



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

# IJRSET

International Journal of Innovative Research in  
**SCIENCE | ENGINEERING | TECHNOLOGY**

# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 10, Issue 12, December 2021

**ISSN** INTERNATIONAL  
STANDARD  
SERIAL  
NUMBER  
INDIA

Impact Factor: 7.569

9940 572 462

6381 907 438

[ijirset@gmail.com](mailto:ijirset@gmail.com)

[www.ijirset.com](http://www.ijirset.com)



# Inhibitive Action of Organic Compounds Containing Phenolic Group in Controlling of Carbon Steel in Various Acid Medium

Suraj B. Ade\*

Department of Chemistry, Shri Shivaji College, Parbhani, India

**ABSTRACT:** Resorcinol, 2-Aminophenol, Cresol, P-Chlorophenol, 2-Nitrophenol compounds containing phenolic group as a corrosion inhibitor for carbon steel was investigated. The study revealed that the phenolic group organic compounds 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 phenolic group organic compounds as corrosion inhibitors for metals in 0.1N, 0.01N and 0.001N (HCl, HNO<sub>3</sub> and H<sub>2</sub>SO<sub>4</sub>) 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 phenolic group containing organic compounds.

## I. INTRODUCTION

The development of inhibitors of steel in acid solutions has been the subject of great interest especially from the point of view of their efficiency and application. Mild steel is widely used as structural material in the automobiles, pipes and chemical industries<sup>1</sup>. Mild steel undergoes severe corrosion in pickling processes. Hydrochloric and sulphuric acids are widely used for pickling and decaling of mild steel<sup>2-4</sup>. Different organic compounds have been reported as effective corrosion inhibitors during acidification in industrial cleaning processes<sup>5-7</sup>.

The corrosion inhibition efficiency of organic compounds is related to their adsorption properties. Adsorption depends on the nature and state of metal surface, and the type of corrosive medium and the chemical structure of the inhibitors<sup>8</sup>. Studies report that the adsorption of organic inhibitors mainly depends on some physicochemical properties of the molecule related to its functional group, to the possible steric effects and electronic density of donor atoms; adsorption is also supposed to depend on the possible interaction of  $\pi$ -orbital of the inhibitor with d-orbitals of the surface atoms, which induce greater adsorption of the inhibitor molecule onto the surface of C-steel, leading to the formation of corrosion protecting film<sup>9-10</sup>.

The effectiveness of an organic compound as an inhibitor depends on the structure of inhibitor. Organic compounds containing one or more N, O, S and P atoms with lone pair electrons can inhibit the corrosion of metal in aqueous acid solutions<sup>11-13</sup>. The inhibitor molecules should have centers capable of forming bonds with the metal ions surface by electron transfer. The metal ion acts as an electrophile and organic compound with N, O, S and P atoms with lone pairs have nucleophilic centers and readily available for sharing.

Among the several methods of corrosion control such as cathodic protection, anodic protection, coating and alloying the use of chemical inhibitors is often considered as the most effective and practical method of corrosion prevention. A corrosion inhibitor is a chemical additive which when added to corrosive aqueous environment reduces the rate of metal wastage. It is widely accepted that inhibitors especially the organic ones work by an adsorption mechanism. The resultant film of chemisorbed inhibitor is then responsible for protection either by physically blocking the surface from the corrosion environment or by retarding the electrochemical processes. The main functional groups capable of forming chemisorbed bonds with metal surface are amino [ -NH<sub>2</sub> ], carboxyl [ -COOH ] and phosphate [ PO<sub>3</sub>H<sub>2</sub> ] although other functional groups or atoms can form coordinate bond with metal surfaces. The aim of the research work is to evaluate the inhibition efficiency of phenolic (-OH) group in controlling the corrosion of carbon steel immersed in various acid solution.

