LEAD INDUSTRIES ASSOCIATION
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METALLIC LEAD PRODUCTS DIVISION

THIS [illegible] AS IT [illegible] A RE-RUN OF PREVIOUS BULLETIN.

[illegible], 1956

CHEMICAL BULLETIN NO. 66

SUBJECT: [illegible]

To Members of the Metallic Lead Products Division:

Attached is a reprint on "How to Maintain and Inspect Lead Linings" published in the November, 1956 issue of "Petroleum Refiner."

This reprint is an abstract of the paper presented by a former member of the staff before the Society for Nondestructive Testing at their annual convention in October, 1955, which was subsequently printed in the January-February, 1956 issue of "Nondestructive Testing," and reprints circulated to you as Chemical Bulletin No. 63, dated April 3, 1956. A rewrite of that paper was published in the November, 1956 issue of "Chemical Engineering" and will be circulated as a chemical bulletin as soon as reprints have been received.

The first of these more complete treatments of the subject was circulated to our mailing list of approximately 1,100 chemical construction companies, chemical engineers, chemical engineering professors and others interested in chemical construction, and the other will be similarly circulated shortly.

Additional copies are available as long as our supply lasts.

Very truly yours,

Secretary-Treasurer.

How to Maintain and Inspect Lead Linings

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Reprinted from PETROLEUM REFINER, November, 1956

When lead is attacked by a corrosive material, a protective film is formed. In the lead lining shown here, strips of sheet lead are used to protect the studs which hold the lining in place

How to Maintain and Inspect Lead Linings

Resistance of lead to chemical attack depends on the protective film formed when the lead corrodes. Keeping this film intact calls for proper inspection and maintenance.

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DESPITE THE FACT that more than one-third of the lead consumed in this country is used for protection against corrosion, lead is by its chemical nature a corrodable metal. Oddly enough, it is this corrosive character of lead that accounts for its well-known resistance. The reason is simple enough. When lead is attacked by a corrosive medium, a compound of the lead and the corrosive forms immediately as a film. In this respect, lead differs little from aluminum, stainless steels and other materials which owe their corrosion resistance to protective films.

Corrosion Characteristics of Lead—Generally speaking, lead has good resistance to neutral solutions where lead carbonate and possibly oxide are corrosion products. It has fair resistance to alkaline solutions in which these are soluble. Experience has shown that lead is commercially resistant to chromic, sulfuric, sulfurous and phosphoric acids, that it is subject to corrosion at somewhat higher rates by hydrochloric and hydrofluoric acids and that it is susceptible to being strongly corroded by acetic, formic and nitric acids. Nitrate salt solutions are moderately corrosive, whereas carbonate solutions are not.

After establishing that lead can be used with a particular corrosive, it is important to keep in mind that lead depends for this resistance on its protective film. It is true that a good protective film is self-healing but by consistently taking advantage of the self-healing characteristics and losing sight of the fact that the self-healing process involves the corrosion of a portion of the metal, the result may be premature failing of the lining. Therefore, conditions such as excessively fluctuating concentration or temperature, the introduction of entrained particulate matter, or mechanical abuse, will all have a destructive effect on lead's normally protective film and thus its ability to handle corrosive efficiently.

In dealing with mixed corrosives [illegible] one of the constituents will [illegible] the formation of a protective film while the other will dissolve the film. Whether lead can or cannot be used under these conditions depends on the proportions. For example, mixed hydrochloric and sulfuric acids

have been handled successfully in lead when the sulfuric acid concentration was above 15 percent and the hydrochloric acid below 5 percent. Temperature, too, will affect this ratio.

There have been occasions when lead would not perform satisfactorily because a sufficiently protective film could not develop. For example, in a lead lined sulfuric acid vessel maintained partially filled, it was found that corrosion proceeded at a much more rapid rate in the vapor zone. The fumes that formed here as a result of the presence of oxygen were less stable than pure sulfate films and therefore failed to prevent corrosion. This situation was corrected by periodically raising the level of the liquid in the vessel long enough for a lead sulfate film to form. In general it is a better practice to maintain vapor-zone areas by maintaining vessels as completely full as possible.

