Study on the inhibition of mild steel corrosion by various amino group of organic compounds in different acidic medium

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ABSTRACT: The inhibition of corrosion of mild steel in HCl, HNO_3 and H_2SO_4 in acid medium by aromatic amines like P-Chloroaniline, O-Anisidine, P-Ethoxy aniline, Nitroaniline and α-Naphthol amine. It was shown that these inhibitors act as good corrosion inhibitors for mild steel protection. The inhibition efficiencies were attributed to the simple blocking effect by adsorption of inhibitor molecules on the mild steel surface. Weight loss data at different acid medium were used to determine inhibition efficiency of aromatic amines.

KEYWORDS: Corrosion, Inhibition, carbon steel, Weight loss and Aromatic amines.

INTRODUCTION

Steel is widely used as part of our life in different applications in automotive, household appliances, machinery and heavy construction such as the marine, petroleum and chemical industries which make it very important to research corrosion and protection of iron and its alloys. The most issue of iron is how to improve its resistivity against corrosion phenomena, which is one of the measure regions for industrial accident and consumption of material resource[1-2]. Corrosion is an electrochemical phenomenon and is accompanied by the flow of electrical phenomenon and is accompanied by the flow of electrical current. Organic compounds have become widely accepted as if effective corrosion inhibitors in various media. Most of the organic inhibitors containing nitrogen, oxygen, sulfur atoms, and multiple bounds in their molecule's facilities adsorption on the metal surface[3-5]. Organic compounds are recognized as effective inhibitors of the corrosion of corrosion of many metals and alloy. The efficiency of an organic compound as a corrosion inhibitor is closely associated with the chemical absorption[6-7,] acid inhibitors have many important roles in the industrial field as a component in pre-treatment composition, in cleaning solution for industrial equipment's an in acidization oil wells. The absorption of the surfactant on the metal surface can markedly change corrosion resisting properties of the metal[8-9,] so the study of the relation between the adsorption and corrosion inhabitation is of great importance. Amines have been investigated as corrosion inhibitor by many workers in different metals and in different environments [10-12]. In the present work, the effect of aromatic amines like p-chloroaniline, o-anisidine, p-ethoxy aniline, nitroaniline and ∝-napthol aniline as corrosion inhibitor for mild steel in HCl, HNO_3 and H_2SO_4 acid has been reported.In this context, the effects of the structural changes on the ability of these compounds to act as corrosion inhibitors by theoretical calculations were investigated.

EXPERIMENTAL SECTION

To study the effect of inhibition efficiency of different amino group of organic compounds. The simple experiments were carried out. Mild steel binding wire were cleaned first by regmal paper and wash with water and it was dried. After drying it was cuted in small 5cm pieces and its weight were determined on analytical balance as initial weight. 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 20ml 0.001N 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. After the preparation of the mixture solution in different labeled beaker, dipped binding wire pieces in each beaker for 48 hours. After 48 hours the wire pieces were taken out from the beaker. They were washed with water and dried at room temperature. Its weight was determined on analytical balance as final weight. The loss in mass was determined using the relation.

$$I.E. = \frac{Wu - Wi}{Wi} \times 100$$

Where,

I.E. = Inhibition efficiency.

