

NOTE

Adsorption Isotherm for Copper-Benzotriazole System in HCl

A.K. SINGH† and B.K. SINGH*

*Department of Chemistry**Maharaja College, (V.K.S. University), Arah-802 301, India*

The adsorption for copper benzotriazole system is presented. Upon analysis it shows that the adsorption is due to Frumkin. During the analysis relative size has been taken into account.

Key words: Adsorption, isotherm, copper-benzotriazole.

Benzotriazole (BTA) arguably is the most effective inhibitor for the corrosion of copper in a number of corrosive environments¹⁻³, where the nature of complex in this system has been widely studied⁴⁻⁶. The nature of the adsorption process in an electrode/corrosion inhibitor system can be derived from its adsorption isotherm⁷. This paper presents an analysis of benzotriazole-copper system adsorption isotherm, taking into account the relative size factor.

The adsorption of benzotriazole (BTA) on to copper was determined on the basis of experiments on the corrosion rate of copper samples in 0.2 M HCl at 30°C in presence and absence of inhibitor. Specimens of pure copper (99%) of dimension 30 sq mm were degreased, ground and pickled for the immersion test of duration 120 h in a corrosive environment of volume 300 mL with constant stirring the system, for a better reproductivity of results. Average values of six experiments were obtained. The degree of coverage ϕ of electrode surface is given by $\phi = 1 - (\Delta w / \Delta w_0)$, where Δw is the weight loss of the copper sample in a solution of 0.2 M HCl containing BTA and Δw_0 is the weight loss of copper sample in 0.2 M HCl. It is assumed that BTA molecules screen the surface when they are adsorbed on it.

The experimental results (average of six experiments) are given in Table-1. The plot of adsorption of benzotriazole on to copper surface of 0.2 M HCl solution has been given in Fig. 1. The plot is 'S' type. In the analysis the adsorption is due to Frumkin^{8,9} isotherm, *i.e.*,

$$B \cdot c = \frac{\phi}{1 - \phi} \exp(-f \cdot \phi)$$

with B, f and associated thermodynamic quantities having the following values

$$B = 113.6, f = 3.84$$

†S.B. College, Arah-802301, India.

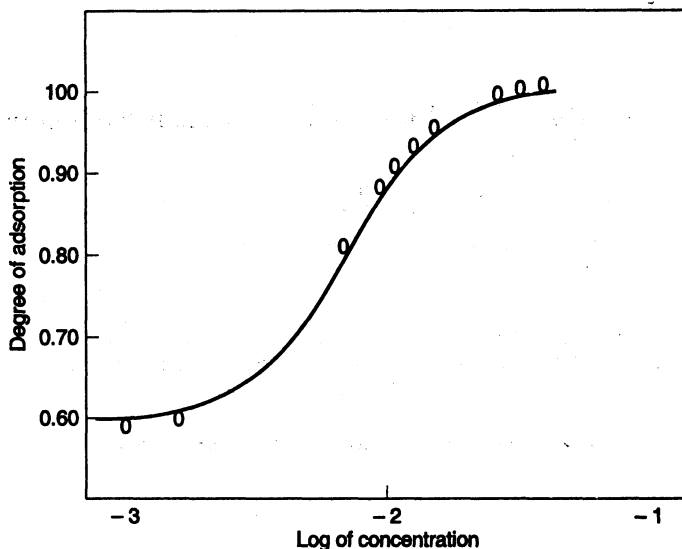


Fig. 1. Adsorption of BTA on to copper in presence of 0.2 M HCl solution

and from the equation
$$B = \frac{1}{55.5} \exp\left(\frac{-\Delta G_{0\text{ ads}}}{RT}\right)$$

Therefore
$$\Delta G_{0\text{ ads}} = -21.60 \text{ kJ/mole}^{-1}$$

Adsorption equilibrium constant log K, can be calculated from

$$\Delta G_{0\text{ ads}} = -RT \log_e K = 3.76$$

TABLE-1
WEIGHT LOSS DATA FOR CORROSION OF COPPER
IN 0.2 M HCl AND INHIBITION BY BENZOTRIAZOLE

Concentration of degree of surface inhibitor (ppm)	Weight loss (mg)	Degree of surface coverage $D = 1 - (\Delta w/\Delta w_0)$
0	9.30
1	3.64	0.608
2	3.26	0.650
3	1.63	0.824
4	0.50	0.945
5	0.34	0.962
6	0.25	0.974
7	0.15	0.990
10	0.03	0.998
20	0.03	0.998
30	0.03	0.998

Conclusion and Recommendation

The negative value of $-\Delta G_{0\text{ ads}}$ obtained in the present work suggests chemisorption but not a very strong chemisorption if it were a positive value corresponding to interaction between metal surface and adsorbed molecule. The Frumkin isotherm is also favouring the chemisorptive properties of adsorption of BTA on to the metal surface.

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Legends

b	Modified equilibrium constant
c	Concentration of inhibitor
f	Interaction parameter,
ϕ	Degree of surface area,
ΔG_0	Standard free energy of adsorption

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