, 1.9 g. per L, and ferrous iron, 4.1 g. per L.

In the manufacture and handling of sulphurous acid for the sulphite paper process lead has many uses. The hot SO_2 gas is taken through a cooling system which usually consists of 100 or 200 ft. of 8 or 12 in. lead pipe undergoing a continuous cold water spray. Lead fans impell the gas countercurrent to a water stream through limestone packed towers to form the sulphite liquor which usually contains 1 percent SO_2 combined with lime and 5 percent free SO_2. Sulphite liquor and wood chips are brought into a digester with a lining of acid-proof brick set in a cement made of litharge (PbO), sand, and glycerine. Here temperatures vary from 270-300 deg. F. and pressures are 75-125 psi. At the digester top 3 in. antimonial lead covers, 36 in. in diameter, have given good service at 250 deg. F. at 20 percent of the cost of covers previously used.

Lead digester relief valves, usually 2 or 4 in. in diameter, have been successfully used on the digester cover where relatively low velocities of steam and SO_2 are encountered. Lead is not suitable for relief regulating valves for digesters as steam and SO_2 are encountered at 250 deg. F. and pressures of 75-125 psi. Other materials, much harder than lead, are rapidly cut to pieces in this service where the valves are never fully opened. Thousands of feet of antimonial lead pipe are used in digester relief lines in the various sulphite mills throughout the country. These lines are immersed in cooling water for a great part of their length so that the SO_2 gas will be more readily absorbed in the recovery tower. Lead pipe has proven to be the most satisfactory and economical material available for digester relief lines. In addition, quite a few lead lined wooden tanks and lead pipe lines are used in the sulphite pulp industry to handle the sulphurous acid, SO_2 gas, and also the acid sludge which is used in paper sizing.

Lead lined equipment has proven very satisfactory for neutralizers, evaporators, and settlers used in the manufacture of potassium metabisulphite (see Chem. & Met., Nov. 1945, p. 231), a product which demands high purity and freedom from soluble lead salts because of its use as a fermentation arrester in wineries and as a preservative for photographic solutions. An excess of sulphur dioxide is encountered in the neutralizers of wood and lead lined construction.

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Fluorine versus ....

Lead

Kempton H. Roll, Lead Industries Assn., New York, N. Y.

In contact with fluorine gas, particularly in the presence of moisture, lead is transformed into the fluoride. Behaving somewhat like lead sulphate, the fluoride coating or film on the lead surface prevents or substantially decreases further reaction. At temperatures up to at least 100 deg. C., lead is known to handle fluorine gas safely.

Lead fluoride is soluble in nitric acid or sulphuric acid, insoluble in acetic acid, hydrofluoric acid or ammonia. Its solubility in water at 20 deg. C. is 0.064 g./100 ml.

Often when fluorine encounters lead, it is only a minor constituent of other corrosive gases. Many ore roasting operations, for example, frequently evolve fluorine gas along with sulphur dioxide and other gases. In the recovery of these gases, particularly when converting to sulphuric acid, lead lined ducts and chambers are often employed. A large Belgian zinc ore roasting plant purges fluorine from its reactor gases by means of several types of lead equipment, all of which [illegible] for many years. [illegible] is [illegible] in order to ensure purity of the [illegible] dioxide before conversion to sulphuric acid by the contact process. From the roasters, the hot gases containing fluorine are conveyed through water cooled lead coils and thence through lead ducts into the defluorinating chamber. The latter is lined with sheet lead and constructed in such a manner that the fluorine is removed by solution in a water spray. The use of lead in handling hydrofluoric acid, one of the products of this reaction, was described in these columns in October.

Lead is regularly used as a washer in an adaptor assembly for external connections to the cylinder valves in use with compressed fluorine.

It thus appears that an important but restricted usage of lead is found in industry for combating corrosion by fluorine under various conditions of concentration, temperature and moisture content.

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Hydrofluoric Acid versus ....

Lead

Kempton H. Roll, *Lead Industries Association, New York, N. Y.*

Hydrofluoric acid is one of the principal mineral acids to which lead is corrosion resistant. Lead of $\frac{1}{8}$ in. or greater thickness usually gives years of service in equipment handling this chemical, particularly if the acid is at room temperature.

The limiting concentration lies in the range of 60 to 65 percent, depending on the acid temperature. Lead has been used successfully with unaerated 60 percent acid up to the boiling point (184 deg. F.). Nevertheless the use of lead with hydrofluoric acid at temperatures above room temperature is generally to be recommended with caution.

Considerable lead is used for storage, conveying and pumping hydrofluoric acid solution. At one time it was also used extensively for shipping the acid.

