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Study on Synergy Effect of Corrosion Inhibitor and Metal Cation on Metals Corrosion

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Summary

It was reported that corrosion rate of steel inhibited as gluconate ions in model fresh water, and it suppressed more coexistence of Zn^{2+}. The increasing corrosion inhibition ability of gluconate ions by Zn^{2+} may be attributed to reduce the defects in the protective film of gluconates on steel. However, metal cation effect on inhibition ability of corrosion inhibitor is not clarify. In this study, the influence of metal cations on the ability of gluconates to inhibit corrosion of mild steel in a model fresh water, and corrosion behavior of aluminum alloy in model sea water containing gluconates and zinc ions were investigated. For these purpose, immersion test, electrochemical impedance spectroscopy (EIS) and surface observation and analysis with SEM and X-ray photoelectron spectroscope (XPS) were carried out.

The solutions used to investigate are model fresh water and model sea water. Three different solutions: 1 mol m^{-3} NaCl with 1 mol m^{-3} sodium gluconate (NaG), 1 mol m^{-3} NaCl with 0.5 mol m^{-3} calcium gluconate (CaG), and 1 mol m^{-3} NaCl with 0.5 mol m^{-3} zinc gluconate (ZnG), were used as the model fresh water. For electrochemical impedance measurement, 0.5 kmol m^{-3} H_3BO_3 - 0.05 kmol m^{-3} $Na_2B_4O_7$ (borate) was added to each solution as a supporting electrolyte. For different solutions: 0.6 kmol m^{-3} NaCl (NaA), 0.598 kmol m^{-3} NaCl + 1 m kmol m^{-3} $ZnCl_2$ (ZnA), 0.6 kmol m^{-3} NaCl + 10 mol m^{-3} sodium gluconate (NaG), 0.598 kmol m^{-3} NaCl + 10 mol m^{-3} sodium gluconate + 1 mol m^{-3} $ZnCl_2$ (ZnG) were used as the model sea water.

From immersion tests, the corrosion inhibition of gluconates with mild steel and aluminum alloy is improved by metal cations that have large Y values in the model solutions. Surface and cross-sectional SEM results showed that zinc ions suppress the morphology changes of aluminum alloy in model sea water with gluconates. XPS analyses indicated that gluconates in the solutions adsorb on the oxide films of aluminum alloy and protective films of the adsorbed gluconates would prevent the penetration of chloride ions to the aluminum alloy. From XPS analysis, gluconate ligands can adsorb on metals and metal cations that have large Y can bond to metals in the model fresh water. Metal cations that have large Y values may decrease the defect incidence in the protective film of gluconates on mild steel in the model fresh water.