Chelating agents used as metal corrosion inhibitor in different mineral acidic medium

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Abstract: Dimethyl glyoxime, Cupron (α-benzoin oxime), Oxine (8-hydroxy quinoline), α-nitroso β-naphthol, Ethylene diamine tetra acetic acid (EDTA) as a corrosion inhibitor for carbon steel was investigated. The study revealed that the Chelating agents has an inhibitory action on the corrosion of carbon steel in the investigated medium. Corrosion rate of carbon-steel was studied using chemical weight loss method at room temperature. This research paper presents use of Chelating agent as corrosion inhibitors for metals in 0.1N, 0.01N and 0.001N (HCl, HNO_3 and H_2SO_4) acidic medium. The phenomenon of chemical adsorption forms thin film on the surface of the material that stops access of the corrosive substance to the metal which increases in its inhibition efficiency.

Keywords: Corrosion, Inhibition, carbon steel, Weight loss and Chelating agents.

INTRODUCTION

Mild steel is widely used as a constitutional material in many industries due its good mechanical properties and low cost. The corrosion of mild steel is fundamental academic and industrial concern that has received a considerable amount of attention. Acid pickling baths are employed to remove undesirable scale from the surface of the metals. Once the scale is removed, the acid is then free from further attack on the metal surface. The use of inhibitor is one of the most practical method for protection against corrosion, especially in acidic media. The use of inhibitors is one of the most practical methods for protecting metal or alloys from corrosion. Compared with inorganic salt corrosion inhibitors, using organic corrosion inhibitors in an effective, in expective and less pollution means of reducing the degradation of metal or alloys in many fields of applications, and which has been extensively investigated during the last decade [1 – 3]. Most of the well-known inhibitors are organic compound containing nitrogen, oxygen and Sulphur atoms, heterocyclic compounds and the delocalized π- electrons. It is generally accepted that organic molecules inhibit corrosion via adsorption at the metal solution interface[4-7]. making the adsorption layer to function has a barrier, and isolating metal from the corrosion[8-10]. Inhibitors that change cathodic or anodic processes kinetically also are important additives in the technological processes of metal deposition.[11-13] Chelating agents find use in paper pulp bleaching detergents and cleaning water treatment and food industries[14-16]. Chelates have also been used for the extraction of metals [17,18]. Other applications where chelating agents are used include fertilizers [19], photography [20] and pharmaceuticals [21].

EXPERIMENTAL SECTION

Corrosion inhibition of mild steel in various acidic medium by chelating agent. Steel binding wire was purchased from the local market. First all wire cleaned by sand paper, and then it was washed by cleaning solution later on by distilled water. After cleaning the wire, it was dried by keeping at room temperature. After the preparation of the mixture solution in different labeled beaker 1-54, the previously weighed steel wire was dipped for 48 hours. After 48 hours the wire pieces were taken out from the beaker, pieces were washed with distilled water and dried. The weight of each wire was determined by using electronic balance in mg and they were recording tables. In this experiment beakers were labeled from 1-54 and in beakers having labeled 1-6 20ml 0.1N HCl, 7-12 20ml 0.01N HCl, 13-18 20ml 0.001N HCl, in beakers 19-24 20ml 0.1N HNO_3, 25-30 20ml 0.01N HNO_3 and in beaker 31-36 20ml0.001N HNO_3 and in beakers 37-42 20ml 0.1N H_2SO_4, 43-48 20ml 0.01N H_2SO_4, 49-54 20ml 0.001N H_2SO_4 were added. 20 mg of DMG, Cupron (α-benzoin oxime), Oxine (8-hydroxy quinoline), α-nitroso β-naphthol, EDTA of were added to beakers. The Chelating agents of different organic compounds used are labeled as, Compound (A)Dimethyl glyoxime, Compound (B)Cupron (α-benzoin oxime), Compound (C)Oxine (8-hydroxy quinoline), Compound (D)Ethylene diamine tetra acetic acid, Compound (E) α-nitroso β-naphthol. Weight of metal wire pieces before and after dipping in corrosion solution, loss in weight, % loss weight was calculated by usual method. The % inhibition efficiency was calculated by using following formula,

$$I.E. = \frac{W_u - W_i}{W_u} \times 100$$

Where,

I.E. = Inhibition efficiency.

