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CORRIOSION INHIBITION EFFECT OF DPDS-LANTHANIDE COMPLEXES ON MILD STEEL IN NITRIC ACID

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Abstract:-Addition of corrosion inhibitors is one of the widely used methods to control corrosion. In this work, an attempt has been made to explore the possibility of using 2,2'-dipyridyl disulphide (DPDS) complex as an inhibitor on mild steel in 0.2 M HNO_3. The inhibition efficiency of DPDS complex has been evaluated by conventional weight loss method and thermodynamic parameter studies. Experimental results are fitted to various adsorption isotherms. The result reveal that DPDS acts as an effective inhibitor around 90% of I.E. in HNO_3 media.

Keywords: Corrosion, inhibitor, DPDS complexes mild steel.

INTRODUCTION

Most large structures in industries are made by steel owing to its cheapness, availability and strength. In corrosive environments mild steel is susceptible to corrosion attack and the losses incurred due to corrosion.

Most of the acid inhibitors are organic compounds nitrogen, sulphur and oxygen atoms. It has been reported that many heterocyclic compounds containing heteroatoms like N, O, S have been proved to be effective inhibitor for the corrosion of steel in acidic solution has been investigated by several authors. The inhibition property of these compounds is attributed to their molecular structure. The planarity and lone pairs of electron on the heteroatoms are important features that determine the adsorption of these molecules on the metallic surface. They can adsorb on the metal surface, block the active sites on the surface and there by reduce the corrosion rate.

The aim of this work is to investigate the role played by newly synthesized 2,2'-dipyridyl disulphide (DPDS) complexes with lanthanide on the corrosion of mild steel in 0.2 M nitric acid. Using DPDS complexes various study using DPDS complexes is a new methodology though its synthesis already exists. Since the work on the corrosion inhibition of mild steel is not expensive, an attempt was made to examine the inhibitive action of mild steel in acidic solutions.

RESULT AND DISCUSSION :

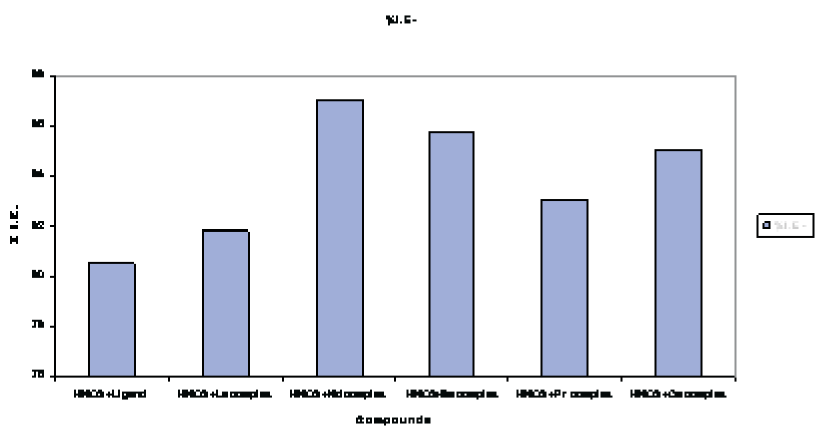
Weight loss measurement :

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	0.791	0.761	0.030	80.51
3.	HNO_3 + La complex	0.845	0.817	0.028	81.81
4.	HNO_3 + Nd complex	0.847	0.823	0.024	87.01
5.	HNO_3+ Sm complex	0.834	0.812	0.222	85.77
6.	HNO_3 + Pr complex	0.847	0.821	0.226	83.11
7.	HNO_3 + Ce complex	0.831	0.808	0.023	85.06



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

2.Free energy of Adsorption :

The values of free energies of adsorption (ΔGα)were calculated with the help of following equation as[1].

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

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[2].

Table No. 2 : Calculation of ΔGa values

Sr. No.	Concentration	θ	$\log\left(\frac{\theta}{1-\theta}\right)$	Log B	Δ Ga
1	-	-	-	-	-
2	0.0002723	4.13	-0.05667	2.50828	-8335.43
3	0.0009725	4.50	-0.1091	2.9029	-9647.03
4	0.0009673	5.40	-0.09691	2.9174	-9695.20
5	0.0009580	6.10	-0.07918	2.9394	-9768.31
6	0.0009725	4.90	-0.09912	2.9129	-9680.25
7	0.0009738	5.60	-0.08539	2.9261	-9724.11

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

3.CORROSION RATE AND ENERGY OF ACTIVATION :

The corrosion rate in gm cm^{-2} h^{-1} was calculated from the following formula as[3].

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

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 () and temperature (T) in acid medium is given by Arrhenius equation as.

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

Or

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

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.	ρ	Ea (KJ mol^{-1})
1	-	-
2	0.000317	32497.25
3	0.000296	31827.43
4	0.000250	32251.45
5	0.000230	32460.85
6	0.000279	32012.65
7	0.000243	32322.77

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.

$$\Delta H^0 \text{ ads} = \text{Ea} - \text{RT}, \quad \Delta S^0 \text{ ads} = \frac{\Delta Hads - \Delta Gads}{T}$$

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	29144.340	124.1050
3	29316.602	129.01860
4	29470.627	130.5822
5	29950.022	132.3940
6	29501.390	129.7420
7	29811.942	130.9140

Complexes shows maximum enthalpy of adsorption as compared to Pr, La and Free lingand. While Sm, Ce, Nd have maximum entropy of adsorption as compared to Pr, La and free ligand.

CONCLUSION :

2,2'-dipyridyldisulphide (DPDS) complexes exhibits maximum efficiency towards corrosion inhibition of mild steel in 02 M HNO_3 media even at a very low concentration. The inhibition of corrosion by DPDS complexes is due to the physical adsorption on the metal surface. It is apparent from the molecular structures that these compounds are able to get adsorbed on the metal surface through π electrons of aromatic ring and lone pair of electrons of N, O and S atoms.

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