W_i= Weight loss of metal in inhibitor solution

W_u = weight loss of metal in control solution

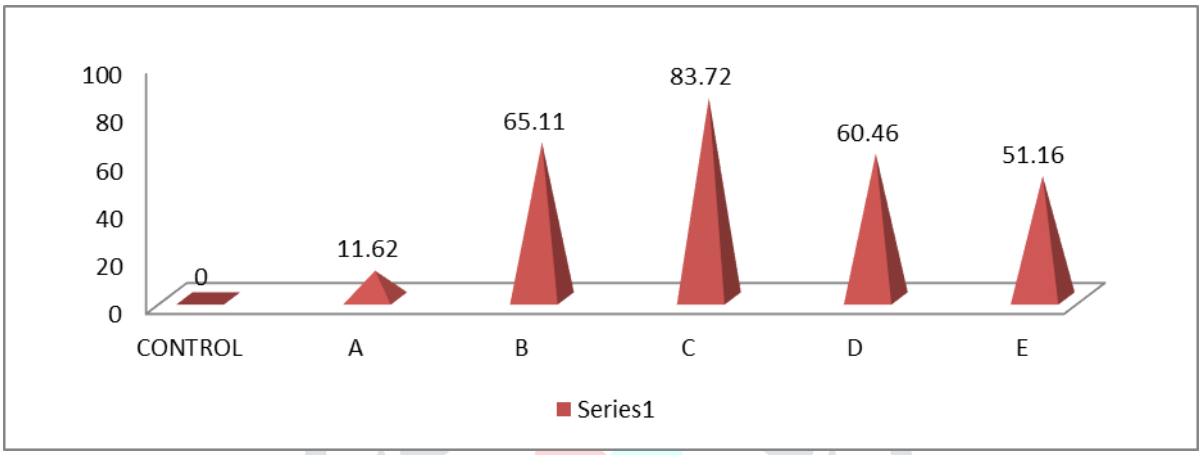
RESULT AND DISCUSSION

Effect of various amino group of organic compounds on corrosion in 0.1N HCl

Table No. 1

Compound	Initial weight (W_1)	Final Weight (W_2)	Loss in weight ($\triangle W$)	% Loss in weight	I.E. (%)
Control	0.331	0.288	0.043	12.99	-
A	0.316	0.278	0.038	12.02	11.62
B	0.300	0.285	0.015	5.00	65.11
C	0.305	0.298	0.007	2.29	83.72
D	0.307	0.290	0.017	5.53	60.46
E	0.313	0.292	0.021	6.70	51.16

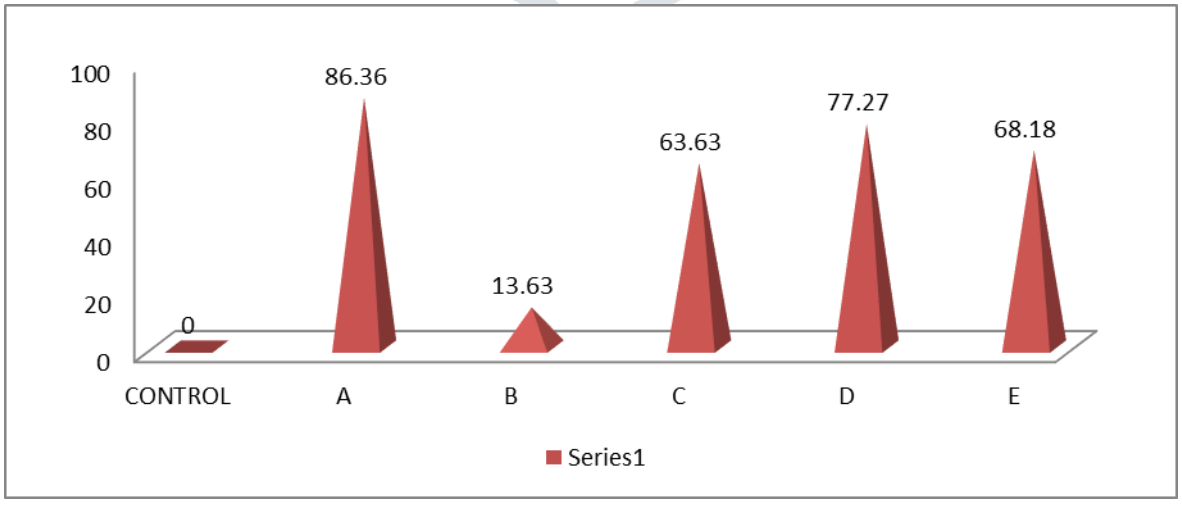
Fig: Variation of weight loss of mild steel in 0.1N HCl solution containing different amino group of organic compounds (Graph No.1)



Effect of various amino group of organic compounds on corrosion in 0.01N HCl (Table No. 2)

Compound	Initial weight(W_1)	Final Weight(W_2)	Loss in weight($\triangle W$)	% Loss in weight	I.E. (%)
Control	0.328	0.306	0.022	6.70	-
A	0.290	0.287	0.003	1.03	86.36
B	0.344	0.325	0.019	5.52	13.63
C	0.343	0.335	0.008	2.33	63.63
D	0.310	0.305	0.005	1.61	77.27
E	0.286	0.279	0.007	2.44	68.18