## II. EXPERIMENTAL SECTION

Corrosion inhibition of mild steel in various acidic medium by organic compounds containing phenolic group. 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<sub>3</sub>, 25-30 20ml 0.01N HNO<sub>3</sub> and in beaker 31-36 20ml 0.001N HNO<sub>3</sub> and in beakers 37-42 20ml 0.1N H<sub>2</sub>SO<sub>4</sub>, 43-48 20ml 0.01N H<sub>2</sub>SO<sub>4</sub>, 49-54 20ml 0.001N H<sub>2</sub>SO<sub>4</sub> were added. 20 mg of Resorcinol, 2-amino phenol, Cresol, P-Chlorophenol, 2-Nitrophenol of were added to beakers. The phenolic group of different organic compounds used are labeled as, Compound (A) Resorcinol, Compound (B) 2-amino phenol, Compound (C) Cresol, Compound (D) P-Chlorophenol, Compound (E) 2-Nitrophenol. 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

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

I.E. = Inhibition efficiency.

$W_i$  = Weight loss of metal in inhibitor solution

$W_u$  = weight loss of metal in control solution

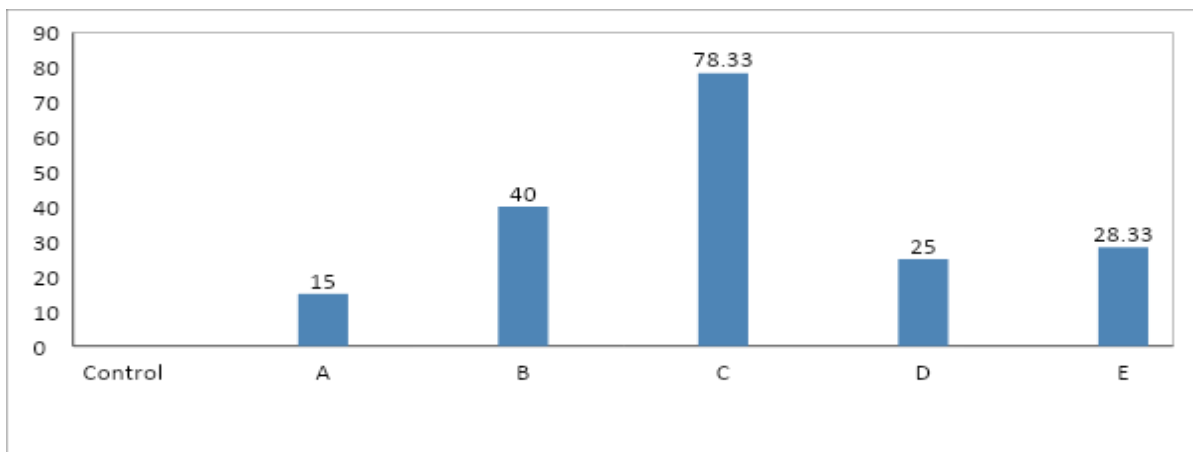
## III. RESULT AND DISCUSSION

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

(Table no.1)

Compound	Initial weight (W <sub>1</sub> )	Final Weight (W <sub>2</sub> )	Loss in weight (ΔW)	% Loss in weight	I.E.(%)
Control	0.315	0.255	0.060	19.04	-
A	0.326	0.275	0.051	15.64	15
B	0.322	0.286	0.036	11.18	40
C	0.341	0.328	0.013	3.81	78.33
D	0.350	0.305	0.045	12.25	25
E	0.338	0.295	0.043	12.72	28.33

Fig: Variation of weight loss of mild steel in 0.1N HCl solution containing different phenolic group (Graph no.1)

