LEAD INDUSTRIES ASSOCIATION

420 LEXINGTON AVENUE

NEW YORK 17, N. Y.

NOT FOR PUBLICATION

CHEMICAL CONSTRUCTION*

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I should like you to consider with me the use of lead in the chemical industry, and by industry in general, to determine the position lead now occupies as well as its future possibilities.

We will confine our thoughts largely to the use of lead with acids which are the backbone of the chemical industry: sulphuric acid, and acids mixed with sulphuric. But first it may be interesting to trace the earliest references to sulphuric acid, and to the use of lead in its production and handling.

We find that in the first century of the Christian Era Pliny, the Roman, mentioned sulphurous acids as being employed to bleach wool. The first man to develop sulphuric acid, as we know it today, may have been Geber, the Arabian scientist, who lived 1200 years ago. About this there is a difference of opinion but there is little doubt that in the 15th century the writings of the German scientist, Bassilus Valentinus, clearly referred to sulphuric acid, and he is rightly regarded as a pioneer in its development.

Apparently the earliest manufacture of sulphuric acid on a commercial scale goes back more than 200 years. In 1746, the English scientist, Dr. John Roebuck, made experiments which resulted in producing good, usable acid. His work carried on with fragile glass bells, jars and jugs, but efforts to translate his experiments on a commercial scale were handicapped by the limitations of glass equipment, or of steel and copper equipment, which had a very short life. Fortunately Dr. Roebuck solved these difficulties. He constructed and lined production apparatus with lead, in the form of lead sheets, lead pipe and castings. He also persuaded English manufacturers of sulphuric acid to install lead-lined condensing chambers.

The demand for sulphuric acid was increasing tremendously at that time. In the textile industry it proved far superior to sour milk in bleaching, and many new industries thoughout Europe relied on it — to pickle iron, steel and other metals, to reduce wood pulp for the manufacture of paper, and to produce chemical fertilizers. Other industries in which it was indispensable made coal tar, dyestuffs and petroleum products, sulphates of iron and copper, alum and shoe blacking. All these handled, mixed, transported and stored sulphuric acid.

Many old records show the increasing use of lead in the chemical industry in England and Europe. Naturally the equipment was small. Lead chambers for producing sulphuric acid were from six feet to ten feet square, but with passing years their size multiplied. Those at the Spence Alum Works at Newton Heath

*Presented at the 22nd Annual Meeting, Lead Industries Association, April 13-14, 1950, Chicago, Illinois at the Panel Discussion of Lead Consumers were 75 feet long, 40 feet wide and 40 feet high. Jointing procedures involved the use of lead riveted, unwelded, lock type seams. Sheet lead, lead pipe and lead castings gave excellent service because the operation of chemical equipment did not then involve drastic temperatures or temperature cycles, high pressure, vacuum, vibration or shock, nor was heat transfer a factor.

In due time the jointing procedure was improved. Chemical plants commenced to use soldered joints. These, however, offered only a partial solution. The tin in the solder was quickly attacked by sulphuric acid.

On this side of the Atlantic the chemical industry commenced about 1635. By that time John Winthrop, Jr. son of the Colonial Governor of Massachusetts, had equipped a laboratory in Boston. In 1650 he planned the first chemical stock company in U.S. of which we have any record. In 1793 John Harrison of Philadelphia built the first lead chamber acid plant, with a yearly capacity of 300 carboys of sulphuric acid. Fourteen years later he built a larger lead chamber acid plant 50 feet long, 18 feet wide, and 18 feet high, with an annual production of nearly a half million pounds. In [illegible] Eugene Grasselli established his first chemical works at Cincinnati, where he manufactured sulphuric acid, and in 1869 expanded operations by building a new plant at Cleveland.

During all these years it was still the practice to solder lead, and the maintenance problems of those who produced or used sulphuric acid were continuous and costly. Soon after the Civil War Eugene Grasselli learned of a new art developed in France, called lead burning. This made it possible to weld sheets of lead, lengths of lead pipe or lead castings, by using a burning bar or welding rod with the same composition as the lead products themselves. Exercising commendable foresight and initiative, Grasselli brought to America a highly skilled French lead burner named Valiant. With soldering replaced by lead burning, such marked improvements resulted that Grasselli's production materially increased. It took years for other chemical manufacturers to apply this new development, but eventually all construction involving lead was done by lead burning.

Meanwhile, fabricators of sheet lead and lead pipe kept pace with the growing demand for their products. They improved their methods and equipment to produce lead sheets in larger sizes, lead pipe in greater diameters, and lead in all forms in more uniform thicknesses.

As chemical equipment grew larger construction problems increased, but chemical engineers devised ways to strap or support sheet lead and lead pipe so that its physical limitations were not overtaxed. And so, for many years, the chemical industry was an outstanding market for lead. Not only did lead do the job well, no satisfactory competing product was available.

Following the first World War this happy state of affairs changed. Many processes in the chemical industry became increasingly complex. These involved high temperatures and rapid temperature changes; vacuum, agitation, vibration, high pressure and erosion. Sheet lead, lead pipe and lead castings, no matter how constructed and supported, did not have the physical qualities necessary to meet these conditions. For a time all those at interest did the best they could to continue to use lead. The developed alloys, such as hard or antimonial lead, and later tellurium lead, but those improvements were not a full solution.

