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MINERAL DRESSING AND PROCESS METALLURGY
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MINES BRANCH INVESTIGATION REPORT IR-58-135

CORROSION OF STAINLESS STEEL TYPE 316L IN ALKALINE SOLUTIONS APPROACHING IN COMPOSITION THOSE USED IN GRINDING AND LEACHING URANIUM ORE

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Chemical Metallurgy Section

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CORROSION OF STAINLESS STEEL TYPE 316L IN ALKALINE SOLUTIONS APPROACHING IN COMPOSITION THOSE USED IN GRINDING AND LEACHING URANIUM ORE

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Irvine I. Tingley* and R. R. Rogers**

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SUMMARY OF RESULTS

Specimens of stainless steel, Type 316L (extra low carbon) were tested in alkaline solutions approaching in composition those used in the grinding and leaching of uranium ore. Such solutions have produced severe corrosion in mild steel. No corrosion of the stainless steel took place in tests of 183 days' duration.

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INTRODUCTION

Experiments on the corrosion of mild steel in alkaline solutions, approaching in composition those used in the grinding and leaching of uranium ore at the Beaverlodge operation of Eldorado Mining and Refining Limited, were reported previously in M.D. Test Report No. 921-CM, dated December 31, 1957. When this series of experiments was arranged, it was agreed that similar work would be done using stainless steel Type 316L (extra low carbon). A formal request covering this work was received on Sept. 20, 1957. The present report describes the experiments which were performed.

APPARATUS

The test specimens were made from stainless steel Type 316L sheet obtained from a well-known distributor. This steel was quite similar in composition to that used in clad form at the Beaverlodge plant, except that its carbon content was somewhat lower and its molybdenum content considerably higher. The analyses of the two materials are given in Table 1. It is believed that the metal used in these experiments would be superior to that in the clad material due to its lower carbon and higher molybdenum contents.

Table 1

Analyses of Stainless Steel Type 316L Materials

Source of Material	Percentages			
	C	Cr	Ni	Mo
Cladding from Beaverlodge	0.06	17.93	13.26	2.26
Metal Distributor	0.02	17.82	13.41	2.84

The stainless steel sheet was 0.050" thick. The specimen dimensions follow: 24 pieces, 1" x 2"; 24 pieces, 1" x 3½"; and 24 pieces, 1" x 5½", (bent at a right angle to give a horizontal portion 1" x 2" and a vertical position 1" x 3½"). Each specimen in the first two groups had a 1/16" hole drilled through it to permit suspension in the solution, which was done with saran thread.

Two specimens of each size were tested in each of the following solutions:

(1) 125 g/liter sodium sulphate (Na_2SO_4), 40 g/liter sodium carbonate (Na_2CO_3), and 5 g/liter sodium bicarbonate ($NaHCO_3$) with a pH of 10.00;

(2) Same as No. (1) but with 2.94 g/liter sodium chloride (NaCl) added;

(3) 125 g/liter sodium sulphate (Na_2SO_4), 26 g/liter sodium carbonate (Na_2CO_3), and 18 g/liter sodium bicarbonate ($NaHCO_3$), with a pH of 9.50;

(4) Same as (3) but with 2.94 g/liter sodium chloride (NaCl) added;

(5) 125 g/liter sodium sulphate (Na_2SO_4), and 37.8 g/liter sodium bicarbonate ($NaHCO_3$), with a pH of 7.60;

(6) Same as (5) with 2.94 g/liter sodium chloride (NaCl) added;

(7) 60 g/liter sodium sulphate (Na_2SO_4), 60 g/liter sodium carbonate (Na_2CO_3), and 20 g/liter sodium bicarbonate ($NaHCO_3$) with a pH of 9.80;

(8) Same as (7) but with 2.94 g/liter sodium chloride (NaCl) added;

(9) 60 g/liter sodium sulphate (Na_2SO_4), 67.7 g/liter sodium bicarbonate ($NaHCO_3$), adjusted with sodium hydroxide (NaOH) to a pH of 9.50;

(10) Same as (9) with 2.94 g/liter sodium chloride (NaCl) added;

(11) 60 g/liter sodium sulphate (Na_2SO_4), and 67.7 g/liter sodium bicarbonate ($NaHCO_3$) with a pH of 8.00;

(12) Same as (11) but with 2.94 g/liter sodium chloride (NaCl) added.

PROCEDURE

The burrs were filed from one of the specimens to be used in each type of solution, then all specimens were degreased in hot trichlorethylene vapour. Finally, they were passivated in 25% nitric acid solution at 120°F to 125°F for 20 minutes, rinsed in distilled water, dried, and weighed. The 1" x 2" specimens were totally immersed in the corroding solutions, the 1" x 3½" ones partially immersed with ½" above the air-solution interface, and the L-shaped specimens were also partially immersed, with ½" of the vertical portion above the interface. The horizontal portions of these L-shaped specimens were covered to a depth of ¼" by finely divided uranium ore. Twelve of them were placed in 400-ml. beakers like the unbent specimens, and the other twelve were placed in wide-mouthed 500-ml Erlenmeyer flasks, with air bubbling continuously through the solution.

The unbent specimens were left on test for 183 days, and the L-shaped specimens for 137 days. At the end of the test the specimens were removed, washed in running water while brushing with a bristle brush, rinsed with distilled water, dried, and weighed. They then were cleaned by immersion in 25% nitric acid solution for 20 minutes at 120°F, rinsed, dried, and weighed again.

RESULTS

All unbent specimens, tested in the solutions containing no solid material, were unchanged from their original appearance after being brushed and washed at the end of the test. No weight loss had taken place. The L-shaped specimens tested in high sulphate solutions of pH 7.80 and low sulphate solutions of pH 8.00, with uranium ore covering the horizontal portions, showed slight stains on the top two inches of the immersed portions, and slight weight

gains on the first weighing. However, these stains disappeared immediately upon immersion of the specimens in the 25% nitric acid solution, and the specimens no longer showed an increase in weight. This seems to indicate that the stains were not a product of corrosion, but consisted of material derived from the ore.

CONCLUSION

This investigation showed that stainless steel Type 316L, of the second analysis shown in Table 1, is not corroded by the alkaline solutions under the conditions prevailing in this investigation. Under similar conditions these solutions were found, in the earlier investigation, to corrode mild steel severely. These solutions approached in composition the grinding and leaching solutions used in the Beaverlodge project.

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