W_i= Weight loss of metal in inhibitor solution

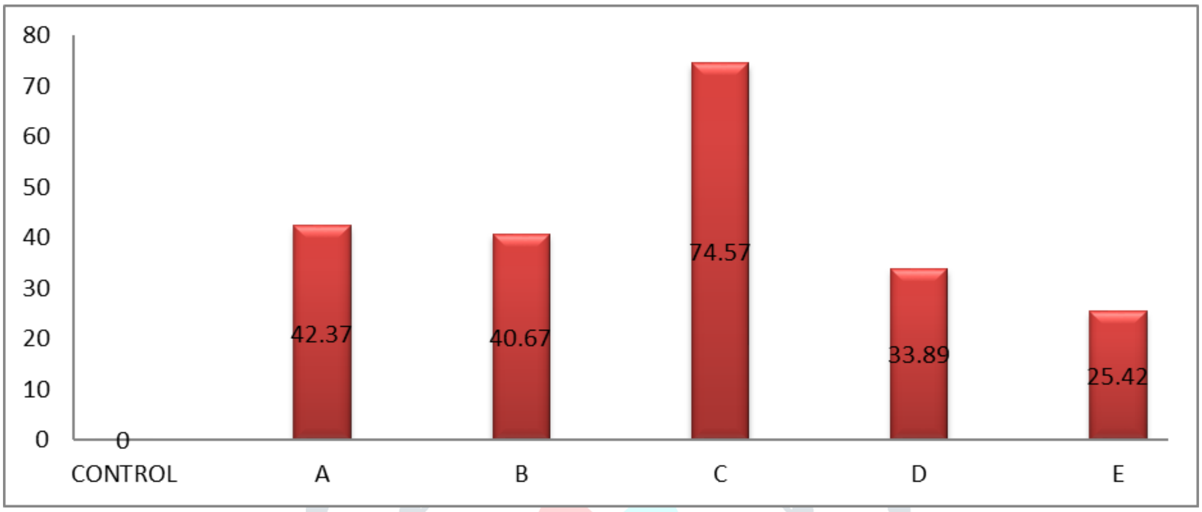
W_u = weight loss of metal in control solution

RESULT AND DISCUSSION

Effect of various Chelating agents on corrosion in 0.1N HCl (Table No.1)

Compound	Initial weight (W_1)	Final Weight (W_2)	Loss in weight (△W)	% Loss in weight	I.E. (%)
Control	0.316	0.257	0.059	18.67	-
A	0.317	0.283	0.034	10.72	42.37
B	0.295	0.262	0.033	11.18	40.67
C	0.304	0.289	0.015	4.93	74.57
D	0.308	0.269	0.039	12.66	33.89
E	0.283	0.239	0.044	15.54	25.42

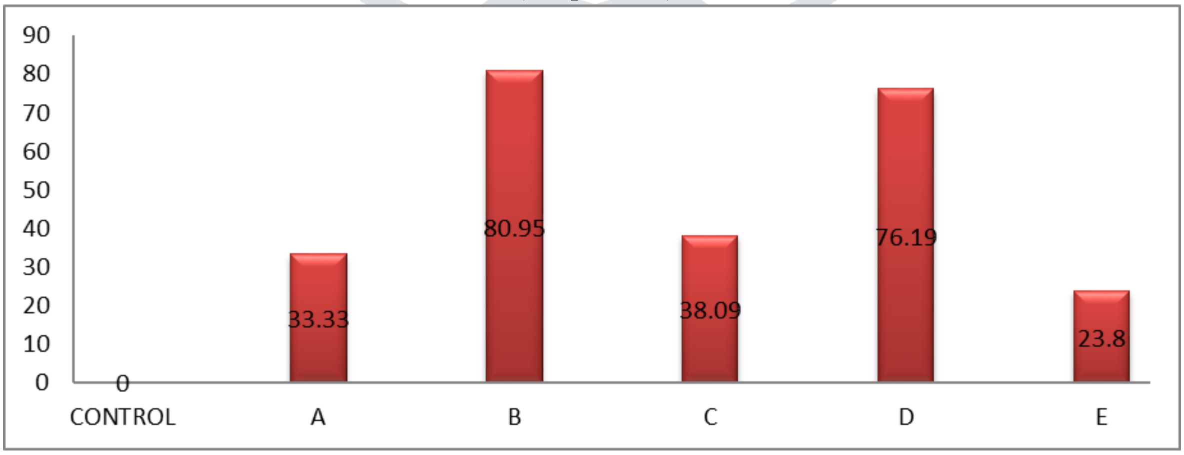
Fig: Variation of weight loss of mild steel in 0.1N HCl solution containing different Chelating agents. (Graph No.1)