In the case of corrosives which, in themselves, do not readily form a protective film and will not dissolve lead sulfate, it is often possible to make the lining corrosion proof by swabbing the lead with dilute sulfuric acid or, if possible, filling the vessel with it for a short period of time in order to establish a protective sulfate film.

(At 70 F. in 25 to 35 percent sulfuric acid chemical lead will form a complete sulfate film in from 9 to 10 hours. Under the same conditions 9 percent antimonial lead forms a sulfate film in from 1 to 1½ hours.)

When specifying antimonial lead, do not lose sight of the fact that while antimonial lead is harder and stronger than chemical grade lead, this condition exists only up to about the boiling point of water. As the temperature increases, the physical strength of 6 percent antimonial lead drops until at 248 F. it is equal to chemical grade lead; above this temperature the antimonial lead actually becomes softer than chemical lead. This is an important consideration when processing temperatures are raised in about changing the processing equipment. Under these conditions it may be necessary to increase the supporting structure to compensate for the strength drop.

Inspecting and Testing Lead Linings. Higher pressures and temperatures and higher corrosive concentrations have all focused attention on the need for the inspecting and testing of chemical processing equipment, particularly prior to being put into service—and lead is no exception. Sheet lead installations may be tested for imperfect welds or pinhole penetrations with fluorescent penetrants or dye penetrants. Both of these depend upon capillary absorption to the defect of special chemicals and subsequent "development" of the chemicals to locate the defect. It has also been found practical to pump dyed kerosene between a lead lining and the outer shell and inspect the inside for the presence of the kerosene. Another technique is to pump freon-loaded air into the area between the shell and the lining. The presence of gas escaping through any perforations can be readily detected with a halide torch.

Bonded lead linings are usually tested for bond discontinuity, pinholing or porosity. The "acid wash test" is generally used for the latter two. After freeing the lead surface of any oil or grease films, a dilute solution of hydrochloric acid (15 percent HCl) is applied and allowed to remain for 12 to 24 hours. On inspecting, a wet spot indicates surface porosity or a pinhole that has not penetrated, whereas rusty discoloration indicates a pinhole that extends through the lead to the steel. Repairs are easily made by removing the lead from this area and rebonding by hand.

Bond discontinuity, on the other hand, cannot be detected by the acid wash test. In this case ultrasonics may be used, relying on either "resonance" or "pulse" methods. In the "resonance" method the test instrument transmits an ultrasonic wave into the metal and the reflected waves are detected. When the lead is well bonded the waves are not reflected by the steel-lead interface, whereas definite signals detected audibly or visibly indicate unbonded or partially bonded areas.

In the "pulse" method vibrations are sent through the metal until it strikes a flaw and is reflected whereas the rest of the waves travel on until they hit the opposite surface and are reflected. Inspection by ultrasonics is made in most cases from the steel or outside of the vessel. This technique also serves as a nondestructive method for checking the thickness of the lead lining.

Another commercially practical method for locating unbonded areas, though limited to pressure vessels, is to seal the vessel and raise the internal temperature by steam or otherwise, to about 500 F., cool as rapidly as possible and examine for lead bubbles whose presence would indicate lack of bond.

Radiographic techniques have been developed for testing brick and lead lined vessels in those cases where it is impractical to remove the brick. Radiography is practical for locating internal flaws or porous areas but does not lend itself well to bond detection.

This article is a condensation of a paper presented at the symposium on Control of Corrosion in the Chemical Industry, sponsored by the Niagara Frontier Section of the National Association of Corrosion Engineers and the University of Buffalo, Buffalo, N. Y., May 10, 1956.

REFERENCES

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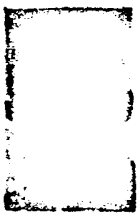
Meet the Author



KEMPTON H. ROLL, formerly with Lead Industries Association, recently was appointed secretary of the Metal Powder Association. With Lead Industries Association, he served as technical director from 1948 to 1956. Before that he was with Magnesium Metal Company as a metallurgist. Roll is a former student of Carnegie Institute of Technology, a graduate of Yale University with a B.S. degree in metallurgical engineering, and holds a M.S. degree from Polytechnic Institute