Analysis of Influencing Factors on the Galvanic Corrosion in a Salt Making Plant

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Summary

Salt making environment is counted as one of the most corrosive media. Highly corrosion resistant materials such as titanium and titanium–palladium alloy are being adopted in a modern salt making plant especially for an evaporator. However, some parts of the plant are still composed of conventional materials such as stainless steels and nickel based alloys. Therefore some of those conventional materials are suffering from galvanic attack due to insufficient insulation. Several factors should be taken into account to predict and control the galvanic effect, e.g. anodic polarization, cathodic polarization, area ratio, isolation resistance, solution resistance etc. But almost no data is available as to the electrochemical behavior of those materials in a concentrated brine at elevated temperatures. The goal of this study is to provide the salt making plant with electrochemical data under evaporating condition so that an adequate control of galvanic corrosion could be achieved.

Corrosion potentials and anodic polarization behavior of Inconel, Hastelloy and Monel were evaluated. Among those metals, Monel showed the most negative corrosion potential and smallest anodic polarization resistance. This means that Monel is most sensitive to galvanic effect with titanium. The corrosion potential of titanium and titanium-palladium alloy, which started from rather negative region, shifted to nobler values with immersion time. The cathodic polarization resistance became larger with the shift of corrosion potential to nobler direction. When Monel was coupled to titanium with identical surface area, the galvanic current density was of the order of 10^{-6} A/cm^{-2}. The coupling current was controlled by the large polarization resistance of titanium of the order of 10^{5} Ω cm^{2}. But the apparent polarization resistance could be reduced by the increase of cathodic area ratio to that of anode, resulting in a large coupling current. The pore anodic polarization resistance of Monel was accounted for by the XPS depth profile of surface films which showed incorporation of chloride and magnesium ions to a significant level.