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Corrosion Inhibition Property of Some SEDA-Complexes on Mild Steel in Acidic Medium

KEYWORDS: Corrosion, Inhibition, Mild steel, SEDA complexes

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ABSTRACT *The present work deals with the corrosion behaviour of mild steel in acidic medium. The inhibitive effect of N'N-bissalicylidine ethylene diamine lanthanide complexes on the corrosion of mild steel in 0.2 M HNO_3 has been studied by weight loss and thermodynamic methods. The thermodynamic parameters for mild steel in acidic medium with and without inhibitor were calculated. The effect of concentration, temperature on the corrosion rate, activation energy and free energy of adsorption were also calculated.*

INTRODUCTION :
Most large structures in industries are made by mild steel owing to it's cheapness, availability and strength. In corrosive attack and the losses incurred due to corrosion rate estimated to be about 36000 crores in India (NACE International India section, Mumbai, 2007). HCl and H_2SO_4 are mainly employed for pilling, descaling, acidizing in mining and oil wells wherein mild steel suffers severe corrosion. Thus uninhibited acid solutions may be useless causing unnecessary dissolution of base metal.

Corrosion inhibitors are used in acid treatment solutions to significantly reduce the over all and local pilling attack and the hydrogen absorption of steel. It has been speculated that organic inhibitors are more effective with MS and specially polar organic compounds containing sulphur and nitrogen are good corrosion inhibitors for the acidic dissolution of methods[1-8]. The high electron density on the S and N atoms in these organic molecules help to get chemisorbed on the metal surface. In the present work a study has been made on the effectiveness of SEDA - Lanthanide complexes on corrosion of mild steel in 0.2 M HNO_3 medium.

EXPERIMENTAL WORK :
Mild steel wire from local manufacturer with 6.6" length and 0.095 cm in diameter were used for corrosion study. The specimen wire is first of all cleaned with dil. Hydrochloric acid and then by sand paper followed by distilled water wash.After it was dried by keeping in oven at 120^{0}c.

In the first beaker 50 ml. 0.2 N nitric acid was taken and labeled as 1 for controlled system. Beaker no.2 along with 50 ml. 0.2 N nitric acid, 30 mg. SEDA ligand was added. In labeled beaker 3, 4, 5, 6, 7 and 8 50 ml. 0.2N nitric acid along with 30mg. La, Nd, Tb, Sm, Pr and Ce complexes were added respectively. The previously weighed steel wire was dipped for 48 hr.

At the end wire pieces were taken out from the beaker,washed with distilled water and dried, The weight of each wire was recorded by using electronic balance in gm up to three digits and is presented in Table no.1.

RESULT AND DISCUSSION :
Weight loss measurement :
Weight of metal wire pieces before and after dipping in corrosion solution, loss in weight, % of I. E. was calculated by usual method. The % of I.E. were calculated by following formula $P = \left(\frac{wu - wi}{wu} \right) \times 100$

Table No. 1 : % Inhibition Efficiency of metal complexes

Beaker No.	compound	Initial wt. gm.	Final wt. gm.	Loss in wt gm	% I.E
1.	Control	0.830	0.676	0.154	-
2.	HNO_3 + Ligand	0.837	0.685	0.152	1.29%
3.	HNO_3 + La complex	0.827	0.677	0.150	2.59%
4.	HNO_3 + Nd complex	0.843	0.692	0.151	1.94%
5.	HNO_3 + Tb complex	0.790	0.646	0.146	5.10%
6.	HNO_3+ Sm complex	0.838	0.690	0.148	3.89%
7.	HNO_3 + Pr complex	0.794	0.646	0.148	3.89%
8.	HNO_3 + Ce complex	0.800	0.658	0.142	7.79%

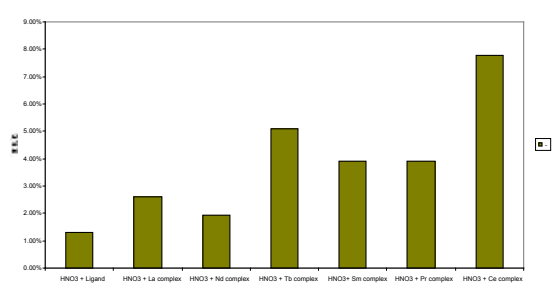

Chart No. 1 : Comparison of % I.E. with different metal complexes.

