

Corrosion Inhibition of Inconel (600) In Sodium Chloride solution by Sodium sulphate

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ABSTRACT

A potentiostatic investigation has been carried out of the corrosion behaviour of Inconel (600) in chloride ions (Cl⁻) over the temperatures 293 to 308 K. The work also involved the examination of the inhibiting effects of sodium sulphate on the corrosion of the alloy in chloride ions. Such changes were examined in both the deaerated and oxygenated atmospheres. The presence of sodium sulphate in the chloride solution caused a decrease in the corrosion current density and a shift in the corrosion potential towards less negative values. Values of the kinetic parameters, and of the thermodynamic quantities of inconel corrosion in chloride ion in both deaerated and oxygenated atmospheres in the absence and the presence of sodium sulphate have been determined. The corrosion reaction was generally feasible on thermodynamic grounds. The kinetic results on inconel (600) occurred on surface sites having different energies of activation.

INTRODUCTION

Nickel is important as an alloy addition and as a base material for corrosion resistance alloys⁽¹⁻⁴⁾. Inconel (600) has a high degree of resistance to corrosion in atmosphere when exposed to fresh and natural water, and the alloy exhibits little tendency to breakdown even in acidic solution containing IN sodium chloride⁽⁵⁻⁷⁾. Because of the high resistance of inconel (600) to corrosion in high purity, it is quite frequently used in nuclear reactors for steam generator tubing and water piping⁽⁵⁾.

They have been numerous investigations on the effect of the organic acids on the anodic dissolution of nickel alloys⁽⁸⁾. Some attempts have been made⁽⁹⁻¹⁰⁾ to determine the effect of sea-water and copper chloride on pitting of inconel (600).

Pervious studies also covered the effect of sulphate and phosphate ions on the pitting potential of inconel (600) in 0.1 M NaCl solution at elevated temperatures. The present paper involves a potentiostatic corrosion investigation of an important nickel alloy (inconel 600) in sodium chloride solutions in the absence and the presence of sodium sulphate. The latter has been selected to inhibit the corrosion behaviour of the alloy in NaCl solution. The experiments have been performed under nitrogen atmosphere as well as in oxygenated condition in an attempt to understand the influence of oxygen onset and extent

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of the metal .No such has so far been reported in the literature

Experimental

Inconel (600) was used in this investigation spectroscopic analysis of the alloy indicated the composition in weight percentages

Element	Ni	Cr	Fe	C	Mn	Si
Wt %	0.5	0.25	0.76	15.5	8 .	0.08

Sodium chloride and sodium sulphates were annular samples obtained from B.D.H. The cell assembly consisted of working, the platinum auxiliary and saturated calomel electrodes, which have been immersed in 750 ml of the test solution .The temperature of the solution was controlled to within 0.01C. Deionized water was used for the preparation of the cell solution.

The working electrode, which was made from the inconel-600 specimen, was cylindrical and the exposed area to the corrosion medium was circular in shape with diameter of 2.5 cm. The reference calomel electrode via aluggin capillary bridge, which was usually filled with test solution.

The polarization curve was obtained using a potentiostat, type part 10-0.5L, which was obtained from Tacussel ⁽¹¹⁾, France. Both the cathodic and anodic current –potential curves were obtained by decreasing or increasing polarization. The potential scan began initially after the specimen immersion in the test solution beginning at- 1.5 volt and proceeded through to +1.2 volt. A potentiodynamic sweep rate of 15 mv/min was used recording the current density continuously with the change of potential.

The surface preparation procedures of the working electrode and the experimental techniques utilized have been described elsewhere ⁽¹²⁻¹³⁾. The experiments have been performed usually under pure nitrogen gas. In series of experiments the NaCl solution, prior to the immersion of the working electrode, was purged for a minimum of 2 hours with pure (99.9pure) oxygen gas at a rate of 150 cm³ per minute.

The anodic (ba) and cathodic (bc) Tafel slopes of the tangents have been drawn to the corresponding Tafel lines ⁽¹³⁻¹⁴⁾ have been determined from the polarization curves. The corrosion potential (E_c) and the corrosion current density (i_c) has been obtained from the point of intersection of the anodic and cathodic Tafel lines using the 4-point method ⁽¹⁴⁾.

TK	Deaerated				Oxygenated			
	-E _{corr} /V	i _{corr} /Acm ²	-bc/Vdecade ⁻¹	ba/Vdecade ⁻¹	-E _{corr} /V	i _{corr} /Acm ²	-bc/Vdecade ⁻¹	ba/Vdecade ⁻¹
293	0.98	5.7 X10 ⁻⁶	0.115	0.100	0.582	0.582	0.085	0.096
298	0.96	7X10 ⁻⁶	0.115	0.110	0.547	0.537	0.100	0.093
303	0.95	8.5X10 ⁻⁶	0.123	0.115	0.501	0.523	-----	0.090
308	0.93	9.2X10 ⁻⁶	0.125	0.118	0.496	0.517	0.102	0.082

Table (1): Values of Corrosion current densities (i_{corr}) and corrosion potential (E_{corr}), Tafel slope and Transfer of inconel in deaerated and oxygenated solution of 0.5 M NaCl solution at four temperatures.