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O T T A W A

May 28, 1945.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1877.

Corrosion Resistance of Copper Sleeves
for Bilge Pumps for Phoenix Steel
Nesting Barges S/4.

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Background:

A letter dated May 9, 1945, was received from Mr. H. B. Percival, for the Transport Controller, Department of Transport, Montreal, Quebec, requesting that corrosion tests be performed on samples of copper cut from sleeves for bilge pumps for Phoenix steel nesting barges S/4. These samples, sheets 4 inches by 5 inches in size, were furnished by Mr. Percival.

According to the request letter,^o "the cases of

^o File Nos. 79-4-B-6F and 79-4-P-5.

(Background, cont'd) -

pumps will likely be transported and stored under the following conditions:

- (a) Temperatures ranging from 25° F. below zero to 110° F. above.
- (b) Humidities ranging up to at least 95 per cent at high temperatures.
- (c) In salt air and fresh water air conditions.
- (d) In areas where changes in temperatures will be rapid and frequent.
- (e) The period of storage would vary considerably. The average period would be for at least 10 months.
- (f) The storage will sometimes be in heated buildings and sometimes in unheated buildings. However, most of the storages will be outside in tropical salt air areas, and the only protection will be the cases themselves plus the waterproof paper over the pumps in the cases."

TESTS PERFORMED:

In order to obtain information regarding the effect of various factors mentioned above on the copper sleeves, the following tests were performed:

Test No. 1.

One sample of copper was placed in the Humidity Cabinet for 6 days at 120° F. and 95 to 100 per cent relative humidity with air passing through.

Result:

The sample changed very little during this test. Figure 1 shows the somewhat tarnished appearance of the sample both before and after the test. At the lower right-hand corner the surface was rubbed with emery cloth to

(Tests Performed, cont'd) -

expose the fresh copper underneath the tarnish.

Test No. 2.

One sample of copper was cut into two halves. These were placed in the Weather-Ometer for $7\frac{1}{2}$ days at 130° F. They were exposed continuously to light, resembling sunlight, produced by an electric arc, and for three minutes out of every twenty they were sprayed with ordinary tap water.

Result:

The tarnish became somewhat darker. Otherwise there was no evidence of corrosion. Figure 2 shows the appearance of the surfaces at the end of the test. Here again, the surface was rubbed with emery cloth at the lower right-hand corner to expose the fresh copper underneath the tarnish.

Test No. 3.

One sample of copper was given the Intermittent Immersion Corrosion Test, using 20 per cent salt (sodium chloride) solution at a temperature of about 95° F. The test lasted 7 days.

Result:

The sample was corroded considerably and the surface became covered with a green corrosion product (see Figure 3). The corrosion product was removed from one corner as before.

Figure 4(c) shows the amount of corrosion product that collected at the bottom of the container during the test.

Test No. 4.

One sample of copper was given the Intermittent Immersion Test, using 3 per cent salt (sodium chloride) solution at about 95° F. This test lasted 10 days.

Result:

There was a certain amount of corrosion, as shown in Figure 5. The amount of corrosion product which settled

(Tests Performed, cont'd) -

to the bottom of the container is shown in Figure 4(b). It is apparent that the rate of corrosion was less than when 20 per cent salt solution was used.

Test No. 5.

One sample of copper was given the Total Immersion Test in 3 per cent salt (sodium chloride) solution at about 95° F. This test lasted 10 days.

Result:

There was a certain amount of corrosion as shown in Figure 6. The amount of corrosion product which settled to the bottom of the container is shown in Figure 4(a). The rate of corrosion in this test was somewhat less than that in the Intermittent Corrosion Test in which 3 per cent salt solution was used.

Test No. 6.

One sample of copper was placed in the Salt Spray Test for 10 days. In this test it was exposed to the spray from a 20 per cent salt (sodium chloride) solution at 95° F.

Result:

There was considerable corrosion under these conditions, as shown in Figure 7.

Conclusions:

1. The effect on the samples of high humidity, ordinary water and sunlight is not appreciable even at temperatures as high as 130° F. The only change in the copper surface due to these factors is a slightly heavier tarnish, which probably would be no disadvantage for the present purpose.
2. The samples are appreciably corroded by either intermittent or total immersion in salt solution or by the

(Conclusions, cont'd) -

spray from a salt solution.

3. Twenty per cent salt solution causes more corrosion than a 3 per cent salt solution. In actual service there undoubtedly will be times when sea water (which normally contains 2.5 per cent sodium chloride) evaporates until it becomes quite concentrated.

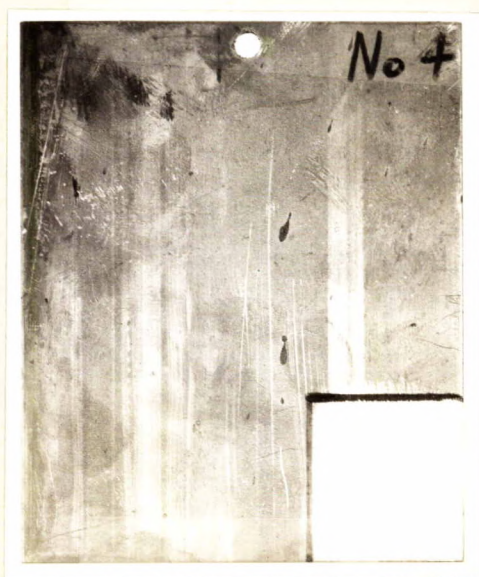
4. It is anticipated that corrosion would be less rapid at the lower temperatures than at the higher temperatures.

5. The effect of fluctuating temperatures on this type of material would be much less than on paints or other organic coatings.

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Figure 1.



