Studies in the corrosion of some alloys in 3% Sodium Chloride solution

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Abstract

The influence of variables such as temperature, agitation, oxygenation on the corrosion of commercial aluminium alloys (2S, 3S and 57S) aluminium brass, 304 SS and nickel cast iron in 3% NaCl solution has been studied by electrochemical and weight loss measurements. It has been observed that corrosion process is essentially under cathodic control for the alloys studied. Next to 304 SS some commercial aluminium alloys merit consideration for use in salt water under conditions similar to those reported in this paper.

Introduction

In an earlier paper[1], mention was made on the usefulness of the nonferrous alloys as constructional materials in desalination plants and marine engineering and the large number of investigations carried out in sea water at normal and elevated temperatures. Apart from some of the nonferrous alloys discussed earlier for use in secondary cooling systems for desalination of sea water and as impellers, propellers, condenser components, heat exchangers etc., ferrous alloys like 304SS and nickel cast iron as also some commercial aluminium alloys(2S 3S and 57S) and aluminum brass may be of interest to the design engineers. They have been selected for corrosion studies in 3% NaCl solution under different conditions of experiment as those reported in the earlier paper[1].

Experimental

The experimental details and procedure are the same as that reported in our earlier paper[1].

Results and Discussion

Comparing the corrosion rates under different conditions it is observed that the corrosion rate at 30°C increases in the order Al 2S, 3S, 57S, while at 40°C the order is reversed. The corrosion rates at both the temperatures in the presence of oxygen follow the same pattern as at 30°C where oxygen is absent, the exception being that in the case of A13S at 30°C in the presence of oxygen the corrosion rate is less than that of A 12 S. In a stirred solution at 30°C the corrosion rate is of the same order for all the three alloys but higher than in unstirred solution. However, in the case of A157S the difference in the effect of oxygen and stirring is observed in that the corrosion rate is nearly three times in the former case compared to the latter. This indicates that oxygenation adversely affects the corrosion rate of Al 57S. While oxygenation at 30° C increases the corrosion rate sharply, at 40°C except in the case of Al 57S where there is a weight gain, the corrosion rate decreases in the case of Al 2S and A 13S. In an earlier study[1] it was observed that under oxygenation Al 24S was superior to Al 52S. The behaviour of Al 57S under similar conditions is comparable to that of Al52S. The corrosion rate of Al 2S and 3S is considerably less than that of Al IS under all the conditions studied,

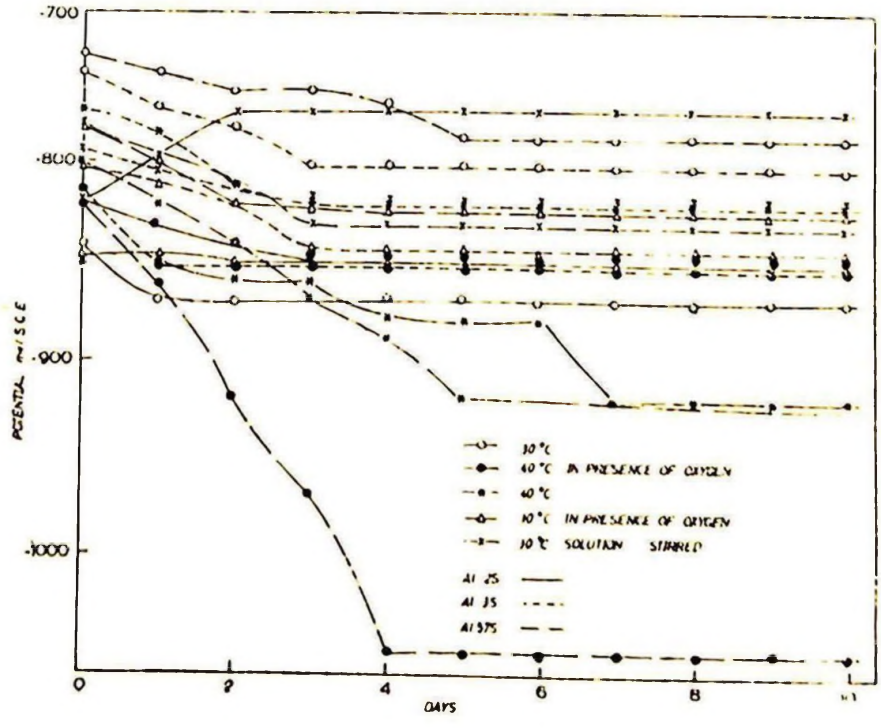


Fig. 1. Variation of electrode potential with time for commercial aluminium-alloys in 3% NaCl solution under different condition of experiment.

Under identical experimental conditions the corrosion rate of aluminium brass is of the same order as that of Nickel cast iron except at 30°C where the latter has a much lower corrosion rate (weight gain) compared to the former.

The effect of oxygenation at 40° C and stirring at 30°C is to increase the corrosion rate in both the cases. At 30°C however oxygenation decreases the corrosion rate of aluminium brass while the corrosion rate increases in the case of Nickel cast iron.

Compared to both the above alloys 304 SS is superior under all conditions except at 30°C in the absence of oxygen. The corrosion rate is of the same order varying only between 0.33 to 0.67 MDD under the different conditions of experiment. Except under the experimental conditions wherein the solution is stirred at 30° Cupro-nickel (70% Cu-30%Ni) has Just about the same corrosion rate as 304SS while monel is practically unaffected[1].