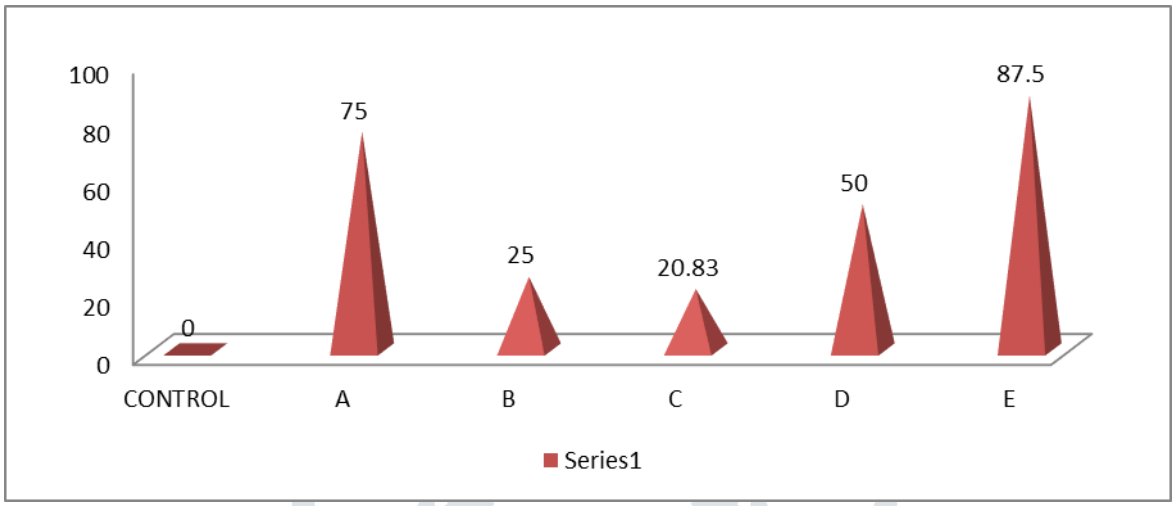
Fig: Variation of weight loss of mild steel in 0.01N HCl solution containing different amino group of organic compounds (Graph No. 2)



Effect of various amino group of organic compounds on corrosion in 0.001N HCl
(Table No. 3)

Compound	Initial weight (W_1)	Final Weight (W_2)	Loss in weight (ΔW)	% Loss in weight	I.E. (%)
Control	0.295	0.271	0.024	8.13	-
A	0.296	0.290	0.006	2.02	75.00
B	0.285	0.267	0.018	6.31	25.00
C	0.287	0.268	0.019	6.62	20.83
D	0.298	0.286	0.012	4.02	50.00
E	0.281	0.278	0.003	1.06	87.5

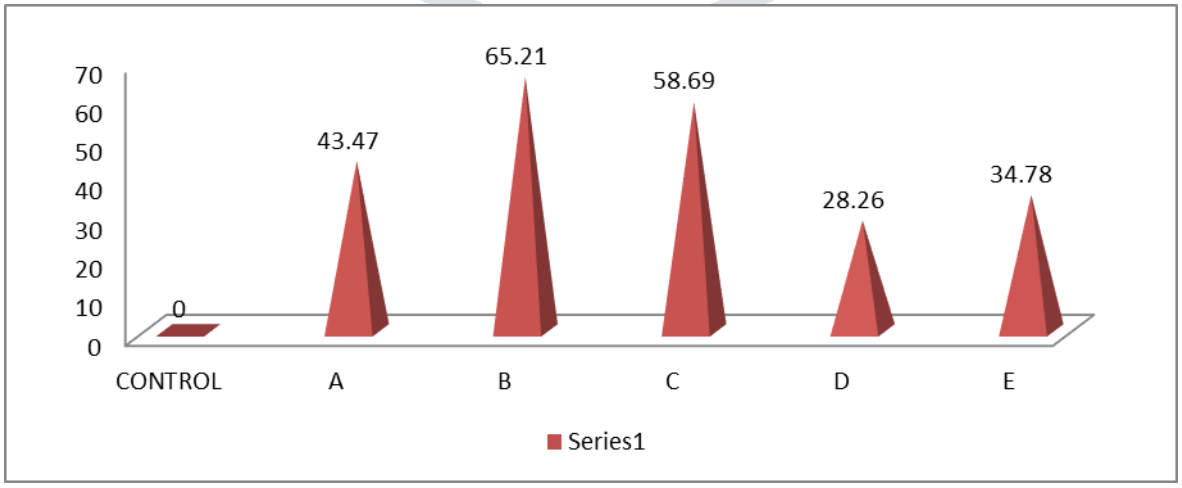
Fig: Variation of weight loss of mild steel in 0.001N HCl solution containing different amino group of organic compounds (Graph No. 3)