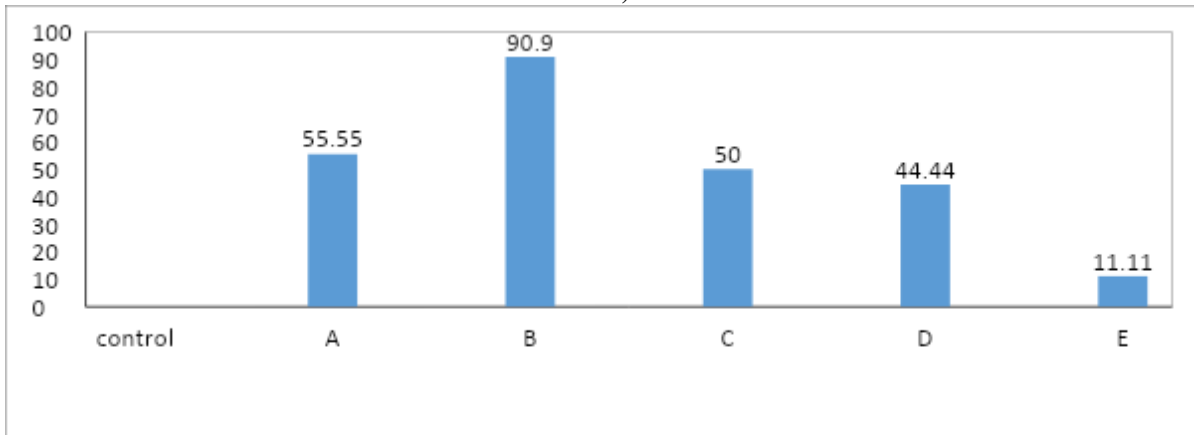




Effect of various Phenolic group of organic compounds on corrosion in 0.01N HCl (Table no.2)

Compound	Initial weight (W <sub>1</sub> )	Final Weight (W <sub>2</sub> )	Loss in weight (ΔW)	% Loss in weight	I.E.( %)
Control	0.280	0.262	0.018	6.42	-
A	0.294	0.286	0.008	2.72	55.55
B	0.253	0.252	0.001	0.39	90.90
C	0.284	0.273	0.009	3.16	50
D	0.290	0.280	0.010	3.44	44.44
E	0.294	0.278	0.016	5.44	11.11

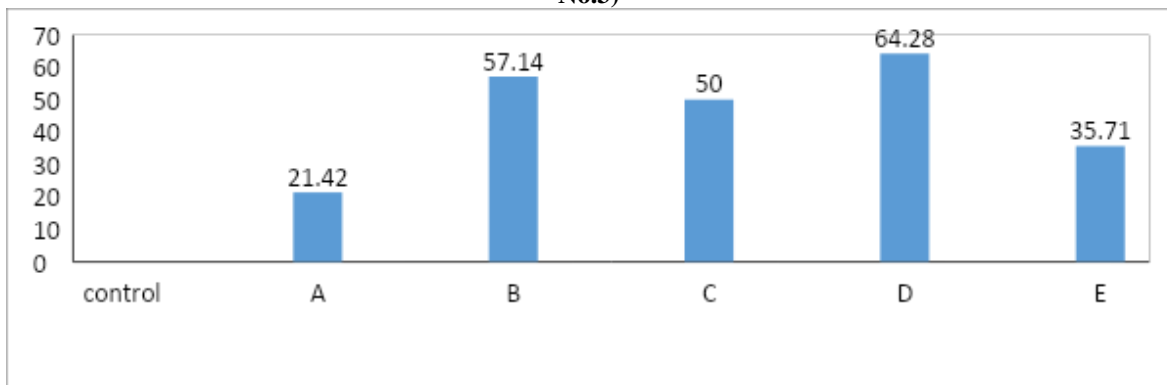
Fig: Variation of weight loss of mild steel in 0.01N HCl solution containing different phenolic group (Graph No.2)



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

Compound	Initial weight (W <sub>1</sub> )	Final Weight (W <sub>2</sub> )	Loss in weight (ΔW)	% Loss in weight	I.E.( %)
Control	0.295	0.281	0.014	4.74	-
A	0.312	0.301	0.011	3.52	21.42
B	0.294	0.288	0.006	2.00	57.14
C	0.314	0.307	0.007	2.22	50
D	0.292	0.287	0.005	1.71	64.28
E	0.307	0.298	0.009	2.93	35.71

