TECHNICAL REPORT

Thiocresol as a Corrosion Inhibitor for Brass

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The inhibitory action of p-Thiocresol hydrochloric acid, nitric acid and sodium hydroxide solution has been investigated. It is found effective in acetic acid, and poor in nitric acid. The inhibition afforded by p-thiocresol in alkaline medium is lower that observed in acidic media. The galvanostatic measurements show that in acidic media p-thiocresol increases polarization of cathode to a considerable extent compared with that of the anode.

In the present investigation an attempt has been made to study the influence of p-thiocresol towards corrosion of 63/37 brass in hydrochloric acid, nitric acid acetic acid and sodium hydroxide solutions. Acetic acid has been found to be moderately corrosive to brass.[1–3]

Experimental

Brass sheets (63/37) were cold rolled and annealed at 550°C. It has the following composition : Cu-63.2, Zn - 36.6, Sn - 0.07 and Pb - 0.01%. The procedures for the preparation, testing and cleaning of specimens were adopted as those described by Champion.[4] Each specimen 3 × 6 cm (26 S. W. G.) was fully immersed in 250 ml of the test solution. All experiments were performed at 30 ± 2°C. The solution of p-thiocresol was prepared in ethanol.

For the galvanostatic studies the coupons used had an effective area of 4 sq. cm. (2 × 2 cm), the length of the handle being 4 cm. The handle as well as the back of the test coupons and auxiliary platinum electrode were coated with perspex and wax. The highest concentration of inhibitor was taken for the polarization studies. The external current was supplied from a storage battery.

Results and Discussion

The weight loss data on corrosion and its inhibition of brass (63/37) are given in Tables — 1 and 2.

(i) **Acetic acid :** In 0.1N acetic acid p-thiocresol acted as an excellent inhibitor at most of its concentration for 5-days duration. At 10 days duration, excellent inhibition was observed. In 0.5N acetic acid, excellent inhibition was observed at the intermediate concentration at both the durations.

The results of galvanostatic measurements showed that cathode was highly polarized even at lowest current density. At 2.5×10^{-5} amp/cm² current density a jump in cathodic potential was observed, indicating the film formation on the surface. The value of cathode potential remarkably increased with further increase in current density. Compared with the cathode polarization, anodic polarization was negligible. Hence, the reaction is predominantly under cathodic control.

(ii) **Hydrochloric acid :** In 0.5N HCl, p-thiocresol acted as an excellent inhibitor at its highest concentration. Its protective power decreased with duration, and also with increase in its concentration. In 1.0N HCl, its inhibitive power increased with the duration. At 10 days duration its inhibitive power decreased with its concentration. In general, p-thiscresol was found to be an excellent corrosion inhibitor for 63/37 brass. It formed a brown film on the metal surface which was difficultly removable by 5% sulphuric acid.

The galvanostatic measurements showed that p-thiocresol is predominantly cathodic inhibitor. A sudden shift in the cathodic potential indicates the film formation on the metal surface. Anodic polarization was not considerable in comparison with that of cathodic polarization.

(iii) **Nitric acid :** In 0.5N HNO_3, p-thiocresol acted as a fair inhibitor. The inhibitive power somewhat increased with its concentration. In 1.0N HNO_3, it acted as an accelerator of corrosion, more particularly at 2 days duration. The acceleration of corrosion increased with its concentration at 2 days duration.

The polarization studies showed that both the electrodes were polarized when an external current was impressed. At very low current density, cathodic potential was remarkably shifted towards more negative value probably due to mechanical film formation on

the metallic surface. At 2.5×10^{-3} amp/cm^2, cathode polarization was tremendous. Hence, the inhibition is predominantly under cathodic control.

(iv) **Sodium hydroxide** : p-Thiocresol was effective only in 0.5 N NaOH at its highest concentration. Its inhibitive power increased with its concentration but remained constant at longer duration. Its inhibitive power remarkably decreased in 1.ON NaOH. It is a poor corrosion inhibitor for 63/37 brass in sodium hydroxide solution.

In the case of p-thiocresol, the chemisorption should take place through sulphur atom. In p-thiocresol methyl group is attached to the benzene ring. The methyl radical is an electron repelling group. As a consequence the electron density over the sulphur atom is increased to some extent via benzene ring. This results in an increase in the overall inhibitive power.

