Passivity and Passive Corrosion of Alloys 625 and 22

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Introduction

This non-quality affecting report consists of three sections. Section I attempts to address long-term passive film stability and related environmental effects on expected corrosion behavior of Ni-base alloys. Cyclic potentiodynamic polarization (CPP) technique was used at the University of Virginia (UVA) to evaluate the localized corrosion behavior of Ni-base Alloys 625 and 22 (UNS N06625 and UNS N06022, respectively) as functions of temperature, electrolyte composition, pH and oxide aging. The passive dissolution rate (i_{pass}) was evaluated for both alloys under varied test conditions. Sections II and III present the results of potentiostatic tests and reviews of current literature on passive dissolution and film characteristics of Ni-Cr-Mo and Ti alloys.

Both Q (laboratory air aged condition) and non-Q (freshly-polished NSF) specimens were tested. The compositional differences between the Q and non-Q materials of both alloys were negligible. Crevice specimens were prepared according to the ASTM Standard G 78. Tests were performed at temperatures ranging from 60 to 95^{o}C in aqueous environments containing LiCl, Na_2SO_4 and $NaNO_3$ with pH levels of 2.75 and 7.75. The forward and reverse potential scan rate during CPP experiments were maintained at 0.05 mV/sec.

CPP Results

The results indicate that i_{pass} increased with increasing applied potential. However, the measured values of i_{pass} did not differ significantly between the tested alloys. In addition, no relationship existed between pH and i_{pass}.

While no temperature effect on i_{pass} was observed for Alloy 625, the passive dissolution rate in Alloy 22 was influenced by temperature in that higher i_{pass} values were observed at 95^{o}C than those at lower temperatures. i_{pass} for Alloy 625 was slightly greater than that for Alloy 22.

Attempts were made to analyze the CPP data through multifactor analysis of variance and multiple regression analysis. Based on these analyses, a relationship was established between the crevice potential and the exposure temperature.

Potentiostatic Data

No conclusive remarks as to the role of environmental factors on i_{pass} can be made due to lack of credible data generated under potentiostatic condition.

Literature Review on Passive Films on Ti and Ni-base Alloys

It is well known that the excellent corrosion resistance of Ti and its alloys is primarily due to the spontaneous formation of protective oxide films on their surfaces that are amorphous in nature. Under certain conditions, such as, elevated temperatures, fast application of potential above the primary passivation potential, and introduction of compressive stresses, crystallization of these oxide layers can occur by a field assisted defect mobility mechanism. Literature suggests that the crystallization of titanium oxide can be related to decreased coulombic efficiency for oxide growth, changes in ionic, optical and dielectric properties, oxygen evolution, and formation of pits, crevices and cracks. Crystallization of titanium oxides could possibly be delayed or suppressed through surface modification or alloying.

As to the enhanced corrosion resistance of Ni-Cr-Mo alloys, formation of chromium oxide (Cr_2O_3) on their surfaces can be credited for such performances in many hostile environments. These oxide films become more resistant as the Cr content increases. However, the beneficial effects of Mo on oxides and their passivity are uncertain since these phenomena have not been thoroughly investigated.