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

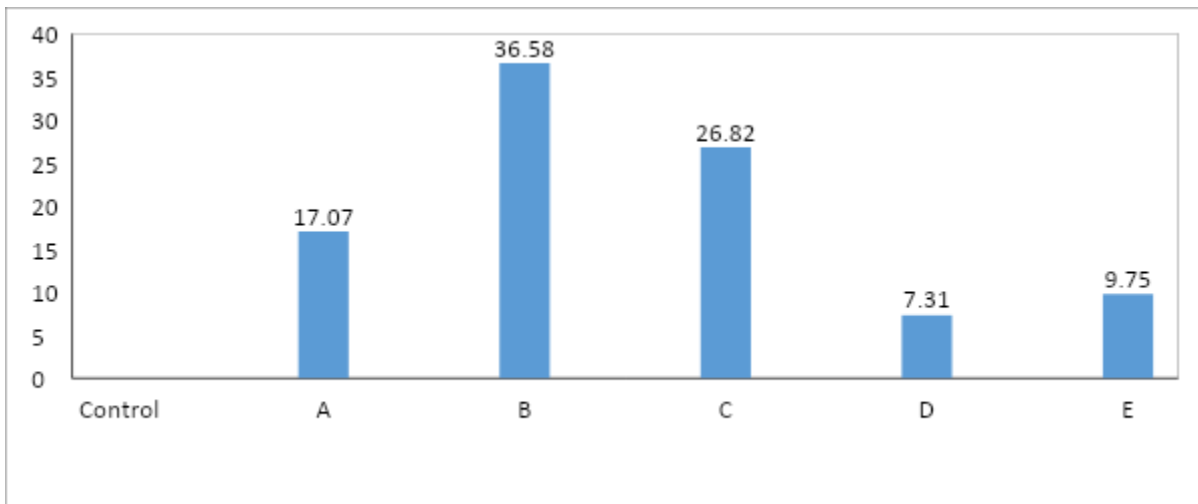




Effect of various Phenolic group of organic compounds on corrosion in 0.1N HNO<sub>3</sub> (Table no. 4)

Compound	Initial weight (W <sub>1</sub> )	Final Weight (W <sub>2</sub> )	Loss in weight (ΔW)	% Loss in weight	I.E.( %)
Control	0.358	0.317	0.041	11.45	-
A	0.334	0.300	0.034	9.28	17.07
B	0.330	0.304	0.026	7.87	36.58
C	0.336	0.306	0.030	8.92	26.82
D	0.366	0.328	0.038	10.92	7.31
E	0.335	0.298	0.037	11.04	9.75

Fig: Variation of weight loss of mild steel in 0.1N HNO<sub>3</sub> solution containing different phenolic group (Graph No. 4)

