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Role of composite ion on the Zn-Al barrier layer on mild steel for better corrosion resistance

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The authors have studied and compared the surface properties of mild steel with barrier layers of zinc, Zn + 3%Al, Zn + 3%Al + 1% misch metal + 1.5% SiC, and other different compositions. The electrochemical parameters like weight loss, corrosion rate, i_{corr} and open circuit potential values were obtained in 0.04N NaOH solution with 0.09% NaCl. Impedance values were also obtained. Specimens were evaluated in salt spray cabinet for their performance. The layer composition Zn+ 3%Al+1%misch metal+1.5% SiC, revealed superior electrochemical properties. The thickness of the barrier layers, was determined and the photomicrographs of the cross section reported.

Key words: Galvanizing, barrier layers, composite, corrosion resistance

INTRODUCTION

Zinc finds application in the galvanizing industries and also as sacrificial anodes in cathodic protection [1,2]. In literature [3 – 5], quite a number of alloy systems have been reported, based on zinc for steel surface e.g. Zn-Ni, Zn-Cr, Zn-Ni-Cr, Zn-Al-Sb, Zn-Mn, Zn-Al-Si, Zn-Al-Si-Mg, Zn-Al-Si-Cu, etc. It has also been reported that none of the alloying additions of Mg, Al-Mg, Sb-Cu, Ba, Ni, Co, Mo, P to hot-dip zinc and electrogalvanizing bath for steel gave significant corrosion resistance. Coatings of steel surface with Zn(30-35%) Mn and Zn(5-35%) Fe are also well known.

In this paper, the authors have studied the as-coated performance of the alloys of zinc, like Zn+3%Al, Zn+3%Al+1%misch metal, Zn+3%Al+1%misch metal + 1.5%SiC, Zn+15%Al. Pure zinc and Zn+3%Al + 1%misch metal+1.5%SiC coating on mild steel are also heat treated and studied.

EXPERIMENTAL

0.15% carbon steel rods were used for coating zinc and its alloys. 99.9% pure zinc coating was given as per ISI standard. Electrochemical tests like impedance potentiostatic anodic polarisation, potential vs time, weight

TABLE-I: Electrochemical parameters of carbon steel with and without zinc and Zn-alloy barrier layers

Layers	Type of barrier layer					
	No barrier layer	Pure Zn barrier	Zn+3%Al barrier	Zn+3%Al + 1% misch metal	Zn+ 15% Al	Zn+3%Al+ 1% misch metal +1.5% SiC
Corrosion g/cm^2. hr 48 hours	1.5×10^{-4}	1.5×10^{-4}	5.4×10^{-4}	2.7×10^{-4}	2.5×10^{-4}	1.04×10^{-4}
i_{corr}(mA.cm^{-2}) 0.04N NaOH with 0.09% NaCl	0.1	0.082	0.58	0.10	0.07	0.03
O.C.P mV 0.04N NaOH with 3%NaCl vs SCE	−450	−875	−850	−840	−850	−750
Thickness (μm)	0	131–170	100–131	131–215	131 –215	170–215

TABLE- II: Long term exposure test for zinc coated panels

Exposure in salt-spray cabinet	Type of barrier layer					
	No barrier layer	Pure zinc	Zn+3%Al	Zn+3%Al +1%misch metal	Zn+ 15% Al	Zn+3%Al+ 1.5%SiC+ 1% misch metal
300 hrs. OCP mV vs SCE	−516	−955	940	−1010	−915	−935
Visual observation	Brown rust	Thick white rust	Thick white rust	Thick white rust	Thick white rust	Thin layer of dull bright rust
20 days OCP mV vs SCE	—	−820	—	−850	−820	−810
Visual observation	—	Thick white rust	—	Thick white rust	Thick white rust	Thin dull white layer

loss test and salt-spray accelerated testing were conducted to characterize the coated and uncoated panels.

RESULTS AND DISCUSSION

Table I reveals the electrochemical parameters and thickness of carbon steel specimens with and without zinc and zinc alloy barrier layers. It is clearly seen that Zn+3%Al+1%misch metal +1.5%SiC reveals minimum weight loss corrosion rate i_{corr} value and more +ve OCP. Moreover, the thickness values are also more for the above.

Table II reveals the data obtained from long time exposure tests of the coated panels in salt spray cabinet and after immersion in 0.04N NaOH containing 3% NaCl solution. It is clearly seen that the zinc composite alloy layer (Zn+3%Al+1.5%SiC + 1%misch metal) reveals more +ve potential after exposure in both the salt spray cabinet and in 0.04N NaOH containing 3% NaCl. Moreover, this barrier layer reveals thin layer of dull bright to dull white rust which is insignificant compared to the thick layer of white rust observed in other systems.

CONCLUSION

Zn+3%Al+1.5%SiC+1%misch metal barrier layer on carbon steel provides very high resistance to corrosion.

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REFERENCES

1. B A Shenoi, K Balakrishnan, R Arghode, N Palaniswamy, Malathy Pushpavanam, *Proc. Symp Corrosion and Control in Power and Chemical Industries*, M. S. University, Baroda. 15–17, Dec. (1982) p VI-5-1
2. D Mukherjee, B Venkataraman, N Palaniswamy and K Balakrishnan,*J Electrochem Soc India*, **37**–3 (1988)
3. D Mukherjee B Venkataraman and K Balakrishnan *Preprints, 10th ICMC*, Madras, 7–11 Nov (1987) IV, 3689
4. *Metals Handbook*, Metals society, U.S.A. *Zinc,* November (1984) p 2
5. C H Mathewson, *Zinc; The Science and Technology of Metals, Alloys and Compounds*, Chapman and Hall Ltd, London, (1959) p 586