Effect of various Chelating agents on corrosion in 0.01N HCl. (Table No. 2)

Compound	Initial weight (W_1)	Final Weight (W_2)	Loss in weight (△W)	% Loss in weight	I.E. (%)
Control	0.302	0.281	0.021	6.95	-
A	0.304	0.290	0.014	4.60	33.33
B	0.285	0.281	0.004	1.40	80.95
C	0.319	0.306	0.013	4.07	38.09
D	0.309	0.304	0.005	1.61	76.19
E	0.303	0.287	0.016	5.28	23.80

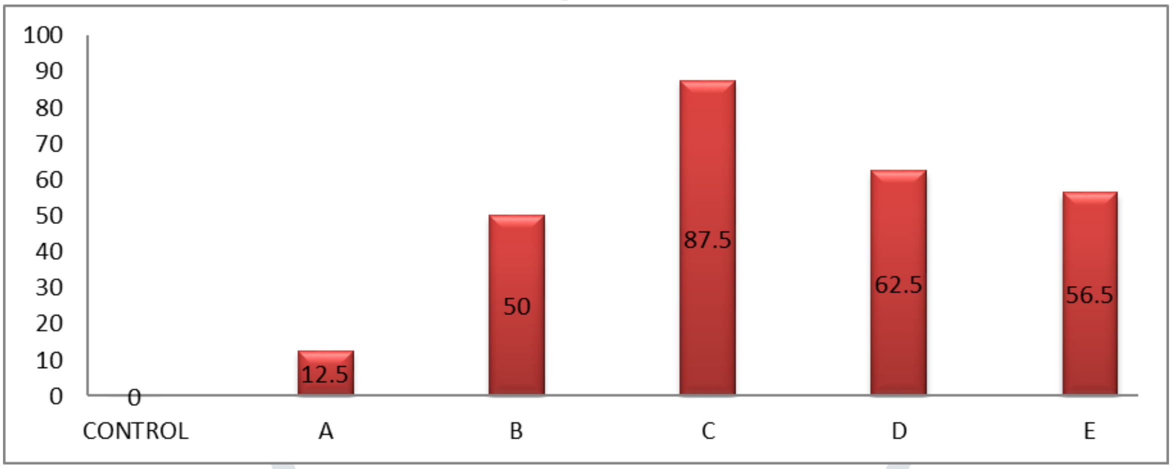
Fig: Variation of weight loss of mild steel in 0.01N HCl solution containing different Chelating agent. (Graph No. 2)



Effect of various Chelating agents on corrosion in 0.001N HCl. (Table No. 3)

Compound	Initial weight (W_1)	Final Weight (W_2)	Loss in weight (△W)	% Loss in weight	I.E. (%)
Control	0.322	0.306	0.016	4.96	-
A	0.337	0.323	0.014	4.15	12.5
B	0.283	0.275	0.008	2.90	50.00
C	0.304	0.302	0.002	0.65	87.50
D	0.333	0.327	0.006	1.80	62.50
E	0.313	0.306	0.007	2.23	56.52

