TECHNICAL DIVISION

THE CORROSION OF 2S ALUMINUM IN SODIUM BORATE AND LEAD ACETATE SOLUTIONS

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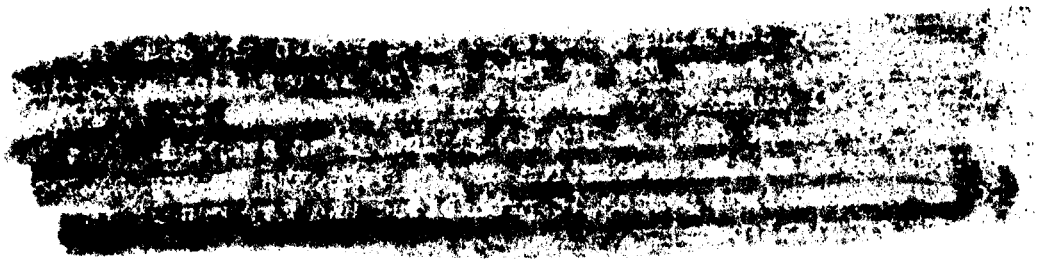

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ABSTRACT

Static corrosion tests were conducted with annealed 2S aluminum panels exposed to 5 percent borax solutions and 25 percent lead acetate solutions at room temperature. Corrosion attack was severe in the lead acetate solutions (1.7 mils/month) and less severe in sodium borate solutions (0.031 mils/month). In all cases, corrosion damage appeared to be the result of direct chemical attack and was generally of a uniform nature with very minor localized attack.

Water-line attack was studied by partial immersion of the specimens in the corroding media and was of minor consequence in the borax solutions but was very pronounced on the panels immersed in lead acetate.

Various organic-type protective coatings were employed to prevent corrosion attack on 2S aluminum by lead acetate solutions. Bakelite lacquer and Pruf-cote were found to be the most resistant.

TEST DATA

A) Samples and Preparation

The 2S aluminum used for the corrosion tests was in rectangular form of dimensions 1/8 x 1-1/4 x 2-1/2 inches. The samples were annealed at 245 °C.

This material had the following chemical analysis:

Silicon	0.25 percent
Iron	0.54
Copper	0.15
Aluminum	balance

Prior to exposure to the corrosive media the natural aluminum oxide film was removed from the metal by a 30 second immersion in 2 percent hydrofluoric acid. Specimens were then rinsed in alcohol, dried at 110 °C, and weighed. At the completion of the corrosion tests, adhering corrosion products and/or films were removed by a 20 minute immersion in a solution containing 5 percent phosphoric acid and 2 percent chromic acid at 50-55 °C. The specimens were washed in cold water, rinsed in alcohol, dried at 110 °C, and reweighed for determination of weight losses.

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Test solutions were made by dissolving the necessary quantities of commercially pure borax and lead acetate in demineralized water. The demineralized water had the following average composition:

	ppm
Dissolved CO_2	7.0
Dissolved solids	8.0
SiO_2	11.0
Fe	0.05
Al	0.06
Cu	0.02
Ca	0.14
Cl	0.28
SO_4	17.0
Na	1.8

All tests were conducted at 25-30 °C. The solution volume/specimen area ratio was 80 ml/cm^2.

The aluminum panels were exposed to the test solutions in three positions:

a) complete immersion
b) partial immersion (for water-line attack)
c) exposure to solution vapors

The exposure time for specimens exposed to the borax solutions was 1512 hours; the exposure time in the lead acetate solutions was 907 hours. The average pH of the sodium borate solutions was found to be 9.9.

All tests were run in duplicate and the following corrosion data was based on the average of the results obtained from duplicate specimens.

B) Sodium Borate Corrosion Tests

Sample position	Max.pit depth,mils	Pit count per sq.cm.	Wt.loss, mg./sq.dcm.	Penetration rate, mils/month
Complete immersion	2.0	0.3	442	0.31
Partial immersion	2.0	0.1	279	0.19
Vapor exposure	1.2	0.07	9	0.005

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Water-line attack was not pronounced and was on the same order of magnitude as attack on the specimens which were completely immersed.

In all cases, pitting attack was almost negligible and the specimens exhibited a uniformly etched appearance rather than an intensified localized attack.

C) Lead Acetate Corrosion Tests

Sample position	Pit count per sq.cm.	Wt. loss, mg./sq.dcm.	Penetration rate, mils/month
Complete immersion	neg.	1452	1.70
Partial immersion	neg.	866	0.90
Vapor exposure	neg.	7	0.008

Large, bulky masses of lead were deposited on the surfaces of the aluminum. This reaction was expected due to the relative positions of these two elements in the electromotive series. After the removal of the metallic lead, the sample surfaces showed severe uniform corrosion attack with very little pitting.

Water-line attack was very evident but corrosion damage at these points again appeared as a result of direct chemical attack. There was no pronounced localized corrosion attack at these areas.

D) Protective Coatings - Lead Acetate Corrosion Tests

Various types of protective organic coatings were applied to 2S aluminum panels and exposed to the 25 percent lead acetate solution. The specimens were completely immersed for 907 hours at 25 °C.

Protective coating	Final condition of coating	Wt.loss of 2S Al, mg./sq.dcm.	Penetration rate of 2S Al, mils/month
Bakelite	excellent	nil	nil
Pruf-cote	good	neg.	neg.
Pen-Kote	swollen	wt. gain	---
Zincilate	badly blistered	95	0.152

The first two materials exhibited very good protective properties. The last two materials were unsatisfactory since the coatings swelled and blistered badly.

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The Bakelite lacquer film was superior to the Pruf-cote film in offering the better resistance to attack by the lead acetate solution. This film remained completely unaffected during the exposure. The Pruf-cote film, although protective, showed signs of cloudiness and slight attack at the end of the test.

The Bakelite lacquer application consisted of three coats, allowing 4 hours for air-drying between coats. This procedure may be considerably shortened, depending upon the nature of the article being coated, by normal drying for 30 minutes followed by a 20 minute baking period at 275 °C for each coat.

CONCLUSIONS

From the results of this investigation, the following conclusions may be drawn:

1) Annealed 2S aluminum is rapidly attacked in 25 percent lead acetate solutions at room temperature and is less rapidly attacked in 5 percent borax solutions. Assuming corrosion attack as a linear function of time, penetration rates of 0.020 and 0.004 inches per year, respectively, were obtained.

2) Corrosion damage in both solutions was characterized by a uniform, direct chemical attack rather than an intensified localized attack.

3) Water-line attack was pronounced only in the case of exposure to the lead acetate solution.

4) Bakelite lacquer proved very effective in preventing corrosion attack on 2S aluminum exposed to 25 percent lead acetate solution.

James L. English

Oct. 30, 1943

Engineering Materials Section IV

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