Effect of Nitrate on the Critical Potentials of Alloy 22 in Chloride Containing Environments.

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The study of Alloy 22 has been undertaken in several selected nitrate/chloride (NO_3^-/Cl^-) electrolytes. These electrolytes include chloride concentrations [Cl^-] of 1.0, 3.5 and 6.0 molal with NO_3^-/Cl^- ratios of 0.05, 0.15 and 0.5 at various temperatures.

Alloy 22 maintains its passivity in most industrial environments. As a result, it is highly desirable for numerous industrial applications including underground waste disposal systems. Alloy 22 possesses remarkably low general corrosion rates. It has exceptional resistance to localized corrosion including environmentally assisted cracking [1-7]. Alloy 22 (N06022) is a nickel (Ni)- alloy and contains 22% chromium (Cr), 13% molybdenum (Mo), 3% tungsten (W) and about 3% iron (Fe).

The goal of this study was to determine the levels of NO_3^- required for effective inhibition of crevice corrosion in Alloy 22. To achieve this, carefully designed statistical test matrixes covering the selected range of Cl^- compositions and temperatures were employed in carrying out the experiments. Specimens for these experiments were in the form of multiple crevice assemblies (MCA), optimized with 24 artificial potential crevice sites. Tests used in this investigation included open circuit potential monitoring, polarization resistance, and cyclic polarization experiments. Potentiostatic polarization tests were also employed.

Results showed that the crevice breakdown and repassivation potentials increased with increase in NO_3^-/Cl^- ratio and decreased with increase in temperature (Figure 1). The absolute [Cl^-] concentration was found to have less of an effect on these critical potentials (Figure 2) compared with temperature and the NO_3^-/Cl^-.

Regression analyses were carried out and expressions were derived to describe the relationship between the critical potentials, temperature, [Cl^-] and [NO_3^-] for the conditions tested. Figure 3 is a 3-D plot of the repassivation potential as a function of [Cl^-] and [NO_3^-] at 100 °C. The surface is derived from the regression analyses. Included in Figure 3 are experimental data points from the environments tested at 100 °C (with [Cl^-] of 1.0, 3.5 and 6.0 molal and [NO_3^-/Cl^-] ratio of 0.05, 0.15 and 0.5).

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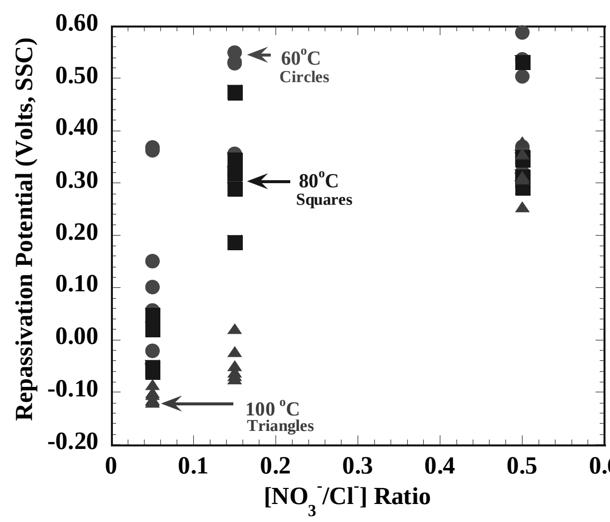

Figure 1. The repassivation potential as a function of [NO_3^-/Cl^-] ratio at [Cl^-] of 1.0, 3.5 and 6.0 molal, and temperatures of 60, 80 and 100 °C.

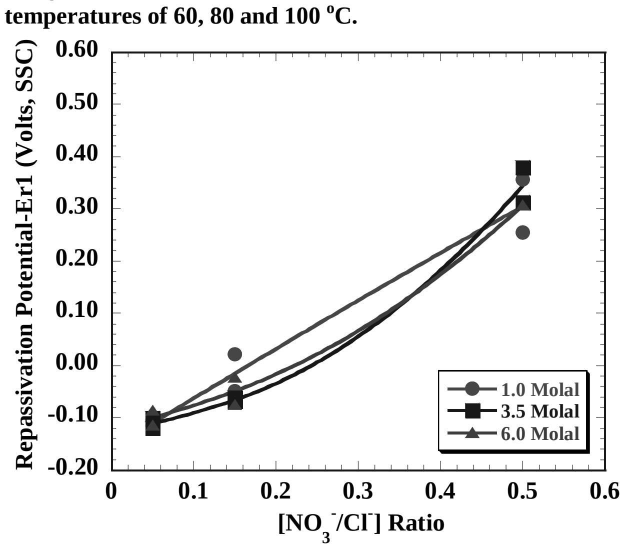

Figure 2. The repassivation potential as a function of [NO_3^-/Cl^-] ratio comparing the [Cl^-] of 1.0, 3.5 and 6.0 molal, at 100°C.

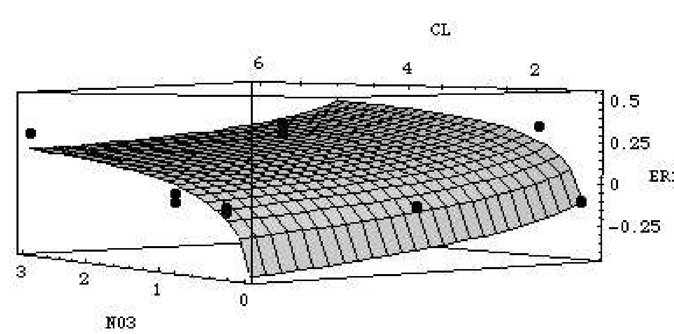

Figure 3. 3-D plot of repassivation potential as a function of [Cl^-] and [NO_3^-] at 100 °C. The surface describes regression analyses at T=100°C. Included in this plot are experimental data points T= 100°C (with [Cl^-] of 1.0, 3.5 and 6.0 molal and [NO_3^-/Cl^-] ratio of 0.05, 0.15 and 0.5).