In acetic acid cathode is polarized considerably in the presence of p-thiocresol. Anode is also polarized but slightly. In hydrochloric acid cathode is principally polarized. p-Thiocresol appears to form a film over the cathode. In nitric acid both the electrodes are polarized but cathodic polarization is found remarkable.

Extrapolation of the cathodic line gives the inhibitive powers which are in good agreement with those obtained by the weight loss data (Table 3.). In p-thiocresol the inhibition in alkaline medium is lower than that observed in acidic media.

TABLE — 1 Inhibition of Brass (63/37) in Acidic Media by p-Thiocresol

Size of specimen : 3×6 cm Temp. 30±2°C

Inhibitor Conc. M×10	Loss mdd	Inhibition %	Loss mdd	Inhibition %	Loss mdd	Inhibition %	Loss mdd	Inhibition %
	— 0.1 N acetic acid —				— 0.5 N acetic acid —			
	— 5 days —		— 10 days —		— 5 days —		— 10 days —	
0.0	21 5	—	22.2	—	27.8	—	24.1	—
1.61	12.7	41	17.9	20	12.2	56	22.3	8
3.22	0.6	98	0.8	97	1.2	96	14.6	39
6.44	0.2	99	0.5	98	0.4	98	0.9	96
9.66	0.1	99	0.6	98	0.2	98	0.8	97
16.10	0.3	99	6.5	71	2.8	90	9.1	62
	— 0.5 N hydrochloric acid —				— 1.0N hydrochloric acid —			
	— 5 days —		— 10 days —		— 5 days—		— 10 days —	
0.0	61.0	—	114	—	77.8	—	181.0	—
1.61	28.4	55	85.8	25	35.6	54	25.0	86
3.22	19.4	68	83.3	30	25.5	67	24.7	86
6.44	16.0	74	53.5	53	24.4	69	35.0	81
9.66	7.0	88	50.5	56	16.7	79	41.6	77
16.10	1.4	98	26.4	77	12.8	84	47.8	74
	— 0.5 N Nitric acid —				— 1.0N Nitric acid —			
	— 5 days —		— 10 days —		— 1 day —		— 2 days —	
0.0	45.0	—	52.8	—	236	—	208	—
1.61	25.0	44	16.2	69	194	15	297	—
3.22	18.0	60	16.0	69	161	32	272	—
6 44	16.6	63	15.4	71	317	—	316	—
9.66	13.9	69	14.7	72	397	—	632	—
16.10	11.4	74	14.2	73	416	—	900	—

TABLE — 2 Inhibition of Corrosion of Brass (63/37) in Sodium Hydroxide by p-Thiocresol

Size : 3×6 cm Temperature : 30±2°C

	7 days		15 days	
Inhibitor Conc. M×10³	Loss mdd	Inhibition %	Loss mdd	Inhibition %
	0.5 N NaOH			
0.0	19.8	—	11.5	—
0.32	8.0	60	5.37	53
0.64	7.53	62	5 00	56
1.29	6.34	68	4.44	61
1.93	6.00	70	2.59	78
3.22	4.00	80	2.40	79
	1.0 N NaOH			
0.0	25.8	—	22.2	—
0.32	21.8	15	12.6	43
0.64	20.2	22	10.9	51
1.29	18.6	28	10.4	53
1.93	16.6	35	10.2	54
3.22	15.8	38	9.44	57

TABLE — 3 Tafel Slope and Percentage Inhibition for 63/37 Brass In Acidic Media in Presence and Absence of p-Thiocresol

Solution	Tafel slope cathodic volts	Corrosion current from extrapolation of cathodic Tafel line A/Cm²	Inhibitor efficiencies from extrapolation of cathodic Tafel line	From weight loss method
0.5N CH_3 COOH	0.25	1.0×10^{-6}	—	—
0.5N CH_3 COOH + 1.61×10^{-3}M p-thiocresol	0.25	1.0×10^{-10}	99	96-98
0.5N HCl	0.17	2.512×10^{-7}	—	—
0 5N HCl + 1.61×10^{-3}M p-thiocresol	0.07	2.512×10^{-15}	99	98-77
0.5N HNO_3	0.10	1.413×10^{-7}	—	—
0 5N HNO_3 + 1.61×10^{-3} M p-thiocresol	0.20	3.162×10^{-8}	78	74-73

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