[illegible]

[illegible] LEAD PRODUCTS [illegible]

[illegible]

[illegible]

Chemical Bulletin No. 6, [illegible] [illegible] and [illegible] [illegible] chemicals at high temperatures [illegible] design engineer [illegible]. It is probably one of the severest tests of lead's applicability in the chemical industry.

An inspection of the installation at Paulsboro was recently made by a representative of the Lead Industries Association. The following information, correlated with the original bulletin, shows how the lead lining in the reaction tank stood up over a period of three years' service.

PROCESS

Demineralized water is first introduced to the alum reactor. Sulfuric acid (66° Bé) is added until the solution is 50% acid, filling the tank to a depth of 18 in. and starting an exothermic reaction. Aluminum tri-hydrate (purified alumina) is added which further increases the temperature to 240° to 260° F. Only 20 to 30 minutes are required to raise the temperature from room to 260° F. The reaction is continued for 1½ to 2 hours, while being continuously agitated with steam to keep the aluminum sulfate above its solidifying temperature of 210° F.

Agitation and heating are accomplished simultaneously by ejecting steam through several bronze (84-10-2) eductors arranged tangentially within the tank. This system effectively eliminates lead steam coils and paddle wheels.

After the reaction is completed the batch is then diluted to make 23% aluminum sulfate and is kept for four hours at 130° to 140° F. Further dilution is done in this tank until it is 9/10 full of [illegible] alum solution, which remains liquid at room temperature. This solution is then pumped out of the tank into a solution preparation tank where it is further diluted to 10%.

The average service of the acid reactor is one batch per day. The most severe service, necessitated by heavy demand during the war, was one batch every eight hours.

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EQUIPMENT AND PERFORMANCE

The reaction tank is 17 ft., 7 in. inside diameter and 7 ft., 3 in. in depth (see drawings in Chemical Bulletin No. 6). In November, 1944, a 16-lb. chemical lead lining was first installed and supported by vertical straps [illegible] apart. This proved unsatisfactory after only [illegible] months operation and was then ripped out. Severe physical distortion of the lead and subsequent penetration by the alum solution was so extensive as to require replacement of the steel bottom and sides to a height of 18 in.

A new tank lining, installed in March, 1945, was put into service in June, 1945, and has served to date. Its bottom and sides are lined with 16-lb. tellurium chemical lead. The slightly convex top is lined with 12-lb. chemical lead. Additional straps consisting of half-oval steel covered by 16-lb. tellurium chemical lead 7 in. wide were installed so that the new lining is strapped every 24 in. on the side walls. The bottom is secured by parallel straps sheathed with 16-lb. tellurium chemical lead 16 to 18 in. apart and 5 in. wide bolted through the steel tank into supporting steel "I" beams beneath. The tank, located in a separate room with one side open to the atmosphere, is supported by steel "I" beams which in turn are set on concrete forms. In effect, the tank is air-cooled although no forced ventilation is employed.

No repairs of the lining were required until October of the following year, sixteen months later. Thereafter, sporadic patching became increasingly frequent. All repairing of the lead lining is made by a lead burner maintained at the refinery who was instructed by the company that made the initial installation to use chemical lead rods for making repairs.

The walls show the least amount of bulging or sagging between the straps, and require the least amount of repairs. The area 1/3 of the height up the side shows the least evidence of corrosion or incipient physical breakdown. Above this area, in the section exposed to hot corrosive foam and where air is accessible to the foaming solution, some corrosion has taken place along the crests of bulged lining.

Cracks and perforations of the tank lining on the bottom have caused the worst trouble. The lead between strapping has bulged in some cases as high as 3 in. above the tank bottom. Trouble with the lining is particularly severe in this chemical reaction because the product formed is liquid aluminum sulfate, which seeps through tiny hair cracks into the cavity under the lead bulge, filling it and later solidifying when the reaction ceases. This prevents flattening of the lead lining and necessitates instead, cutting the bulge open, removing all the solidified aluminum sulfate, and then sealing the lead break. Leaks are detected by weep holes; the presence of aluminum sulfate being noted by the appearance of stalactites.

The source of difficulty with the lead on the bottom seems to be primarily due to the appearance of fine cracks adjacent to the welded seams, on the seams themselves, on or adjacent to welds from earlier repairs, or occasionally along the crests of the bulges. The area surrounding the nozzle of the eductor jet was carefully examined for indications of failure due to abrasion. No such failures were noted. The lead apparently is unaffected by the steam jet and the swirling motion of the reacting solution.

Trouble with the lining is essentially restricted to physical causes brought about by a high temperature differential [illegible] over a comparatively short period of time, coupled with the difference in the coefficients of expansion between lead and steel. The linear coefficient of expansion of lead is almost three times as great as that of steel.

Acid-resistant bricks were tried in this particular installation without success. The bricks were unaffected by the chemicals, but the cementing compounds used apparently could not withstand their attack and eventually released the bricks which then proceeded to batter around in the solution causing damage to the lead lining as well as to the agitating equipment.

CONCLUSION

The operators feel that the lead in this installation has served well and that the termination of three years service for the lining is occasioned only by its physical limitations; that in no way has the lead failed to withstand the corrosive attack of the sulfuric acid solutions. However, the increasing cost and frequency of making repairs has limited the service life of this installation to several more months at best.

As a possible means of extending the life of this equipment it is probable that a proper type of cement could be found which would make an acid-resistant brick lining practical. Thus a lining of brick between the lead and hot chemicals might successfully protect the lead lining from distortion by providing uniform physical support and also by insulating it against temperature extremes. Any leakage of the corrosive chemicals through the brick would be stopped at the lead surface preventing damage to the steel outer shell.

The use of lead in the equipment for this particular reaction is especially applicable since freedom from contamination of the aluminum sulfate by the reacting and handling apparatus is essential to the success of the catalytic action of the finished product. If the material from which the reaction tank is made continuously forms a slightly soluble corrosion product, the aluminum sulfate becomes contaminated and is rendered ineffective as a catalyst. Other equipment in this plant in which the performance of lead has been highly successful for handling various concentrations of sulfuric acid includes storage tanks, pipes, valves and bead forming towers.

The operators will continue with the use of lead linings and hope to extend their life by utilizing every possible construction improvement.