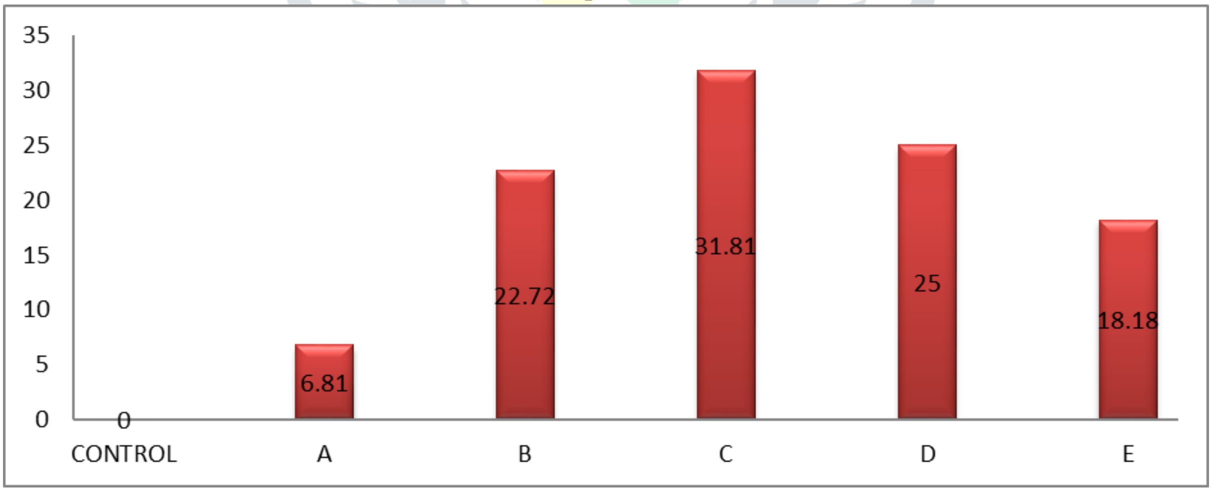
Fig: Variation of weight loss of mild steel in 0.001N HCl solution containing different Chelating agent. (Graph No. 3)



Effect of various Chelating agents on corrosion in 0.1N HNO_3. (Table No. 4)

Compound	Initial weight (W_1)	Final Weight (W_2)	Loss in weight (△W)	% Loss in weight	I.E. (%)
Control	0.304	0.260	0.044	14.47	-
A	0.314	0.273	0.041	13.05	6.81
B	0.303	0.269	0.034	11.22	22.72
C	0.298	0.268	0.030	10.06	31.81
D	0.306	0.273	0.033	10.78	25.00
E	0.273	0.237	0.036	13.18	18.18

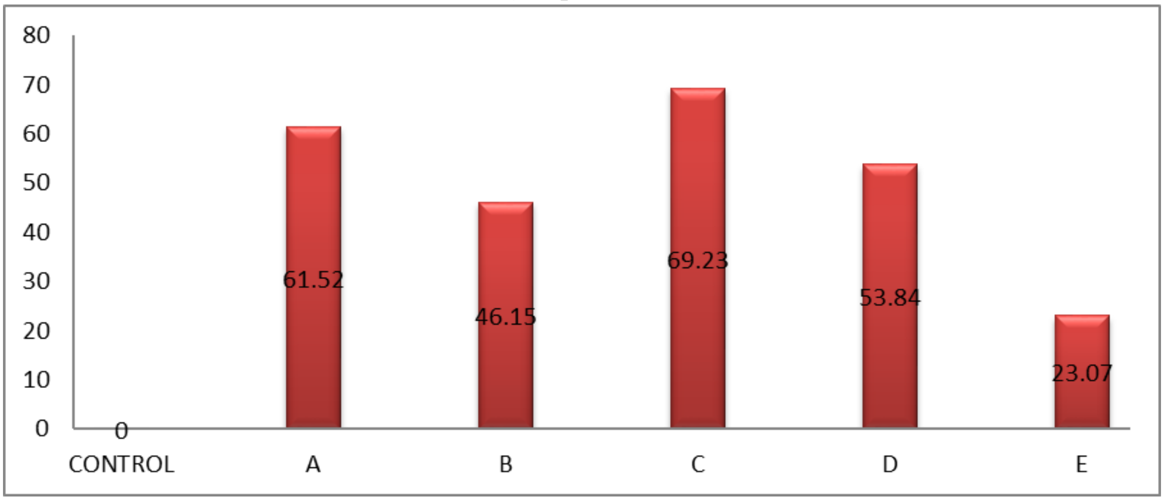
Fig: Variation of weight loss of mild steel in 0.1N HNO_3 solution containing different Chelating agent. (Graph No. 4)



Effect of various Chelating agents on corrosion in 0.01N HNO_3 (Table No. 5)

Compound	Initial weight (W_1)	Final Weight (W_2)	Loss in weight (△W)	% Loss in weight	I.E. (%)
Control	0.307	0.294	0.013	4.23	-
A	0.280	0.275	0.005	1.78	61.53
B	0.301	0.294	0.007	2.32	46.15
C	0.291	0.287	0.004	1.37	69.23
D	0.314	0.308	0.006	1.91	53.84
E	0.307	0.297	0.010	3.25	23.07