Then a variety of products were offered to the chemical industry by others, to meet the new conditions. At first many of those products were of limited scope. They often had the physical qualities to meet operating conditions, but rarely equalled lead in resisting corrosion. The organizations presenting them included the U. S. Steel Co., and its subsidiaries, International Nickel Co., Goodyear, Goodrich and U. S. Rubber Co., Lukens Steel Co., Duriron Co., The Pfaudler Co., Maurice A. Knight, The U. S. Stoneware Co. and the Harbison-Walker Refractories. They were aggressive, technically able, and well financed. They faced their problems and opportunities in a methodical, intelligent, determined way. As a result lead was supplanted in many instances, by duriron, ceramics, stainless steels, by nickel, nickel alloys, clad metals, and by rubber linings, brick linings and glass lined equipment.

Then the use of lead received another heavy blow. For with the advent of the contact system sulphuric acid could be produced at a concentration not corrosive to ordinary steel. It did not require lead. As more and more acid was made by the contact system, there was a decrease in construction of the old lead type chamber which had employed thousands of tons of sheet lead and pipe. Meanwhile chemical engineers had become increasingly dissatisfied with the performance of lead. When used beyond its physical limits, the result was premature failures, losses in production and heavy maintenance costs. The lead burners, who had been highly organized, were difficult to deal with, and where lead users tried to train their own lead burners, they had to contend with poor workmanship for long periods of time.

It was clearly apparent that the high corrosion value of lead under the operating conditions described was not sufficient to insure its use, but that the physical properties of a given medium are of equal importance. That fact explains the success of the competitors of lead. Added reasons were the lack of careful technical information on the performance of lead. Engineering and design "know how" in publicized form was also lacking. Those engaged in lead burning and lead construction could not contribute much to remedy conditions. At that time they devoted their efforts primarily to collecting groups of lead burners, to go out in the field and put up a lead job. Without technical organization themselves, and lacking in personnel, their efforts were inadequate and ineffective.

If the battle had been fought with the participation of powerful factors in the lead industry — if the miners, smelters, refiners and large fabricators had been made fully aware by those engaged in lead construction that many decisions were being made to use other products to supplant lead — the fight would have been won. For during the unfolding of those developments the solution for lead was close at hand, though still to be developed.

Techniques had been discovered for bonding lead homogeneously to steel. The combined product had the high corrosion value of lead and the great physical strength of steel — the latter being the important factor in operating conditions where lead by itself was not suitable. It was found that homogeneous lead-lined steel will withstand high vacuum, vibration and repeated shock. It has high heat transfer value; it operates at temperatures close to the melting point of lead, and it stands rapid changes in temperature, because the lead expands and contracts with the base metal to which it is bonded. This procedure was applied in lining tanks and vessels, as well as pipe, fittings and valves. It was developed to cover steel pipe, copper tubing and other metals with lead.

Why were these products not used promptly and widely, to retain the place of lead in the chemical industry? There were at least four reasons:

1. The processes, particularly for lining vessels and covering copper and steel pipe, were new and not sufficiently developed.

2. In many cases fabricators had large capital investments in sheet lead, lead pipe and other lead products, with which the new products might conflict.

3. Homogenous lead linings and coverings were generally regarded as being only for highly specialized, severe use. Therefore they were custom-built and priced accordingly.

4. Homogeneous lead-lined equipment was fabricated in many instances by small operators, who did not have the facilities and technical knowledge essential to dependable work.

However, in spite of all difficulties and handicaps, the use of homogeneous lead-lined pipe, fittings and valves, vessels and coils, increased steadily, so that by 1945 the total annual volume was more than several million dollars. Many users of chemical equipment have learned that stainless steel, nickel alloys, clad metals, duriron, rubber linings, and other products they have turned to, were not the hoped for solution to their problems. They are ready and willing to reconsider lead, when they realise how greatly its physical qualities have been strengthened and improved through homogeneous bonding. This trend is steady and persistent, even though the lead industry as a whole has not yet put forth a concerted, united effort to win back lost portions of its market, and acquire important new tonnage of lead consumption.

For some years there have been reliable processes for lead-lined steel pipe, fittings and valves. But there are now two other relatively new processes of great significance and value. The first not only produces homogeneous lead covered copper or steel pipe of high quality, for use as heating and cooling coils, but does it at an economical price. The second produces homogeneous lead-lined vessels and process equipment of reliable quality at very reasonable cost. Through use of all these processes complete equipment for a chemical installation may be provided, using a dependable homogeneous lead lining or covering.

The first cost of these products is less than stainless steel, nickel, nickel alloys, duriron, ceramics, etc. and while it is true they cost more than rubber linings, which are only of value where temperatures are less than 180° F., they will out-perform rubber linings with sulphuric acid, often ten to one.

And so we approach the end of our discussion about lead, and these are the conclusions I would leave with you:

First, the markets which remain for sheet lead, lead pipe and castings will continue to be attacked by mediums other than lead, but unless newer products are developed it is hoped competition has done its worst.

Second, these markets will be bolstered by the growing interest in the Mills-Packard type lead chamber, a development which is becoming popular among producers of sulphuric acid.

Third, the employment of sheet lead, lead pipe and lead castings for most present applications remains fundamentally sound, and the economics behind their use should withstand the closest scrutiny.

Fourth, however, it must be realised that homogeneous lead-lined equipment is commanding ever-increasing acceptance. With properly exploited processes it may be expected to supplant sheet lead and lead pipe in many instances.

Fifth, a united, well-supported effort by the miners, smelters, refiners and fabricators of lead if made, will now recapture important lead markets in the chemical industry, and create new markets.

Sixth, if we use all of our weapons, we can re-establish lead and make it outstanding again, as the preferred metal, for use with sulphuric acid in all of its ramifications.