SAMPLE OF COPPER AFTER 6 DAYS IN
THE HUMIDITY CABINET.

Tarnish was removed with emery cloth
at the lower right-hand corner.

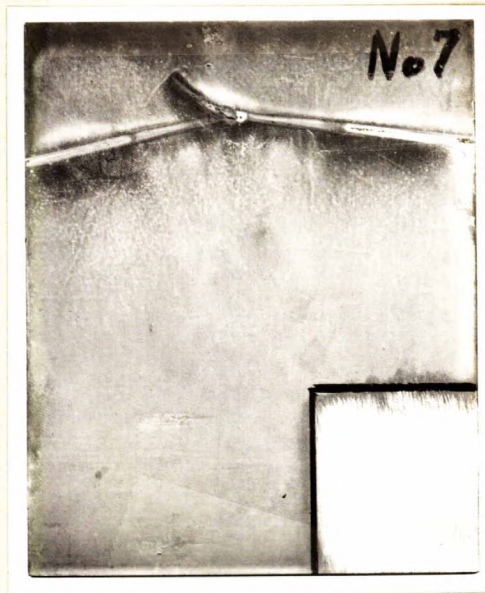
Figure 2.



SAMPLES OF COPPER AFTER 7½ DAYS IN
THE WEATHER-OMETER.

Tarnish was removed with emery cloth at
the lower right-hand corner of each sample.

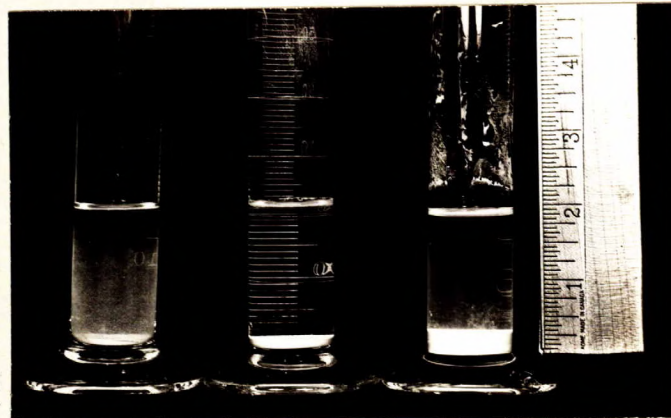
Figure 3.



SAMPLE OF COPPER AFTER 7 DAYS IN THE
INTERMITTENT IMMERSION CORROSION TEST
USING 20 PER CENT SALT SOLUTION.

Tarnish was removed with emery cloth
at the lower right-hand corner.

Figure 4.



(a) (b) (c)

PHOTOGRAPH SHOWING THE AMOUNT OF
CORROSION PRODUCT PRODUCED IN

- (a) THE TOTAL IMMERSION TEST (3 per cent
Salt Solution).
- (b) THE INTERMITTENT TEST (3 per cent
Salt Solution).
- (c) THE INTERMITTENT TEST (20 per cent
Salt Solution).

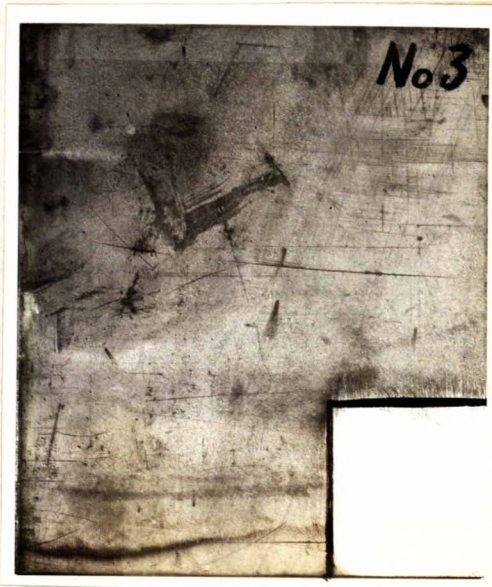
Figure 5.



SAMPLE OF COPPER AFTER 10 DAYS IN THE
INTERMITTENT IMMERSION CORROSION TEST
USING 3 PER CENT SALT SOLUTION.

Tarnish was removed with emery cloth
at the lower right-hand corner.

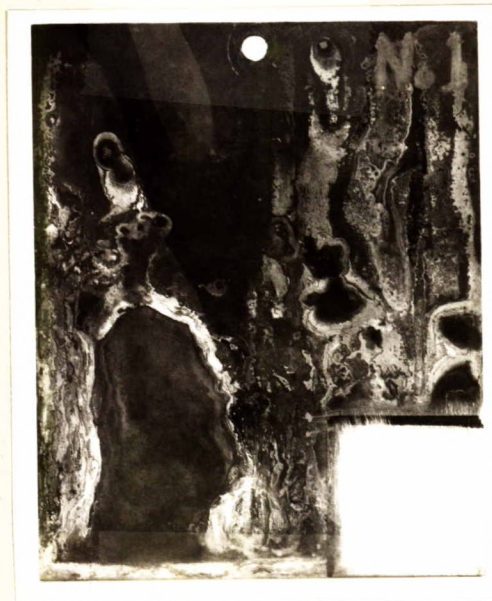
Figure 6.



SAMPLE OF COPPER AFTER 10 DAYS IN THE
TOTAL IMMERSION CORROSION TEST USING
3 PER CENT SALT SOLUTION.

Tarnish was removed with emery cloth
at the lower right-hand corner.

Figure 7.



SAMPLE OF COPPER AFTER 10 DAYS IN THE
SALT SPRAY CORROSION TEST, USING 20
PER CENT SALT SOLUTION.

Tarnish was removed with emery cloth
at the lower right-hand corner.

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