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Summary

Protection of Heavy Metal Against Oxygen Pickup In Ordinary Atmospheres

One hundred and eight electroplated ^u~~tuballoy~~ specimens were exposed to outdoor atmospheric corrosion, ~~at Site B.~~ Twelve of the specimens showed evidence of tuballoy oxidation after ~~four~~⁴ months exposure. No appreciable changes in the weight or the physical appearance of the other specimens were observed. All of the failures were confined to ~~three~~ types of plates namely, composite ~~nickel-chromium~~^{Ni-Cr} composite ~~nickel-copper~~^{Ni-Cu}, ~~nickel~~^{Ni} and brass. Sixteen different types of plates were investigated. A number of electroplates appear to be satisfactory for the protection of ~~tuballoy~~ against ~~oxygen~~ pickup in ordinary atmospheres. /end

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Protection of Heavy Metal Against Oxygen Pickup in Ordinary Atmospheres

I. Introduction

There is some need for a method of protecting tuballoy against oxygen absorption when exposed to ordinary atmospheres. This program was authorized to investigate the suitability of electroplates as protective coatings. Methods requiring elaborate mechanical pretreatment or any treatment involving appreciable metal losses could not be used.

II. Preparation of the Specimens

Extruded reclaimed X size specimens were used for this work. A large percentage of the slugs had rough, defective surfaces.

During the pretreating cycle, end type racks with stainless steel pin point contacts were used. Side type racks were used for plating. The specimens were turned at frequent intervals during the plating process.

All the specimens were plated at the Grasselli Laboratory in Cleveland.

A. Pretreatment of Tuballoy

Of the 108 specimens plated, 96 were pretreated in trichloroacetic acid and 12 in phosphoric-hydrochloric acid mixture.

The following procedure was used for pretreating in trichloroacetic acid.

1. Degrease: (Anodic Treatment)
Solution - 80 grams/liter "Anodex" alkaline cleaner
Temperature - 80°C.
Time - 2 minutes
Current Density - 50 amps./ft.²
2. Running water rinse.
3. Nitric acid pickle: (immersion)
Solution - 35% HNO₃
Temperature - room
Time - 1 minute
4. Running water rinse.
5. Pretreatment: (Anodic treatment)
Solution - Trichloroacetic acid
15 gs./l. plus 20 cc./l.
conc. HCl
Temperature - 50-60°C.
Time - 5 minutes
Current density - 50 Amps./ft.²
6. Running water rinse.
7. Nitric acid pickle: (same as step 3 except that time was increased to 5 minutes).

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8. Running water rinse
9. Plating

The alternate pretreating procedure was the same as that outlined above except for the etching solution used in Step 5. A solution containing phosphoric acid (20 cc/liter) was used instead of the trichloroacetic acid solution.

Subsequent to the preparation of these specimens, more concentrated solutions of trichloroacetic acid were investigated⁽⁴⁾. The results of this study showed that a much better plate is obtained on tuballoy pretreated in a more concentrated solution.

B. Plating Solutions

The composition and operating conditions of the plating baths used for this work are described in the Manual of Commercial Operating Conditions for Plating on Tuballoy which will be issued shortly.

III. Exposure Conditions

The specimens were placed in specially constructed wooden racks located on the roof of Site B on July 1, 1944. The racks with specimens in place are shown in Figure 1.

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TABLE I
ATMOSPHERIC CORROSION

<u>No.</u>	<u>PLATE</u>	<u>PRETREATMENT</u>	<u>OBSERVATIONS</u>
6	0.001" Zn	C Cl ₃ COOH	No evidence of failure
2	"	H ₃ PO ₄ -HCl	No evidence of failure
6	0.001" Cd	CCl ₃ COOH	No evidence of failure
6	0.003" Cu	CCl ₃ COOH	No evidence of failure
6	0.003" Ni	"	No evidence of failure
2	"	H ₃ PO ₄ -HCl	No evidence of failure
6	0.003" Cr	CCl ₃ COOH	No evidence of failure
6	0.001" Ni-0.001" Zn	"	No evidence of failure
2	" "	H ₃ PO ₄ -HCl	No evidence of failure
6	0.001" Cu-0.001" Zn	CCl ₃ COOH	No evidence of failure
2	" "	H ₃ PO ₄ -HCl	No evidence of failure
6	0.001" Ni-0.001" Cd	CCl ₃ COOH	No evidence of failure
2	" "	H ₃ PO ₄ -HCl	No evidence of failure
6	0.001" Cu-0.001" Cd	CCl ₃ COOH	No evidence of failure
2	" "	H ₃ PO ₄ -HCl	No evidence of failure
6	0.001" Cu-0.001" Pb	CCl ₃ COOH	No evidence of failure
6	0.001" Cu-0.002" Pb	"	No evidence of failure
6	0.001" Ni-0.001" Cr	"	All of the specimens showed pit type of corrosion
6	0.001" Cu-0.001" Ni	"	No evidence of failure
6	0.001" Ni-0.001" Cu-0.001" Ni	CCl ₃ COOH	5 of the specimens showed peeling of the plate at the ends.
6	0.001" Sn*	"	No evidence of failure
6	0.001" Brass*	"	One specimen showed pit type of corrosion.

* Placed in test one month later than the other specimens.

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V. Observations

The specimens were photographed and weighted (accuracy ± 0.05 g.) before being placed in test. After four months exposure, the specimens were closely examined, re-photographed and re-weighted.

The balance used for weighing the specimens was not sufficiently accurate to detect the small changes in weight (probably < 0.1 g) which may have occurred during the testing period.

In general, the specimens showed little change in physical appearance. Typical specimens are shown in Figure 2. The photograph shown in Figure 2A was taken before the specimens were placed in test. Figure 2B shows the same three slugs after four months exposure. Figure 3 shows the before and after appearance of specimens that failed.

As indicated in Table I, 12 of the 108 specimens subjected to the test showed evidence of base metal oxidation after four months exposure. These failures were limited to three of the sixteen types of plates studied. Failure of the composite Ni-Cr plates was probably due to strains produced in the relatively thick chromium overplates. In the commercial production of composite plates of this type, very thin chromium plates (usually 0.0001") are used in order to minimize this tendency. Incomplete coverage of rack marks and flaws in the surface of the tuballoy are also likely causes for some of the observed failures.

All the specimens were returned to the racks for further exposure. Results of the examination, to be made three months hence, will be reported under the electroplating authorization.

The results of this study show that a variety of electroplates appear to be satisfactory for the protection of tuballoy against oxygen pickup in ordinary atmospheres.

References:

1. CT-1793 - Pictures of the various racks are shown in this report.
2. CT-1793, CT-2443 - Pretreating solutions are discussed in these reports.
3. CT-1937
4. CT-2443
5. Note Books # 859-B and 362-B

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After Exposure - Macro 1373

Before Exposure - Macro 711

Figure 2

The above specimens showed no evidence of failure after four months exposure.

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Before Exposure - Macro M-708

After Exposure - Micro 1368

Figure 3

The above specimens failed after four months exposure.