Some actual plant corrosion tests were conducted in dilution and storage vessels for 60 to 40 percent hydrofluoric acid. At average atmospheric temperatures, the test specimens were immersed in the acid solution for a period of 33 days. The lead corroded at the rate of 3 mils per year. In another test, commercial 60 to 65 percent hydrofluoric acid containing 15 to 25 percent fluosilicic acid, 0.1-1.25 percent sulphuric acid and 0.01-0.03 percent iron was held in storage. The test specimen was immersed in the solution which ranged from 60 to 80 deg. F. in temperature. After 28 days exposure, the corrosion rate for lead was shown to be 16 mils per year.

Many ore roasting plants convert their roaster gases to sulphuric acid, in this manner protecting the community against hazardous air contaminants as well as recovering a valuable product. Due to the presence of fluoride minerals in most zinc ores, the roaster gases often contain fluorine which must be removed prior to [illegible] conversion. This is [illegible] accomplished by forming [illegible] acid and [illegible] it in [illegible] vessels. In one installation [illegible] is encountered as a corrosive contaminant to the extent of 1 g/[illegible]. No effect on the lead linings in the coolant handling equipment has been apparent over the past several years of operation.

In the manufacture of anhydrous hydrofluoric acid (AHF), lead is satisfactorily used as a construction material for circulating pumps.

It is important in discussing corrosion that a uniform system of designation be used, such as mils or inches penetration per month or year, or milligrams per square decimeter per day. But either of these systems can be somewhat misleading insofar as the common tendency is to judge best performance on the basis of the lowest corrosion rate. This is especially true in the case of lead in chemical equipment which for mechanical reasons is used in thicknesses generally of $\frac{1}{8}$ in. or greater. Such thicknesses are of a distinct advantage from a corrosion viewpoint. Other corrosion resistant materials are normally used in much lighter thicknesses. Thus for equal uniform corrosion rates, lead would far outlast such other materials because of this difference in thickness.

Designating corrosion rate according to weight loss in milligrams per square decimeter per day instead of volume loss as inches penetration per year is also misleading in the case of lead since lead has the highest density of any commonly used corrosion resistant material. This means that what might appear to be an excessive corrosion rate expressed in weight loss of lead could actually be a very nominal rate of corrosion in terms of volume loss.

When comparisons are being made between various corrosion resistant materials it follows that an understanding and appreciation of the above will lend much to the proper interpretation of corrosion rate data.

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[illegible], New York [illegible], N. Y.
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HYDROCHLORIC ACID (Muriatic Acid) versus....

LEAD

[redacted]
Lead Industries Assn., New York

Hydrochloric acid is an example of a corrosive with which the use of lead is possible under certain conditions but is not generally recommended. It has been used with some corrosion at concentrations up to 30 percent at normal temperatures and 20 percent at 140 deg. C. Strong, concentrated acid can be used cautiously with either chemical or antimonial lead at room temperature. Of course, the attack on lead by any corrosive chemical increases with the agitation to which the solution is subjected.

Purity of the acid also influences the degree to which it will attack lead. The presence of water in hydrochloric acid causes corrosion by forming a slightly soluble lead chloride corrosion product. Anhydrous HCl is commercially handled by lead. Gaseous HCl, a by-product of some chlorinators processes, has been and is being handled successfully in lead equipment. Certain impurities in the acid solution also influence its effect on lead. For example, commercial acid containing 0.5 to 0.8 percent chlorine may double the corrosion of lead over that of the pure acid and the presence of 1 percent iron chloride may increase corrosion as much as five times.

The addition of Quinoline as a corrosion restrainer has been used effectively with hydrochloric acid and lead but it is not effective enough to permit lead to be used without fear of reaction with the acid.

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Wet and Dry Chlorine vs. Materials of Chemical Plant Construction

LEAD

H. M. CHURCH
Lead Industries Assn.
New York, N. Y.

Lead is recommended as a material for handling moist chlorine up to 230 deg. F. with slight corrosion, and the chemical when dry has very little effect on lead. Small amounts of chlorine, such as are used in water treatment, have no effect on lead. For handling hydrochloric acid, the use of lead is not generally recommended, but at normal temperatures there is only slight corrosion in concentrations up to 90 percent, and at 212 deg. F. concentrations as high as 20 percent have been used. Thus, when chlorine with some moisture present results in the formation of small amounts of dilute hydrochloric acid, there is a possibility of slight corrosion depending on amount upon other conditions.

Chlorine is a gas at room temperature and is inert to most metals when cool and dry, but the dry gas when heated attacks all metals to a certain extent. Hydrochloric and hypochlorous acids, formed in the presence of moisture, attack most metals except platinum, silver, lead, and certain special alloys. A protective layer of lead chloride forms over the lead and further corrosion is resisted while the film remains intact. This protective film prevents lead's use with moist chlorine up to 230 deg. F. with only slight corrosion.

Lead pipe is used to introduce chlorine gas or liquid into a bath of caustic in a concrete tank in the manufacture of sodium hypochlorite. Pure lead tubing gives satisfactory length of service without undue expense. In general, at room temperature, corrosion of lead by wet or dry chlorine, either liquid or gaseous, is sufficiently moderate to recommend its use from an economic standpoint.