From data it can be seen that, the Ce, Tb, Sm and Pr complexes have maximum Inhibition efficiencies than La, Nd, complexes. The ligand shows the least inhibitor efficiency.

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2. Free energy of Adsorption :
The values of free energies of adsorption (ΔGa) were calculated with the help of following equation as[9].

$$\log C = \log\left(\frac{\theta}{1-\theta}\right) - logB$$

Where,

$$\log B = -1.74 \times (\Delta Ga / 2.303RT),$$

C = Inhibitor concentration and

$$\theta = \left(\frac{wu - wi}{wi}\right) \times 100$$

is the fraction of metal surface covered by the inhibitors[10].

Table No. 2 : Calculation of Δ Ga values

Sr. No.	Concentration	q	$\log\left(\frac{\theta}{1-\theta}\right)$	Log B	Δ Ga
1	-	-	-	-	-
2	0.0022388	0.0197	-1.6969	0.9532	-3167.71
3	0.0008392	0.02666	-1.5624	1.5137	-5030.38
4	0.0008330	0.01986	-1.6933	1.3860	-4606.00
5	0.0008164	0.05479	-1.2368	1.8512	-6151.97
6	0.0008261	0.04054	-1.3741	1.7088	-5678.74
7	0.0008370	0.4054	-1.3741	1.7031	-5659.80
8	0.0008378	0.08450	-1.0348	2.0422	-6786.04

The free energy of adsorption of Ce complex is maximum compaired to free energy of adsorption of Tb, Sm, Pr, La and Nd complexes and ligand.

3. Corrosion rate and Energy of activation :
The corrosion rate in gm cm^{-2} h^{-1} was calculated from the following formula as[11].

$$P = \frac{\Delta W}{At}$$

Where ΔW is the weight loss, A is the total area of the wire and t is the immersion time. The relationship between the corrosion rate (r) and temperature (T) in acid medium is given by Arrhenius equation as.

$$\log \rho = \log A - \frac{Ea}{2.303RT}$$

Or

$$Ea = 2.303RT \log \frac{A}{P}$$

Where Ea is the apparent activation energy, R is the molar gas constant and T is the absolute temperature.

Table No. 3 : Values of corrosion rate and Energy of activation

Sr. No.	r	Ea (KJ mol^{-1})
1	-	-
2	0.00160	17867.70
3	0.00138	17899.51
4	0.00159	17883.32
5	0.00154	17963.69
6	0.00154	17631.69
7	0.00156	17931.31
8	0.00150	18029.61

Results of corrosion rate and energy of activation also show similar trends as that for % I.E.

4. Enthalpy of adsorption and entropy of adsorption :
The enthalpy of adsorption $(\Delta H^0 ads)$ and entropy of adsorption $(\Delta S^0 ads)$ were calculated using the following equation as.

ΔH^0 ads = Ea – RT, ΔS^0 ads $= \frac{\Delta Hads - \Delta Gads}{T}$

Table No. 4 : ΔH^0 ads and ΔS^0 ads

Sr. No.	ΔH^0 ads (kJ mol^{-1})	ΔS^0 ads (J mol^{-1} k-1)
1		
2	15356.88	61.3397
3	15388.69	67.6128
4	15372.50	66.1539
5	15452.87	71.5392
6	15452.87	69.9722
7	15450.49	69.8022
8	15518.79	73.8504

Ce, Tb, Sm, Pr complexes shows maximum enthalpy of adsorption as compared to La, Nd and free ligand. While Ce complex shows highest entropy of adsorption than Tb, Sm, Pr, La, Nd and free ligand. Free ligand has the least entropy of adsorption.

CONCLUSION :
From study it reveilles that the % I.E. free energy of adsorption, corrosion rate, Enthalpy of adsorption and entropy of adsorption has more values for the metal complexes than that of free ligand. The Ce complex has maximum efficiency while an Nd complex has the least efficiency of inhibition. Thus Ce complexes of these ligand can be efficiently employed as potential corrosion inhibitor.

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