From a study of variation of electrode potentials with time (Fig 1), it is observed that the electrode potentials of the three commercial aluminium alloys studied tend to anodic direction under all the conditions studied, the exception being the tendency of Al2S to become noble in stirred solution at 30° C. However, a steady potential is obtained in practically all the cases in about 3 to 4 days time. Similar behaviour has been observed in the case of aluminium alloys reported earlier [01] A marked change in potential is observed particularly in the case of Al57S at 40°C the effect of oxyegnation being to make the alloy more anodic. From Fig. 2 in the case of aluminium brass the potentials tend to anodic direction except at 30°C in presence of oxygen where the potentials tend to noble direction. The potentials remain constant after 3 to 4days of test in most of the cases except in stirred solution at 30° C where the steady constant potential is attained after 6 days, Comparing cupro-nickel alloy[1] with aluminium brass it is observed that in the former alloy potentials tend to noble direction under all the conditions of experiment except at 30°C in the presence of oxygen wherein the potentials tend to anodic direction within 1 to 5 days and thereafter shift to noble direction and remain constant upto 10 days. In the case of 305 SS while the potential remains constant in a stirred solution at 30°C the potentials tend to noble direction with time for rest of the conditions studied. An early passivating tendency (within 2 to 4 days) and then a return to the normal open circuit potential has been particularly observed at 30°C in the presence of oxygen. In the case of nickel cast iron the potentials tend to noble directions in all the cases except for the trend to anodic direction upto 4 days and then shift to the noble direction observed at 40°C. This behaviour of potential tending towards noble direction is observed also for hasstelloy 'B' and 'C' and inconel[1].

Monel, cupro-nickel and 304 SS followed by commercial aluminium alloys 2S, 3S, 24S, 52S and 57S merit consideration for use in salt water uuder conditions of experiment reported. It is of interest to extend these studies to observe their behaviour in dynamic systems.

Potentiostatic studies on the anodic and cathodic polarisation of these alloys including mild steel at room tempreature show that the corrosion process control is essentially cathodic.

Acknowledgement

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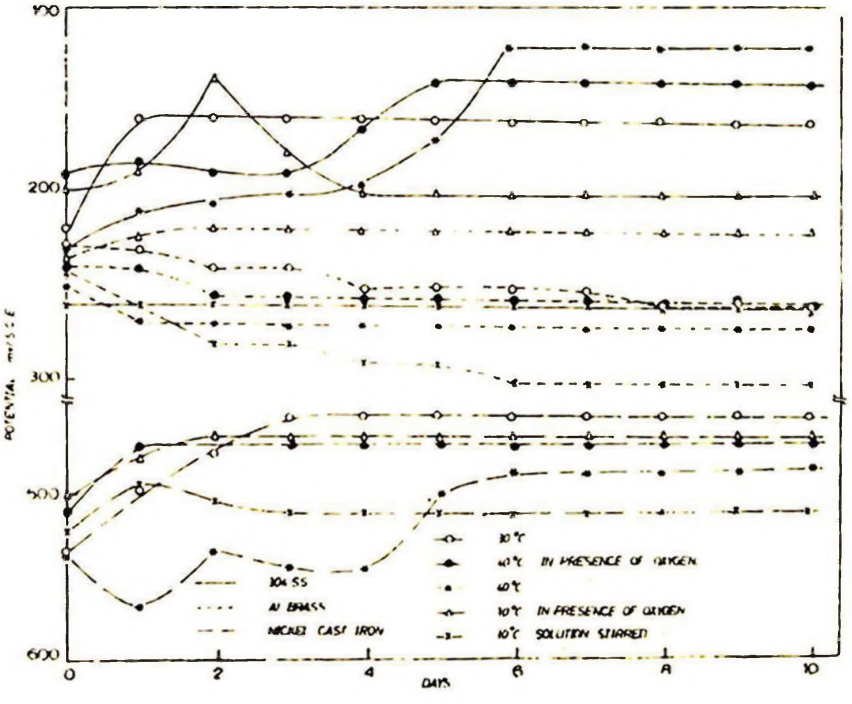


Fig. 2. Variation of electrode potential with time for 304 S. S. aluminium brass and nickel cast-iron in 3%NaCl solution under different conditions of experiment.

TABLE I

Corrosion rate values (MDD) of the alloys in 3% NaCl solution.

Period of immersion : 10 days
Corrosion rate is based on weight loss except when otherwise stated.

Alloy/experimental conditions	Corrosion rate (MDD) milligrams per square decimetre per day				
	30°C	30° C in presence of oxygen	40 °C	40°C in presence of oxygen	30°C with solution stirred
Commercial aluminium alloys.					
Al 2S	0.16	0.96	4.84	1.12	0.75
Al 3S	0.29	0.72	2.92	1.56	0.97
Al 57S	0 65	2.32	0.43	3.43*	0 84
Copoer base alloy.					
Aluminium brass (76%Cu, 22%Zn, 2%Al	9.04	4.32	6.77	22.40	28.50
Ferrous alloys.					
304SS	0.55	0.64	0.33	0.36	0.67
Nickel castiron (13.6%Ni, 2.01%Si, 1.14%Mn, 1.99%cr) 1.8%)	0.14*	6.06	7.37	23.70	40.50

* Weight gain

REFERENCES

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