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Erosion-Corrosion of Aluminum Alloys in Sea Water Environment

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Summary

Aluminum alloys are used as heat exchangers in air separation plants that are operated at cryogenic temperature, including ethylene plants, liquefaction gas plants and gas vaporization plants, because of their excellent mechanical properties at lower temperature, high heat transfer properties and economical performance. Damage by corrosion is not apparent in an air separation plant, since the fluid processed in the plant is relatively clean. Heat sources such as air, hot water and seawater are used in a gas vaporization plant depending on the environment and the scale of the plant. Seawater is used as a heat source in a large-scale gas vaporization plant in close proximity to the coast, and corrosion that occurs on the surface of the seawater side of the heat exchanger in the plant must be prevented.

A new type of jet-in-slit testing apparatus for a specimen chilled by a peltier element was developed, and corrosion tests and polarization measurements were carried out at various temperatures in artificial seawater under flowing conditions. The effect of chilling the specimen on corrosion was investigated. The surface appearance and cross-sectional profiles of a specimen after the test were observed and corrosion tests at various flow velocities were conducted to define the type of corrosion that occurs. Corrosion tests on a cathodically polarized specimen were conducted under flowing seawater at various temperatures to evaluate the effect of cathodic prevention.

The following results were obtained. The effect of chilling by the peltier element was apparently the same as the corrosion behavior in a solution 5˚C lower than the temperature of the solution in this apparatus. No unusual corrosion by chilling the specimen was found. As the temperature of the solution became lower, corrosion damage to the specimen decreased. This was caused by the formation of an excellent passive film against corrosion at lower temperatures. Corrosion damage to an aluminum alloy increased with increasing flow velocity of seawater at 30˚C, and a breakaway velocity was recognized, therefore, damage occurring at 30˚C is “Erosion-corrosion”. The extent of corrosion damage at lower temperatures was very low, and it was not affected by flow. A corrosion test of a specimen polarized at -1000 mV was carried out under flowing seawater, and the corrosion was accelerated at temperatures below 25˚C. This is because a passive film could not be formed on a specimen by cathodic polarization.

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