Effect of various amino group of organic compounds on corrosion in 0.1N HNO_3
(Table No. 4)

Compound	Initial weight (W_1)	Final Weight (W_2)	Loss in weight (ΔW)	% Loss in weight	I.E. (%)
Control	0.277	0.231	0.046	16.60	-
A	0.282	0.256	0.026	9.21	43.47
B	0.278	0.262	0.016	5.75	65.21
C	0.268	0.249	0.019	7.08	58.69
D	0.269	0.236	0.033	12.26	28.26
E	0.271	0.241	0.030	11.07	34.78

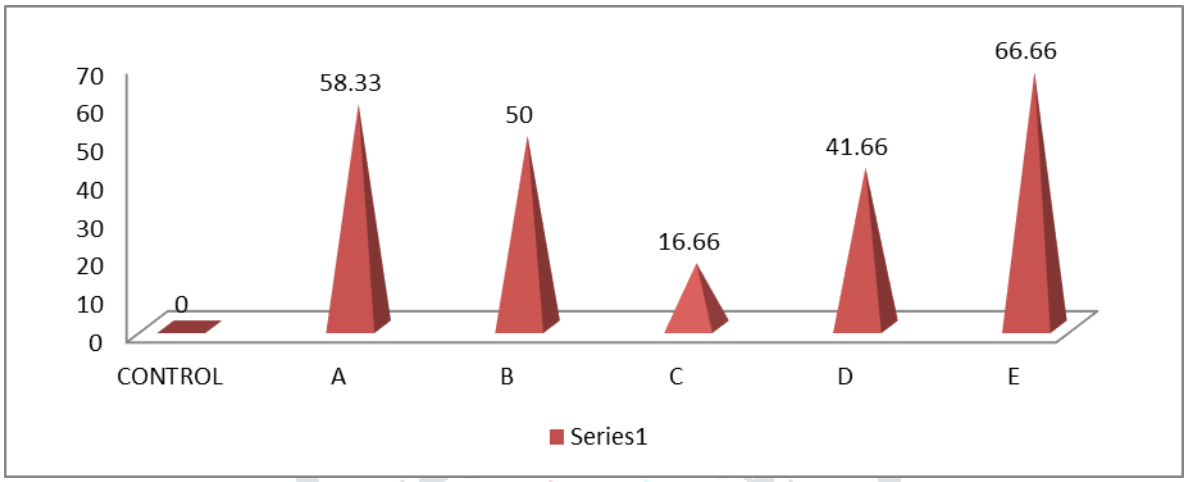
Fig: Variation of weight loss of mild steel in 0.1N HNO_3 solution containing different amino group of organic compounds (Graph No. 4)



Effect of various amino group of organic compounds on corrosion in 0.01N HNO_3 (Table No. 5)

Compound	Initial weight (W_1)	Final Weight (W_2)	Loss in weight (ΔW)	% Loss in weight	I.E. (%)
Control	0.249	0.237	0.012	4.81	-
A	0.261	0.256	0.005	1.91	58.33
B	0.276	0.270	0.006	2.17	50.00
C	0.287	0.277	0.010	3.48	16.66
D	0.273	0.266	0.007	2.56	41.66
E	0.267	0.263	0.004	1.49	66.66