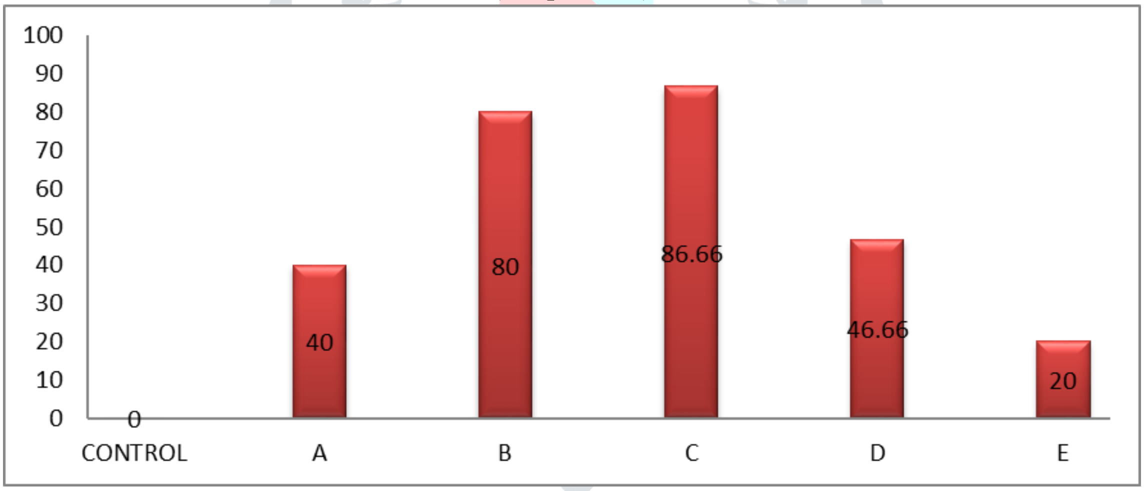
Fig: Variation of weight loss of mild steel in 0.01N HNO3 solution containing different Chelating agent (Graph No. 5)



Effect of various Chelating agents on corrosion in 0.001N HNO_3 (Table No. 6)

Compound	Initial weight (W_1)	Final Weight (W_2)	Loss in weight (ΔW)	% Loss in weight	I.E. (%)
Control	0.280	0.265	0.015	5.35	-
A	0.297	0.306	0.009	3.03	40.00
B	0.300	0.397	0.003	1.00	80.00
C	0.302	0.304	0.002	0.66	86.66
D	0.287	0.279	0.008	2.78	46.66
E	0.294	0.282	0.012	4.08	20.00

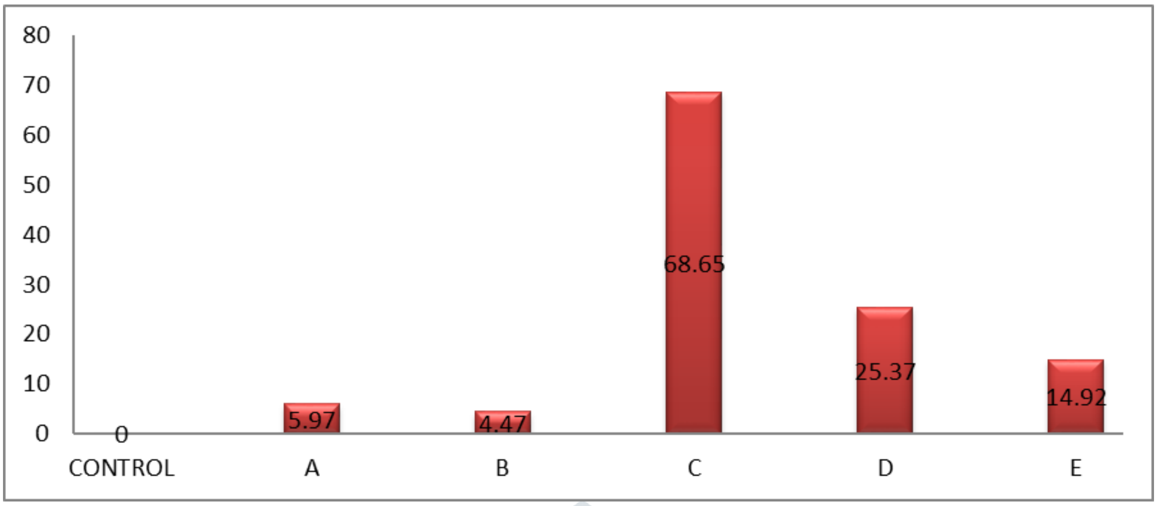
Fig: Variation of weight loss of mild steel in 0.001N HNO_3 solution containing different Chelating agent (Graph No. 6)



