No. 07A2-09A2

Flow-Induced Corrosion of Copper Alloys in a High Salt Concentration Environment

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Summary

Salt production plants have severe corrosive conditions with solutions of high salt concentration flow causing intense corrosive damage to equipment and pipes. To avoid the corrosion damage, stainless steels and copper alloys, which generally have anti-corrosion properties, have been used for the component materials of the plants. However, it has been reported that corrosion damage occurs in the heat transfer tubes of heat exchangers. When considering the durability of copper alloys in a high salt concentration environment, it is important to know how the corrosion products film formed on their surface will be affected by temperature and dissolved oxygen in solution. The corrosion in plants largely depends on hydrodynamic conditions in fluid, and is accelerated by the fluid's shear force and turbulence. The corrosion products film would be broken away due to impact of salt particles in a higher salt concentration environment.

In the present study, flow-induced corrosion tests for copper alloys, brass (C2801), free-cutting brass (C3604), naval brass (C4641) and cupronickel (C7060, C7150), were carried out in a high salt concentration environment. A jet-in-slit corrosion testing apparatus was used. The effects of salt concentration and temperature in a test solution were investigated. Flow-induced corrosion tests were conducted in a NaCl solution from 1 to 10 wt% at a temperature of 40 to 100 ˚C. The surface conditions of the specimens after corrosion test were observed using SEM. A slurry testing apparatus was developed in order to investigate damage behavior of copper alloys in salt slurry solution. The slurry tests of cupronickel (C7060, C7150) were carried out in slurry solution from 10 to 60 wt% at a temperature of 20 to 80 ˚C.

The following results were obtained. Brass and naval brass were damaged during intense flow in flow-induced corrosion test. When the temperature of the solution increased, the corrosion damage increased. The corrosion damage of cupronickel was quite low compared with damages of brass and naval brass, although the color change of surface was observed. The order of anti-corrosion properties of these copper alloys is C7150 > C7060 > C2801 > C4641. The operating condition of slurry testing apparatus was determined and salt particles were impacted at narrow angle in the apparatus. The damage of cupronickel in salt slurry increased, when the temperature, salt concentration or velocity of the solution increased. Damages of two types of cupronickel (C7060, C7150) in salt slurry was almost the same. It was suggested that the properties of the film formed on the material surface were related to the corrosion damage.