Rapid Discovery of New Corrosion Inhibitors using Combinatorial Methods

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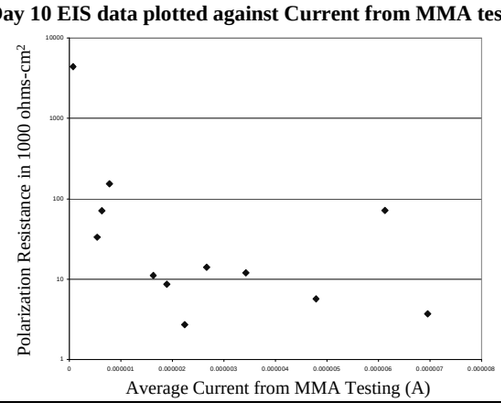
The current method of inhibiting corrosion of aluminum alloy skins present on military aircraft involves the use of chromate-based compounds in the primer. Chromate performs superbly as a corrosion inhibitor but is accompanied by increased costs of handling due to toxicity and potential hazards to environment and health. To date, no single inhibitor has been discovered with inhibiting efficiency comparable to that of chromate. A promising alternative to the use of a single inhibitor species is that of using synergistic combinations of two or more compounds. Synergies between inhibitors at appropriate concentrations may provide inhibiting efficiency comparable to that of chromate.

Since the effectiveness of synergistic combinations depends greatly on the ratio of the compounds, a rapid method of assessing these combinations of inhibitors is needed. Although there are various ways to assess inhibitor effectiveness electrochemically, there are no specified electrochemical parameters that can be rapidly acquired in the laboratory to predict long-term corrosion protection. This paper presents an experimental method in use to rapidly screen for effective inhibitor compounds and combinations of inhibitor compounds.

The method employed for rapid inhibitor assessment is the DC polarization of AA2024 wires 100 mV with respect to each other under the control of a multichannel microelectrode analyzer, or MMA. Two electrodes, AA 2024 wire, were placed in a well containing 2 mL of solution. The current passed between the wires is recorded using a zero resistance ammeter. Our reaction frame consisting of 50 cells containing 2 electrodes each may be tested simultaneously using the MMA.

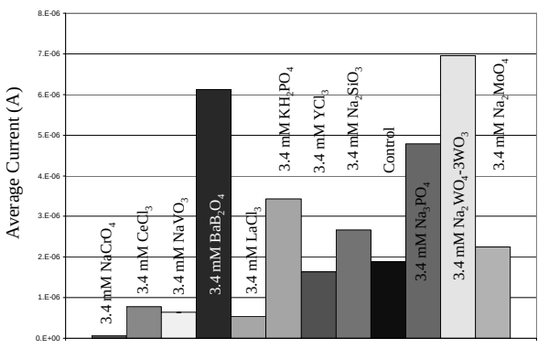
Inhibitors and combinations were tested at various ratios of the inhibiting compounds and at varying pH. Current measured from the MMA testing correlated with the EIS testing of the same inhibitor solutions. The correlation between MMA and EIS testing is shown in the figure in the next column.

Day 10 EIS data plotted against Current from MMA tests



Evaluation of individual inhibitor compounds in 0.6 M NaCl and 3.4 mM inhibitor is shown in the figure below.

Average Current of 3.4 mM inhibitor, 0.6 M NaCl solutions



Synergies found between inhibitors using the MMA testing were examined in more detail to determine surface interactions on the AA2024 responsible for reducing corrosion. Inhibiting efficiencies of synergies discovered thus far are shown in the figure below.T

Inhibitor Efficiencies of Individual Compounds and Combinations