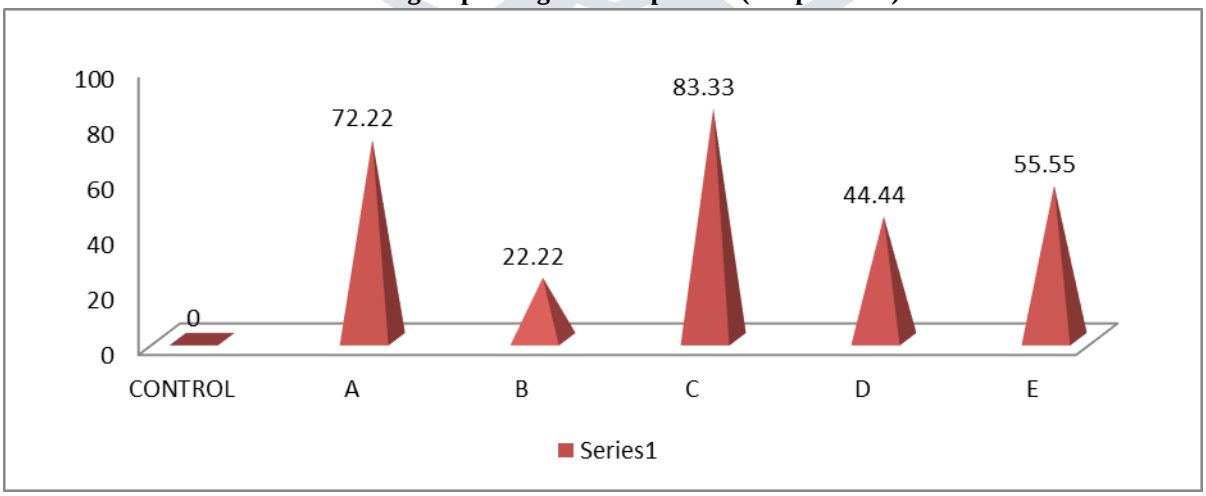
Fig: Variation of weight loss of mild steel in 0.01N HNO_3 solution containing different amino group of organic compounds (Graph No.5)



Effect of various amino group of organic compounds 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	0.262	0.244	0.018	6.87	-
A	0.257	0.252	0.005	1.94	72.22
B	0.265	0.251	0.014	5.28	22.22
C	0.261	0.258	0.003	1.14	83.33
D	0.252	0.242	0.010	3.96	44.44
E	0.267	0.259	0.008	3.03	55.55

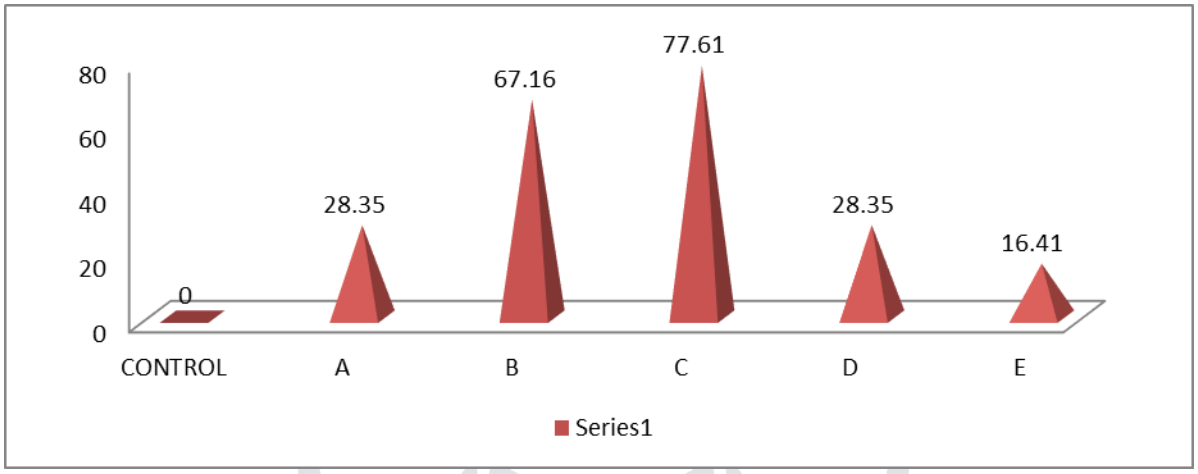
Fig: Variation of weight loss of mild steel in 0.001N HNO_3 solution containing different amino group of organic compounds (Graph No. 6)



Effect of various amino group of organic compounds on corrosion in 0.1N H_2SO_4 (Table No. 7)

Compound	Initial weight (W_1)	Final Weight (W_2)	Loss in weight ($\triangle W$)	% Loss in weight	I.E. (%)
Control	0.279	0.212	0.067	24.01	-
A	0.285	0.237	0.048	16.84	28.35
B	0.275	0.253	0.022	8.00	67.16
C	0.278	0.263	0.015	5.39	77.61
D	0.249	0.201	0.048	19.27	28.35
E	0.272	0.216	0.056	20.58	16.41