Effect of various Chelating agents on corrosion in 0.1N H_2SO_4 (Table No. 7)

Compound	Initial weight (W_1)	Final Weight (W_2)	Loss in weight (ΔW)	% Loss in weight	I.E. (%)
Control	0.324	0.257	0.067	20.67	-
A	0.311	0.248	0.063	20.25	5.97
B	0.333	0.269	0.064	19.21	4.47
C	0.320	0.299	0.021	6.56	68.65
D	0.327	0.277	0.050	15.29	25.37
E	0.322	0.265	0.057	17.70	14.92

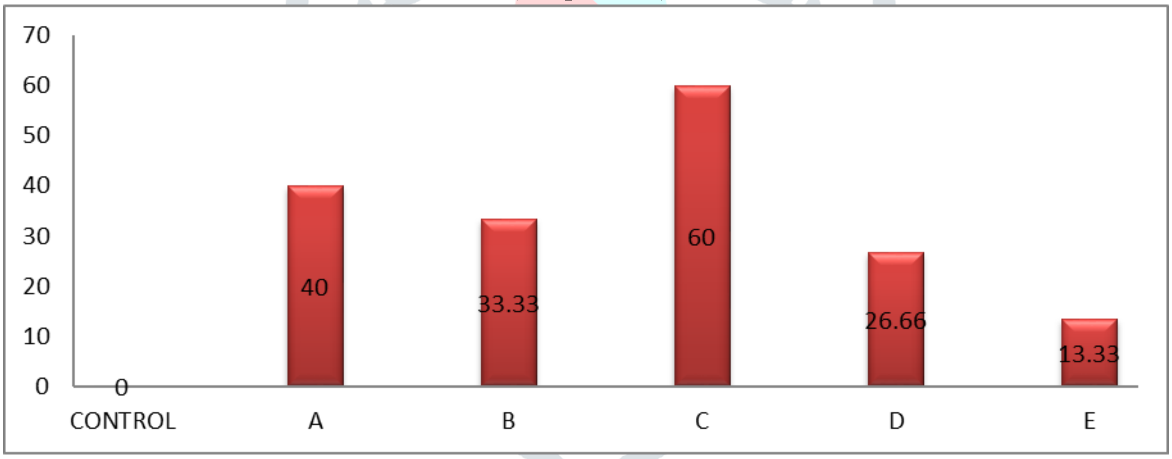
Fig: Variation of weight loss of mild steel in 0.1N H_2SO_4 solution containing different Chelating agent (Graph No. 7)



Effect of various Chelating agents on corrosion in 0.01N H_2SO_4 (Table No. 8)

Compound	Initial weight (W_1)	Final Weight (W_2)	Loss in weight (ΔW)	% Loss in weight	I.E. (%)
Control	0.329	0.314	0.013	4.55	-
A	0.323	0.314	0.009	2.78	40.00
B	0.333	0.323	0.010	3.00	33.33
C	0.315	0.309	0.006	1.90	60.00
D	0.333	0.322	0.011	3.30	26.64
E	0.332	0.318	0.013	3.91	13.33

