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NOTE

Activation Energy of Copper Benzotriazole System in Sulphuric Acid Containing Chloride

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The value of activation energy is low for corroding processes and high in case of inhibition. But it becomes very high when a corrosion accelerator like chloride is used.

Key Words: Activation energy, Copper benzotriazole.

Arrhenius showed that the velocity constant of a reaction (K) increases exponentially, for a large number of reactions; the plot of log K against 1/T gives a linear relationship and the empirical relation[1] is

$$\log K = \frac{-E}{2.303\ R} \times \frac{1}{T} + \text{constant} \quad (1)$$

The value of effective activation energy (E) of the corrosion in the presence or absence of inhibitor is calculated by the following equation:[2]

$$\log K = a + bT \quad (2)$$

where a and b are constants.

From Eq. (2) the following equation is derived:[3]

$$\log K = A/T - B \text{ where A and B are constants.} \quad (3)$$

Distilled water and AR grade sulphuric acid were used to prepare the solution of acid water of different pH. For each sample, 300 mL of sulphuric acid was added and the experiment was carried out at four different temperatures, *viz.*, 20, 40 50 and 60°C. The solutions were kept in a thermostat for a period of 4 h. The value of effective activation energy (E) of corrosion in presence and absence of inhibitor was calculated by the slope of the plot between log corrosion rate (logarithm) *vs.* reciprocal of absolute temperature in each of the states.

The heat of activation is calculated by the slope obtained from the plot of log corrosion rate *vs.* 1/T (Fig. 1) and (Fig. 2). The values obtained are given in Tables 1–3. Heat of activation is the energy barrier which has to be crossed for reaction to proceed, hence it has a positive value. In the absence of inhibitor,

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reaction is fast and hence heat of activation is less[4]. It indicates that in the absence of inhibitor corrosion rate is widely enhanced by temperature. The heat of activation was found to be 5.72 kcal without inhibitor and enhanced to 7.65 kcal in presence of inhibitor. With the addition of chloride, the activation was markedly affected because the corrosion rate was increased. Since with increasing concentration of chloride the reaction becomes faster, consequently the activation energy markedly decreased.

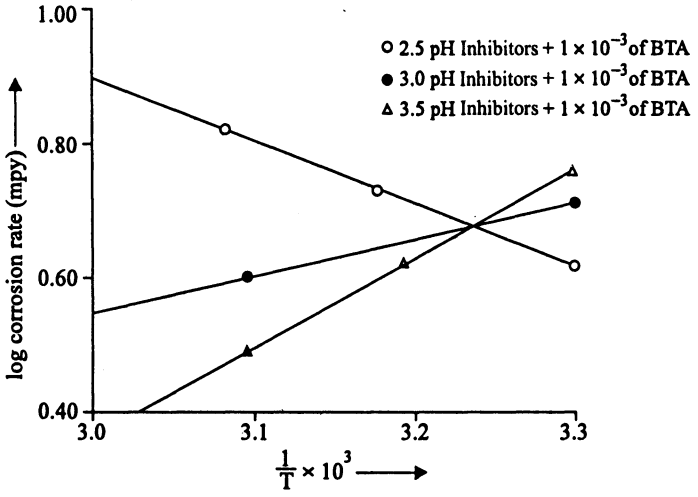

Fig. 1. Plot of log corrosion rate *vs.* 1/T in presence of mixed concentration of BTA

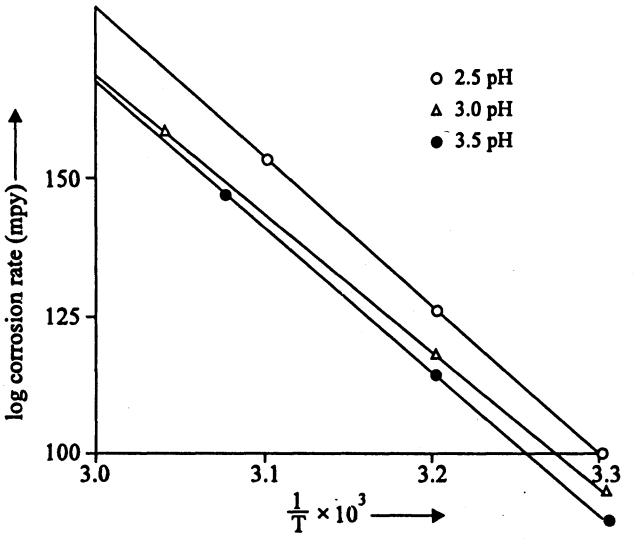

Fig. 2. Plot of log corrosion rate *vs.* 1/T at different pH of inhibitors

TABLE-1
IMMERSION TEST RESULTS OF COPPER IN DILUTE H_2SO_4 SOLUTION (pH = 3.5)

Immersion period = 4 h

Temperature (°C)	Corrosion rate (mpy)	Log rate corrosion (mpy)	Heat of activation (kcal mol^{-1})
30	9.728	0.98	
40	18.583	1.27	5.75
50	31.55	1.49	
60	13.84	1:14	

TABLE-2
IMMERSION TEST RESULTS OF COPPER INHIBITION BY 1×10^{-3} M BTA IN H_2SO_4 (pH = 3.5)

Immersion period = 4 h

Temperature (°C)	Corrosion rate (mpy)	Log corrosion rate (mpy)	Heat of activation (kcal mol^{-1})
30	5.45	0.736	
40	3.22	0.507	7.6
50	3.80	0.580	
60	1.426	0.154	

TABLE-3
IMMERSION TEST RESULTS OF COPPER IN H_2SO_4 (pH = 3.5) + 7×10^{-2} M Cl^-

Period of immersion = 4 h

Temperature (°C)	Corrosion rate (mpy)	Log corrosion rate (mpy)	Heat of activation (kcal mol^{-1})
30	42.20	1.625	
40	45.00	1.653	Zero approximate
50	40.69	1.609	
60	43.29	1.639	

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