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CORROSION RESISTANCE OF ELECTROPOLISHED STAINLESS STEELS

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Stainless steels require modification of their surface to prevent them from rusting. Electrochemical methods of surface modification of stainless steel offers a better solution. Electropolished stainless steel surfaces obtained from various ethanolamine based acid baths were compared with mill finished stainless steel. The corrosion resistance evaluation by Tafel extrapolation and salt spray test revealed that electropolishing offered a better protection than mill finished stainless steel. The triethanol amine based bath offered a good corrosion resistant surface.

Keywords: Electropolishing, stainless steel and ethanolamine.

INTRODUCTION

Stainless steels are ideal materials for construction of both in-door and out-door applications. Though the enhanced corrosion resistance of these steels is due to the oxide layer present on the surface, the nature of the surface preparation greatly influence their use in marine atmosphere [1-5]. On prolonged exposure in marine atmospheres they develop rusting. In order to study the influence of surface roughness on corrosion behaviour, both mill finished and electropolished AISI 304 stainless steels were studied in 5% NaCl solution by electrochemical and salt spray methods.

EXPERIMENTAL

Stainless steel panels of composition 0.8% C, 18-20% Cr, 8-11% Ni, 2% Mn and remainder Fe, were cut into 2.5 x 2.5 x 0.1 cm and the sides of the panels were ground to remove the burrs. The panels were degreased with trichloroethylene and electrocleaned cathodically in an alkaline solution (10% by weight/vol. NaOH) at 323 K for 2 minutes keeping the current density at 7.8 $A.dm^{-2}$. The panels were washed in the running water and rinsed in deionized water and dried.

Table I presents the composition of electropolishing baths used. The mill finished and electropolished specimens of size 2.5 x 2.5 x 0.1 cm were used in salt spray tests.

The electropolished and mill finished specimens were masked on all sides by lacquer to expose 1 cm^2 of the specimen and were used for the electrochemical studies.

Tafel extrapolation method [6]

A three electrode cell assembly is used with stainless steel specimens (1 cm^2) as working, a large platinum gauze as auxillary and saturated calomel electrode as the reference electrode respectively. The polarization measurements were done using BAS-100A electrochemical analyzer.

TABLE I: Composition of various electropolishing baths

Bath	Constituent	Concn (ml/litre)
A	H_3PO_4	500
	H_2SO_4	360
	Monoethanolamine	20
B	H_3PO_4	500
	H_2SO_4	360
	Diethanolamine	20
C	H_3PO_4	500
	H_2SO_4	360
	Triethanolamine	20

Specimen A: Surface obtained from bath A at 353 K, 15.1 $A.dm^{-2}$
Specimen B: Surface obtained from bath B at 353 K, 15.1 $A.dm^{-2}$
Specimen C: Surface obtained from bath C at 353 K, 15.1 $A.dm^{-2}$

Salt spray test

As per ASTM-B117 (DIN 50021), 5% neutral salt spray test was carried out to evaluate the corrosion resistance of the mill finished and electropolished stainless steels. This test includes the use of 5% NaCl solution (*p*H 6.5 to 7.2) at 308 K and was performed on flat panels with masked off edges. The panels were placed in a chamber at a specific angle and the effect of the salt environment on the top surface was evaluated.

RESULTS AND DISCUSSION

From different electropolishing baths, specimens were obtained and their corrosion behaviour with mill finished stainless steel was compared. Fig. 1 presents the polarization curves for electropolished and mill finished stainless steels in 5% NaCl solution.

The mill finished stainless steel offered least corrosion resistance compared to electropolished specimen and electropolished specimen C obtained from triethanolamine bath was most corrosion resistant (Table II). This is because of uniform surface regularities present on electropolished surface, which is evident from the reflectance studies made and reported [3].

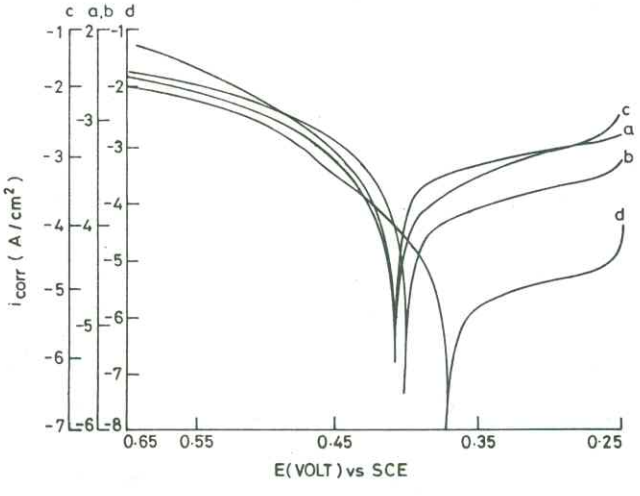

Fig. 1: Typical potentiodynamic polarisation curves for various conditions of stainless steels in 5% NaCl solution at 303 K (5 mV/sec)
(a) Mill finished specimen (b) Electropolished specimen A
(c) Electropolished specimen B (d) Electropolished specimen C

TABLE II: Parameters obtained from log I curves for the corrosion of stainless steels in 5% of NaCl solution

Specimen	Corrosion potential (mV vs SCE)	Corrosion current density (A/ dm^2)
Mill finished	+403	2.5 x 10^{-5}
Electropolished Specimen A	+391	1.6 x 10^{-5}
Electropolished Specimen B	+403	1.1 x 10^{-5}
Electropolished Specimen C	+379	0.4 x 10^{-5}

Salt spray tests were carried out with 8 hours of continuous spraying followed by 16 hours of mist settling on the surface. The first appearance of rust was seen at the end of 80 hours on the mill finished surface. The test was continued and even after 112 hours of spray, no rust spot was seen on the electropolished surfaces.

CONCLUSION

Electrochemical and salt spray test revealed that electropolished stainless steels were more corrosion resistant than mill finished stainless steels. The electropolished surface obtained from triethanolamine as additive exhibited most corrosion resistance.

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