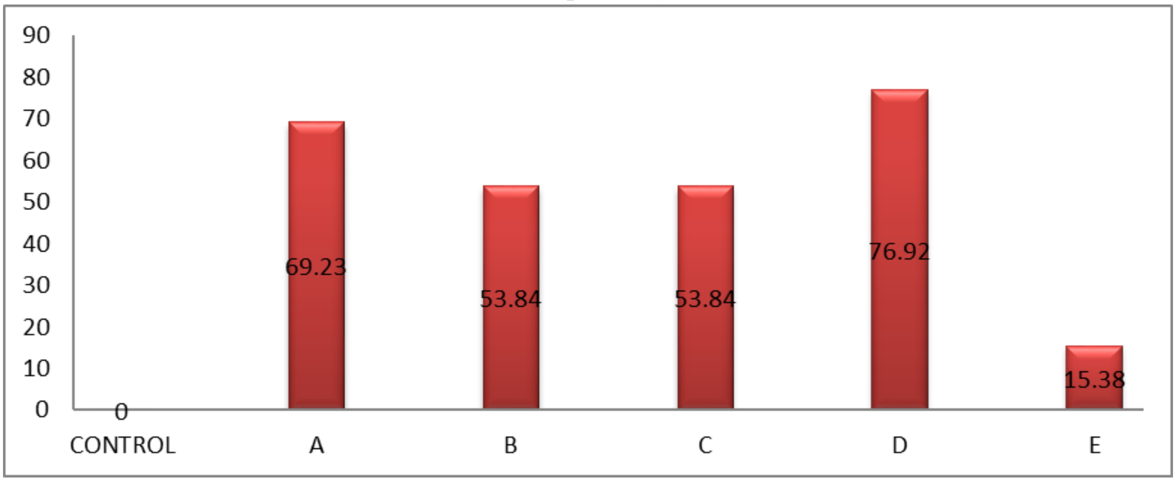
Fig: Variation of weight loss of mild steel in 0.01N H_2SO_4 solution containing different Chelating agent (Graph No. 8)



Effect of various Chelating agents on corrosion in 0.001N H_2SO_4 (Table No. 9)

Compound	Initial weight (W_1)	Final Weight (W_2)	Loss in weight (ΔW)	% Loss in weight	I.E. (%)
Control	0.331	0.318	0.013	3.92	-
A	0.328	0.324	0.004	1.21	69.23
B	0.336	0.330	0.006	1.78	53.84
C	0.327	0.321	0.006	1.83	53.84
D	0.329	0.326	0.003	0.91	76.92
E	0.327	0.316	0.011	3.36	15.38

Fig: Variation of weight loss of mild steel in 0.001N H_2SO_4solution containing different Chelating agent (Graph No. 9)



In this study, corrosion inhibition efficiency of chelating agents on steel binding wire in various acidic medium was determined by weight loss measurements. The weight loss technique studies confirmed the blockage of metal surface through adsorption process. From certain graphical and observation table, we conclude that compound (A) DMG exhibit inhibition efficiency is 61.52 % in 0.01N HNO_3 and 69.23 % in 0.001N H_2SO_4. In higher acid concentration it shows less inhibition effect. In compound (B) Cupron was observed 80.98% in 0.01N HCl and also shows 80% in 0.001N H_2SO_4. Cupron exhibits 4.47% inhibition efficiency in 0.1N H_2SO_4 which low value in all concentration of acidic medium. The most effective corrosion inhibition for the steel binding wire was observed with 8 - Hydroxy quinoline (Compound C) protection factors up to 87.5% in 0.001N HCl solution. Similarly, in other concentration of acids shows 74.57% in 0.1N HCl, 69.23% in 0.01 N HNO_3 and 68.65% in 0.1N H_2SO_4 etc. The inhibition effects of α-nitroso β–naphthol on the corrosion of steel binding wire in various corrosive medium were investigated. In compound (D) α-nitroso β-naphthol inhibitor efficiency can reach a considerable value of 76.005 in 0.01N HCl and also 0.001N H_2SO_4. In different acid dilution exhibits below 50.00%EDTA showed inhibition efficiency 56.50% in 0.001N HCl, comparing EDTA with other chelating agents it shows less inhibition efficiency. The present study investigates the inhibiting effects of 8-Hydroxy quinoline and Cupron functioning as transcription inhibitors and exhibits good inhibition efficiency compounds.

CONCLUSION

In this analysis, corrosion inhibition efficiency of different chelating agents on mild steel wire in (0.1N, 0.01 N, 0.001N), HCl, HNO_3 and H_2SO_4 corrosive acidic medium was determined by weight loss technique. Weight loss inhibition efficiency data reveals to give various values, which accounted for good inhibition efficiency. The inhibition efficiency of mild steel corrosion B in order of 8- hydroxyl quinoline > cupron > α-nitroso β- naphthol > DMG > EDTA.

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