The NaCl-Induced Atmospheric Corrosion of Aluminum; the Influence of Carbon Dioxide and Temperature

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Recently it was reported that the NaCl-induced atmospheric corrosion of aluminum is suppressed by ambient concentrations of CO_2 [1]. At 22°C and 95% RH the corrosion rate was 10-20 times slower in the presence of carbon dioxide compared to CO_2-free air. It was argued that conditions with little or no CO_2 present might occur during the atmospheric corrosion of aluminium, e.g., in crevices.

In the present work the influence of carbon dioxide on the NaCl-induced atmospheric corrosion of aluminum (AA 1070) is investigated at different temperatures. Polished samples are exposed to purified air (95± 0.3 % RH) at 4, 10, 22, 38, 50 and 60°C during 4 weeks.

The exposures are carried out in the presence of 350 ppm CO_2 or in the absence of CO_2. Before exposure, 14 and 70 mg/cm^2 of NaCl was added by spraying an 80/20 ethanol/water solution saturated with NaCl. The corrosion products are investigated by a combination of X-ray Diffraction, Optical Microscopy, Environmental Scanning Microscopy, and Ion-Chromatography.

At 4°C the NaCl-induced corrosion of aluminium is very slow, irrespective of whether CO_2 is present or not. At 10, 22 and 38°C, the corrosion rate in the absence of CO_2 is 5 -20 times higher than in air containing 350 ppm CO_2. Moreover, corrosion attack in the absence of CO_2 was strongly localized while the corrosion in the presence of CO_2 was relatively uniform. It is suggested that the rapid corrosion in the absence of CO_2 is connected to the evolution of high pH areas at the cathodic sites. In these areas the passive film dissolves in the form of aluminate, $Al(OH)_4^-$ [2]. This causes thinning of the passive film and an enhanced corrosion. The corrosion-inhibitive effect of CO_2 is explained by neutralization of the surface electrolyte. In the absence of CO_2, bayerite, $Al(OH)_3$, forms. Only minute amounts of carbonate were found on the surface after exposure to CO_2-containing air.

Above 38 °C, the corrosion rate in the presence of CO_2 increases rapidly with temperature. The corrosion rate in CO_2-free conditions is fairly constant with temperature above 38°C. At 60 °C the rate of corrosion in air with 350 ppm CO_2 and in CO_2-free air is the same.

References

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2. H. Kaeshe in *Passivity of Metals*, R.P. Frankenthal and J. Kruger, Editors, p. The Electrochemical Society, Inc. p. 935 Princeton (1978).