J. Indian Chem. Soc.
Vol. L March 1973, pp. 170-171

# Corrosion Inhibitors for 3s Aluminium in Hydrochloric Acid Solution

S. C. MAKWANA, N. K. PATEL and J. C. VORA

Chemistry Department, University School of Sciences, Gujarat University, Ahmedabad-9, India

*Manuscript received* 21 *February* 1972; *revised* 15 *September* 1972; *accepted* 6 *February* 1973

**The inhibitory action of nicotinamide and thioacetamide on the corrosion rate of 3S aluminium (98% Al) in hydrochloric acid solution has been investigated. Thioacetamide is a better corrosion inhibitor than nicotinamide. Inhibition is governed by cathodic control.**

ALUMINIUM and its alloys are extensively used in industries. Hydrochloric acid is highly corrosive to aluminium[1-5]. In the present investigation an attempt has been made to evaluate the inhibitive power of nicotinamide and thioacetamide towards 3*S* aluminium in 0·5*N* hydrochloric acid solution.

## Experimental

The aluminium alloy sheet (S.W.G. 22, 1/2 hard) had following composition : Al–98, Cu–0·15, Mn–1·0, Fe–0·75 and Si–0·6% (maximum). The preparation, testing and cleaning procedures were the same as those described by Champion[6]. Each specimen, 3×6 cm, was fully immersed in 250 ml. of the 0·5*N* hydrochloric acid solution. Reproducibility of the results of the inhibitive efficiency was ±2%.

For the galvanostatic studies the procedure adopted for the potential measurements was same as that described by Gatos[7]. The current density was varied with 2·5 mA to 50 mA/sq. cm.

## Results

Results of the weight loss are given in Table 1. The inhibitive efficiency of thioaceamide is practically constant at all concentrations while that of nicotinamade increases with increase in its concentration.

TABLE 1—WEIGHT LOSS DATA : 2S ALUMINIUM IN 0.5*N* HYDROCHLORIC ACID WITH INHIBITORS

Size of the coupon : 3×6 cm; Temp : 30°±2°; Duration : 1 day

| Thioacetamide | | | Nicotinamide | | |
|---|---|---|---|---|---|
| Concentration of inhibitor % | loss (mdd) | Inhibition (%) | Concentration of inhibitor % | loss (mdd) | Inhibition (%) |
| 0.0 | 3100 | — | 0.0 | 3100 | — |
| 0.002 | 219 | 93 | 0.005 | 810 | 74 |
| 0.004 | 208 | 93 | 0.01 | 585 | 87 |
| 0.008 | 205 | 93 | 0.025 | 253 | 90 |
| 0.012 | 183 | 94 | 0.05 | 160 | 95 |
| 0.02 | 183 | 94 | 0.1 | 140 | 96 |

It has been observed that the cathode polarization of 3*S* aluminium in 0·5*N* hydrochloric acid is higher than the anode polarization when an external current is applied.

The steady state value of the corrosion potential becomes slightly more cathodic in the presence of inhibitor, the steady state potential of 3*S* aluminium in 0·5*N* hydrochloric acid (along)—690 mv, 0·5*N* HCl+0·02% thioacetamide—710 mv and 0·5*N* HCl+0·1% nicotinamide—705 mv respectively.

## Discussion

The compounds studied have following structural formulae

$CH : N.CH : CH : C.CO.NH_2$ (Nicotinamide),

and

$CH_3.CS.NH_2$ (Thioacetamide).

Organic compounds containing sulphur, nitrogen, or oxygen atoms which can be adsorbed by the metallic surface can act as inhibitors towards corrosion. They can be adsorbed over the metallic surface by their ability to share lone pair of electrons to the metal atoms or ions; nitrogen in the benzene ring (as amino), N-, has one lone pair of electrons; oxygen in carbonyl group, C = O, has two lone pairs and sulphur in thioketo, C = S has two electron pairs. Nicotinamide has two such atoms oxygen (in carbonyl) and nitrogen (in cyclic ring) which faciliate the absorption at the proper sites on the metal surface. Thioacetamide has only one such atom (sulphur in thioketo group). The polarization data reveal that both the compounds are more strongly adsorbed by the cathodic area over the metal, nicotinamide being adsorbed to somewhat greater extent. Overall high efficiency of thioacetamide can be attributed to the ease with which can be adsorbed by the metal surface; in the case of nicotinamide presence of benzene ring adjacent to oxygen atoms might act as a steric hindrance to the adsorption. By extrapolation of the cathodic potential line, percentage protection can be calculated with the help of Tafel parameters and these value of percentage protection is correlated with the data obtained by weight loss method,

**Acknowledgement**

Our thanks are due to Gujarat University for a grant towards chemicals.

**References**

1. W. J. Muller and E. Low, *Aluminium*, 1936, **18**, 478, 541.
2. M. E. Straumanis and Y. N. Wang, *J. Electrochem. Soc.*, 1955, **102**, 304.
3. O. P. Arora, G. R. Ramgopal and M. Metzger, *Chem. Abs.*, 1963, **58**, 5347.
4. T. Inui, K. Hesokawa, Y. Mitsumura and Kyushu Kogyo, *Daigaku Konkyu Hakaku*, 1963, **13**, 11.
5. K. Kuwahara, *J. Sci. Hiroshima Univ. Ser. A.*, 1953, **16**, 541.
6. F. A. Champion ; 'Corrosion testing procedures' Chapman and Hall, London (1952).
7. H. C. Gatos, *Corrosion*, 1956, **12**, 23t.
8. S. Fujji and K. Aramaki, *Boshoku Gijutsu*, 1958, **7**, 342.