

Susceptibility of Nickel and Cobalt Alloys to Localized Corrosion in Fluoride and Iodide Solutions. Comparative Behavior to Chloride and Bromide Solutions

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The localized corrosion resistance of iron (Fe), nickel (Ni) and cobalt (Co) alloys in chloride solutions can be greatly improved by alloying them with chromium (Cr) and molybdenum (Mo). Some Ni and Co alloys also contain tungsten (W), which appears to be a beneficial element when Mo is present as well. Furthermore, the resistance to localized corrosion of stainless steels (Fe alloys) may be improved by the addition of nitrogen (N). In previous studies, it has been shown that the beneficial effect of alloying elements such as Cr and Mo seem less pronounced in bromide solution than in chloride solutions both for stainless steels¹ and nickel alloys.²

The paper will review literature data on the influence of metallurgical and environmental variables on the localized corrosion resistance of commercial Ni and Co alloys. New data will also be incorporated. The latest data explores the effect of alloying elements on the localized corrosion resistance of engineering alloys in presence of fluoride and iodide ions. Table 1 lists the studied commercial alloys and their approximate composition. Cyclic polarization curves were carried out in deaerated solutions of 1 M NaF and 1 M NaI at 50°C.

Figure 1 shows typical cyclic polarization curves for alloy C-276 in 1 M NaCl pH ~ 6, 1 M NaBr pH ~ 6 and 1 M NaF pH 9 solutions. For the three halide solutions the passive current at 0 V was the same and approximately 1 µA/cm². The breakdown potential was the lowest in the fluoride solution even though the repassivation potential for chloride and fluoride were similar. Figure 2 shows the repassivation potential for seven Ni-Cr-Mo alloys. The values for chloride and bromide solutions were published before.¹ The repassivation potential in chloride and bromide solutions were the highest for the strongly alloyed materials such as C-2000, 686, 59 and C-22. However, the repassivation potential for these Ni-Cr-Mo alloys in the fluoride solution were approximately the same and approximately 200-250 mV (SCE). In general, results show that alloying elements such as Cr and Mo seem to have the greatest beneficial effect in chloride solutions and almost no beneficial effect in fluoride solutions.

This paper will also discuss the effect of alloying elements such as W and Mo in cobalt base alloys and the resistance to localized corrosion of nickel and cobalt alloys in iodide solutions.

References

1. R. Guo and M. B. Ives, Corrosion, 46, 125 (1990).

2. R. B. Rebak, N. E. Koon, J. P. Cotner and P. Crook, Electrochemical Society Proceeding Volume 99-27, 473-482 (1999).

Table 1: Approximate Chemical Composition

Common Name	UNS	Composition
316L SS	S31603	Fe17Cr13Ni2.5Mo
59	N06059	Ni23Cr16Mo1Fe
600	N06600	Ni16Cr9Fe
686	N06686	Ni21Cr16Mo5Fe4W
625	N06625	Ni21Cr9Mo5Fe
C-4	N06455	Ni16Cr16Mo
C-276	N10276	Ni16Cr16Mo5Fe4W
C-22	N06022	Ni22Cr13Mo3Fe3W
C-2000	N06200	Ni23Cr16Mo1.6Cu
230	N06230	Ni22Cr14W5Co3Fe2Mo
25	R30605	Co20Cr15W10Ni3Fe1.5Mn
ULTIMET	R31233	Co26Cr9Ni5Mo3Fe2W0.1N

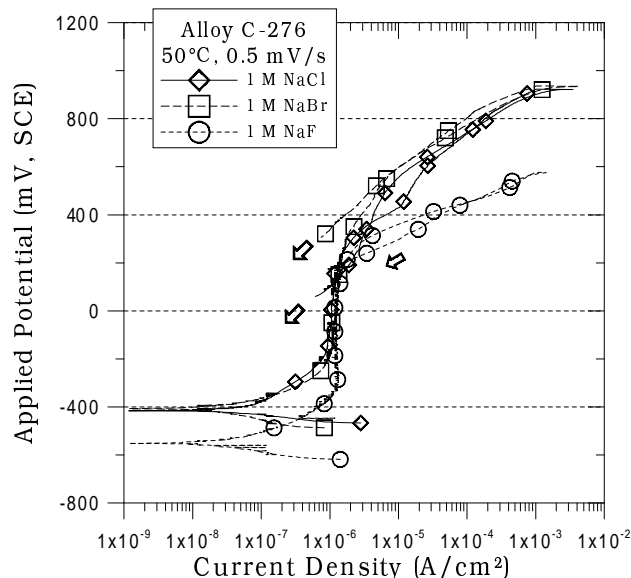


Figure 1: Cyclic Polarization for alloy C-276.

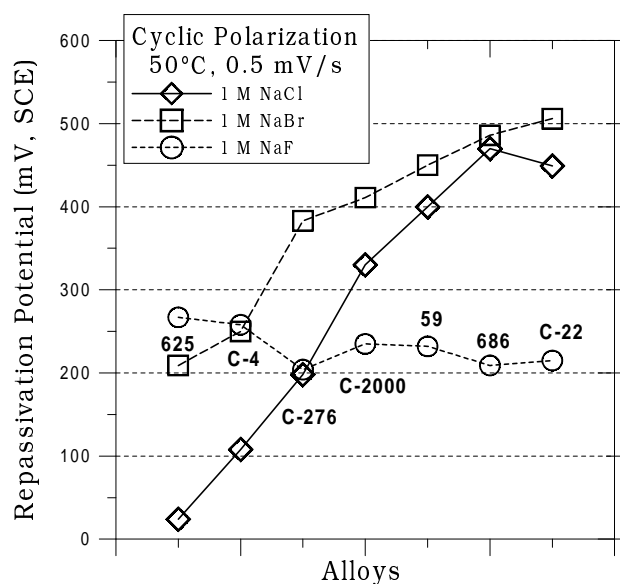


Figure 2: Repassivation Potential for Ni-Cr-Mo Alloys