In some years time, there has been apparently no attack on lead-lined settler tanks of 40 and 50-ft. dia. where a solution containing 1.9 g. per l. of chlorine, with other constituents, is handled. This solution is at approximately 125 deg. F. and is saturated with sulphur dioxide.

Relatively rapid corrosion takes place if lead contains a trace of chloride or is immersed in a relatively strong solution of a chloride and is subsequently exposed to the air. This is the result of a catalytic action in which the chloride acts as an intermediary with the formation of sodium carbonate and lead chloride which is subsequently attacked by the moisture and carbon dioxide in the air to form lead carbonate and sodium chloride.

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Acetic Acid vs. Materials of Chemical Plant Construction

LEAD

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Aqueous acetic solutions are moderately corrosive to lead and it is not generally recommended for handling either dilute or glacial acetic. Even if corrosion, aeration, or high temperatures. This rules out the use of lead except in a storage medium where there is slight possibility for removal of the lead surface film through agitation of the liquid. In a number of cases the amount of lead pickup is sufficient to prohibit the use of lead.

Lead lined tanks and vats have given good service in many cases where glacial acetic acid has been stored. Precautions to be taken here are that the tanks be closed to exclude circulating air. Satisfactory length of service is usually obtained unless the contents are changed quite frequently, in which case corrosion may become excessive because of the frequency of air changes.

Lead pipe or lead lined pipe is not recommended for the transfer of liquid acetic acid. In cases where lead pipe has been used, moderate corrosion occurred in the straight sections, but at bends corrosion was rapid to the extent of completely destroying the pipe wall at the point of impingement.

For comparison, total immersion of lead test samples in quiet acetic and hydrochloric acids give the same corrosion rate (14 mils per year). However, with air agitation the rate for acetic acid becomes more than twice that for hydrochloric.

What laboratory data are available, while not wholly consistent, would seem to support plant experience in the conclusion that lead may be considered for either dilute or glacial acetic acid, but only at low temperatures, no aeration, and no agitation.

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Phosphoric Acid vs. Materials of Chemical Plant Construction

LEAD

H. H. CHURCH
Lead Industries Association
New York, N. Y.

Lead is widely used in the commercial production and handling of phosphoric acid because of its satisfactory resistance to this corrosive. For its corrosion resistance lead usually depends upon the low solubility of the thin adherent film of lead compound formed on its surface. Good protection is offered by the lead phosphate film as it is highly insoluble (0.14 p.p.m. in water). As lead sulphate is also highly insoluble, impure phosphoric acid containing sulphuric acid results in negligible corrosion of lead.

Available data show that lead's resistance to pure phosphoric acid is quite satisfactory and to impure acid is exceptionally good. It is employed with pure acid in concentrations up to 80 percent at 200 deg. C. and with impure acid up to 85 percent concentration. As shown below in the table of corrosion rates, lead is especially resistant to both dilute and concentrated crude phosphoric acid.

Lead-lined wood or steel tanks have proved very satisfactory for the construction of agitators, thickeners, storage tanks, troughs and launders. Where sludges are to be handled, an additional lining of acid-resistant brick should be installed to protect the lead from abrasion and from fluorine attack. The majority of failures of lead-lined chemical equipment have occurred as a result of faulty installation or improper design. Where there are temperature changes, sagging of the lead lining is prevented by lead covered steel straps properly spaced, spacing being dependent upon the temperature differential and other local conditions of design and operation. If the temperature change is excessive an acid-resistant brick lining will serve the threefold purpose of giving the lead lining additional support without stopping, preventing abrasive action on the lead, and acting as an insulating layer which permits higher temperatures and more rapid temperature changes.

In some types of agitators and thickeners, the raking blades are of hard lead with grooves of alundum embedded on the surface for abrasion resistance. This material is called plumbalon and has proved very efficient in resisting combined abrasion and chemical action.

For corrosion resistance, lead pipe and lead-lined steel pipe are used extensively in handling phosphoric acid. The latter is used for operations under pressure and is readily disassembled for ease in removing the crystalline scale which often forms quite readily. The ease of burning extruded lead pipe into coils has brought about the use of lead steam coils in lead-lined evaporators for concentration of the acid.

Homogeneous lead linings may be used in vacuum evaporators and other installations where a vacuum is applied. The evaporator tubes are lead covered copper tubing. Concentration of the acid is also performed in lead vessels employing lead steam coils.

Corrosion Rates of Lead in Phosphoric Acid

Acid Conc., Percent	Temp., Deg. C.	Corrosion Rate, Mils per Year
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
Boiling test with pure phosphoric acid:		
[illegible]	[illegible]	[illegible]
[illegible] (average)	[illegible]	[illegible]

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