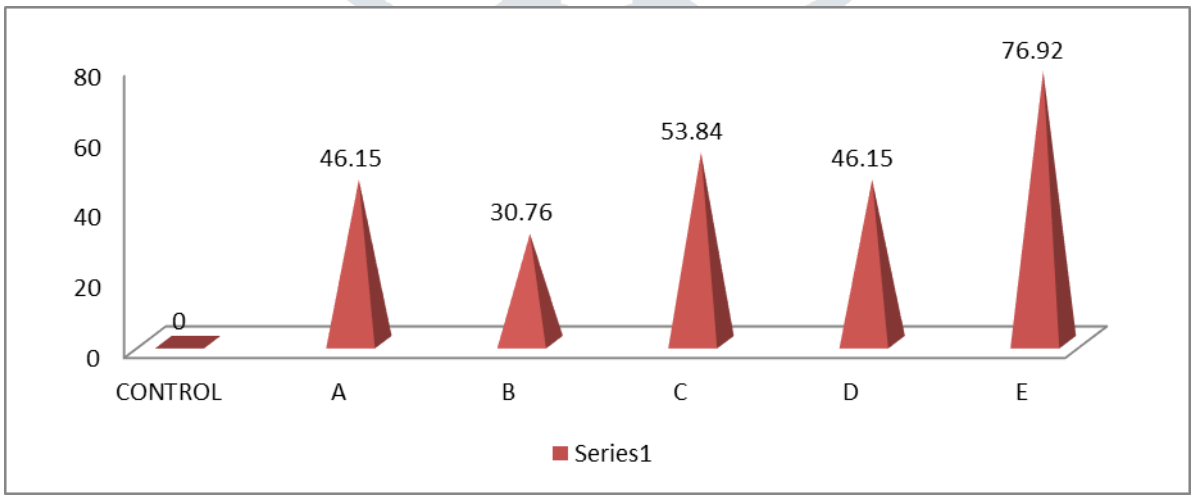
Fig: Variation of weight loss of mild steel in 0.1N H_2SO_4 solution containing different amino group of organic compounds (Graph No. 7)



Effect of various amino group of organic compounds on corrosion in 0.01N H_2SO_4 (Table No. 8)

Compound	Initial weight (W_1)	Final Weight (W_2)	Loss in weight ($\triangle W$)	% Loss in weight	I.E. (%)
Control	0.271	0.258	0.013	4.79	-
A	0.250	0.243	0.007	2.8	46.15
B	0.281	0.272	0.009	3.20	30.76
C	0.280	0.274	0.006	2.14	53.84
D	0.286	0.279	0.007	2.44	46.15
E	0.260	0.257	0.003	1.15	76.92

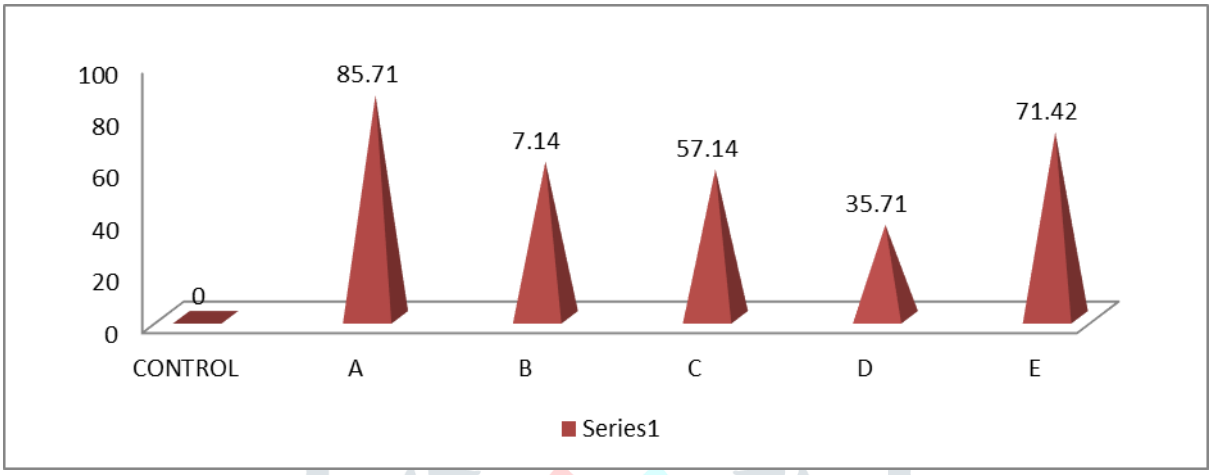
Fig: Variation of weight loss of mild steel in 0.01N H_2SO_4 solution containing different amino group of organic compounds (Graph No. 8)



