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Corrosion Reduction of Aluminum Alloys in Flowing High-Temperature Water

A report has been presented which describes a technique for reducing the corrosion rate of aluminum by the addition of colloidal substances in a closed-loop system. Experimental work showed that the addition of graphite and colloidal hydrated aluminum oxide significantly reduces the corrosion rate in 260°C water flowing at 7 m/sec.

Aluminum alloys have been developed that show good resistance to corrosion by static high-temperature (≤360°C) water; but the corrosion rate of these alloys rises substantially when a rapid flow of water is maintained past the surface.

Previous work had indicated that, under static conditions, cracks or pores in the corrosion product were plugged by a rapidly coagulating and depositing colloid. The normal source of this colloid was postulated to be the precipitation of a soluble aluminum species emerging from the cracks in the oxide film.

In this study it was assumed that the increased corrosion of aluminum alloys in rapidly flowing, high-temperature water is related to the difficulty of precipitating the colloidal corrosion products within the cracks. Predictions based on this hypothesis were experimentally tested.

A series of experiments on Type 8001 aluminum showed that colloidal graphite and colloidal hydrated aluminum oxide could significantly reduce the corrosion rate in 260°C water flowing at 7 m/sec. Corrosion rates approximating those obtained in static tests were achieved in the hydrated aluminum oxide colloid solution.

Complexing the soluble form of the corrosion product to prevent precipitation resulted in higher corrosion rates in a dynamic system, but not in refreshed static systems. The complexing agents did modify initial corrosion behavior in static systems.

The total corrosion for one week in flowing 260°C water varied with small applied currents, increasing when the sample was made the cathode, and decreasing when made the anode.

Arsenic trioxide solution also gave promise of being an effective corrosion inhibitor for high-temperature corrosion of aluminum in flowing water.

The primary alloy chosen for this investigation was Type 8001 aluminum (0.89 w/o Ni, 0.48 w/o Fe, 0.13 w/o Cu, 0.11 w/o Si). The metal loss was measured by an eddy-current gauge. The amount of unreacted metal remaining in corroded specimens was also determined by a destructive technique. A corroded sample was weighed, and its remaining metal dissolved in a methanol iodine solution. Collecting and weighing the undissolved corrosion product made it possible to calculate the metal weight by difference.

The test loops of stainless steel used canned-rotor centrifugal pumps to maintain the rapid flow of solution past the samples at 5.5 or 7 meters/second. Refreshing water or solution was pumped through the equipment at a rate 1.5 liters/hr. A 260°C temperature was chosen.

Notes:

1. The report includes a complete discussion of the experimental procedure and the results.
2. This information may be of interest to metallurgists.
3. Additional information may be found in "Corrosion of Aluminum Alloys by Flowing High-Temperature Water," ANL-7227, January 1967, by J. E. Draley and W. E. Ruther of the Metallurgy Division, Argonne National Laboratory, Argonne, Illinois. The report is available from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Va. 22151; price: $3.00 (microfiche $0.65).

4. Inquiries concerning this report may be directed to:

   Office of Industrial Cooperation
   Argonne National Laboratory
   9700 South Cass Avenue
   Argonne, Illinois 60439
   Reference: B69-10029

Source: J. E. Draley and W. E. Ruther,
Metallurgy Division
Argonne National Laboratory
(ARG-10244)

Patent status:

Inquiries about obtaining rights for commercial use of this innovation may be made to:

Mr. George H. Lee, Chief
Chicago Patent Group
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9800 South Cass Avenue
Argonne, Illinois 60439