Effect of various amino group of organic compounds on corrosion in 0.001N H_2SO_4 (Table No. 9)

Compound	Initial weight (W_1)	Final Weight (W_2)	Loss in weight ($\triangle W$)	% Loss in weight	I.E. (%)
Control	0.289	0.275	0.014	4.84	-
A	0.278	0.276	0.002	0.71	85.71
B	0.279	0.260	0.013	4.65	7.14
C	0.267	0.261	0.006	2.24	57.14
D	0.267	0.258	0.009	3.37	35.71
E	0.272	0.268	0.004	1.47	71.42

Fig: Variation of weight loss of mild steel in 0.001N H_2SO_4 solution containing different amino group of organic compounds (Graph No. 9)



In this research work the inhibition of corrosion of mild steel binding wire in various mineral acid medium by different amino group of organic compounds were studied. The inhibition effectiveness of p- chloroaniline, o- anisidine, p- Ethoxy aniline, 3- nitroaniline and α- napthol aniline have been studied in regarding corrosion of mild steel in 0.1N, 0.01N, 0.001N HCl, HNO_3 and H_2SO_4 acidic medium. Organic compound (A) p- Chloroaniline as higher I.E. in 0.01N HCl and 0.001N H_2SO_4 solution having I.E. is 86.36 and 85.71% but in 0.001N HCl and 0.001N HNO_3 shows I.E range at about 70-75% while in 0.1N HCl solution show lowest I.E. value is 11.62%, hence compound (A) p- chloroaniline more active and show good inhibition efficiency. O-anisidine (B) show higher I.E. in 0.1N HCl, 0.1 HNO_3 and 0.1N H_2SO_4 show I. E. 65% and in 0.01N HNO_3 shows medium I.E. is 50% and other 0.001N HCl, 0.001N HNO_3 and 0.01 N H_2SO_4 solution show I.E. less. In the analysis of compound (C) p-Ethoxy aniline having highest I.E. in the 0.1N HCl solution I.E. 83.72% and in 0.001N HNO_3 solution show I.E. is 83.33%. In 0.1N H_2SO_4 I.E. is 77.61% and in 0.01N HCl, 0.1N HNO_3, 0.01N H_2SO_4 and 0.001N H_2SO_4 show medium I.E. range about 55 to 63% and in 0.001N HCl, 0.01N HNO_3 show less I.E. hence the organic compound (C) p-Ethoxy aniline exhibits good corrosion inhibitor. In certain compound (D) 3-nitroaniline shows I.E. value in 0.01N HCl is 77.27%. All acidic dilution exhibits low I.E. Analysis of α-napthol aniline compound observed inhibition efficiency value is 87.5% and also in 0.01N H_2SO_4 and 0.001N H_2SO_4 solution show I.E. is 76.92 and 71.42% and also in 0.01N HCl and 0.01N HNO_3 show I.E. is 66 to 68%. It is generally assumed that the adsorption of inhibitor at the metal/solution interface is the mechanism of inhibitor through electrostatic attraction between the charged molecules and charged metal. Inhibitors have been forming to give an excellent inhibition due to the presence of electron donating groups. (such as –Cl, -OCH_3, -NO_2, -OC_2H_5) thus leads to be the string adsorption of inhibitors on the metal surface thereby resulting in high inhibition efficiency.

CONCLUSION

The present study leads to the following the corrosion of steel binding wire by various amino group of organic compounds in 0.1N, 0.01N, 0.001N HCl, HNO_3 H_2SO_4 acidic medium. The inhibitor molecules adsorbed on the metal surface and tend to retard the rate of corrosion by reducing the number of available surface sites for corrosion. From observation table and graphical interpretation, alpha-naphthol aniline exhibits maximum inhibition efficiency is 87.5% IN 0.001N HCl. P-chloroaniline show inhibition efficiency 86.36% in 0.01N HCl and in 0.001N H_2SO_4 85.71% compound (D) 3-nitroaniline observed less inhibition efficiency except in 0.01N HCl i.e., 77.27%. p- Ethoxy aniline shows maximum inhibition efficiency in 0.1 N HCl, 0.1 N H_2SO_4 & 0.001 N HNO_3. Also, o-anisidine compound exhibit inhibition efficiency at 65 to 67% in all acidic medium. Obtained results about inhibition efficiencies from weight loss method. All the aromatic amine provides protection through physical adsorption. The extent of inhibition increases with the increase in concentration.

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