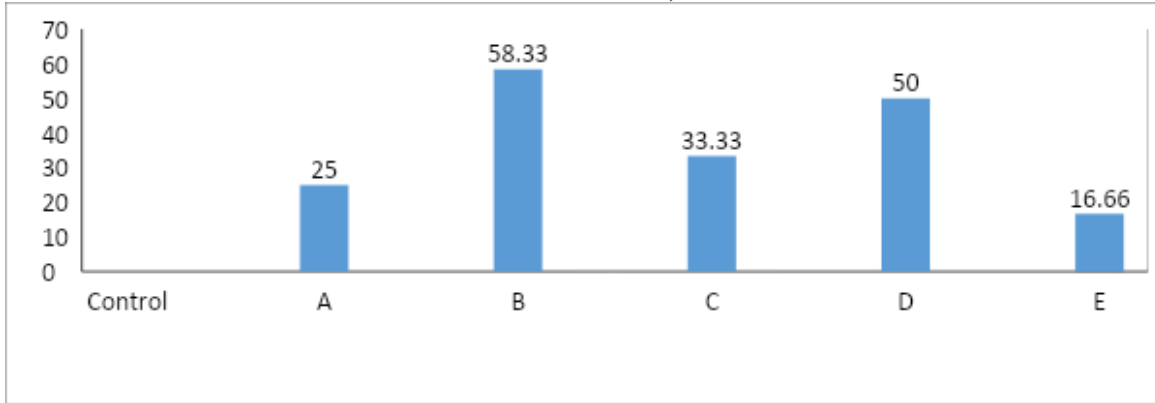


Effect of various Phenolic group of organic compounds on corrosion in 0.01N HNO<sub>3</sub> (Table no. 5)

Compound	Initial weight (W <sub>1</sub> )	Final Weight (W <sub>2</sub> )	Loss in weight (ΔW)	% Loss in weight	I.E.( %)
Control	0.349	0.337	0.012	3.43	-
A	0.320	0.311	0.009	2.81	25
B	0.322	0.317	0.005	1.55	58.33
C	0.345	0.337	0.008	2.31	33.33
D	0.318	0.312	0.006	1.88	50
E	0.326	0.316	0.010	3.06	16.66



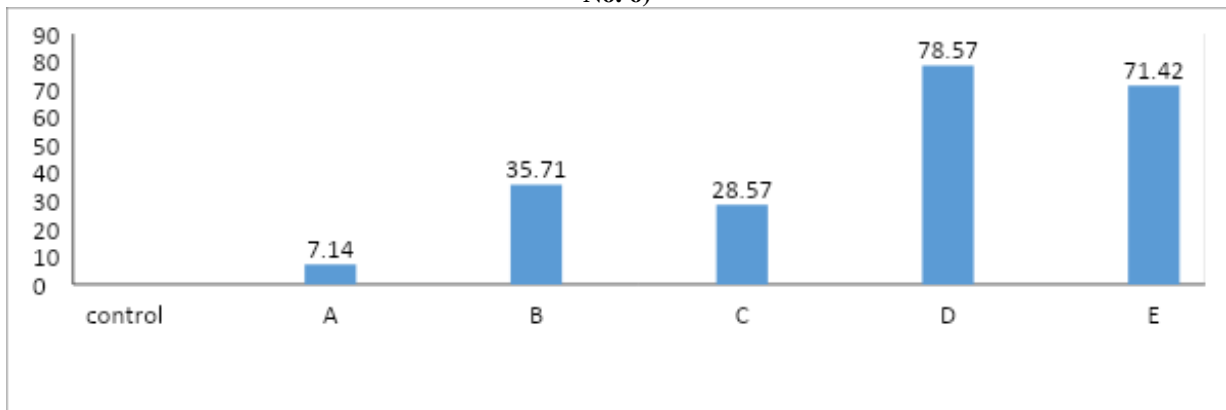
Fig: Variation of weight loss of mild steel in 0.01N HNO<sub>3</sub> solution containing different phenolic group (Graph No. 5)



Effect of various Phenolic group of organic compounds on corrosion in 0.001N HNO<sub>3</sub> (Table no. 6)

Compound	Initial weight (W <sub>1</sub> )	Final Weight (W <sub>2</sub> )	Loss in weight (ΔW)	% Loss in weight	I.E.( %)
Control	0.352	0.338	0.014	3.97	-
A	0.339	0.326	0.013	3.83	7.14
B	0.359	0.350	0.009	2.50	35.71
C	0.340	0.330	0.010	2.94	28.57
D	0.335	0.332	0.003	0.89	78.57
E	0.330	0.326	0.004	1.21	71.42

Fig: Variation of weight loss of mild steel in 0.01N HNO<sub>3</sub> solution containing different phenolic group (Graph No. 6)



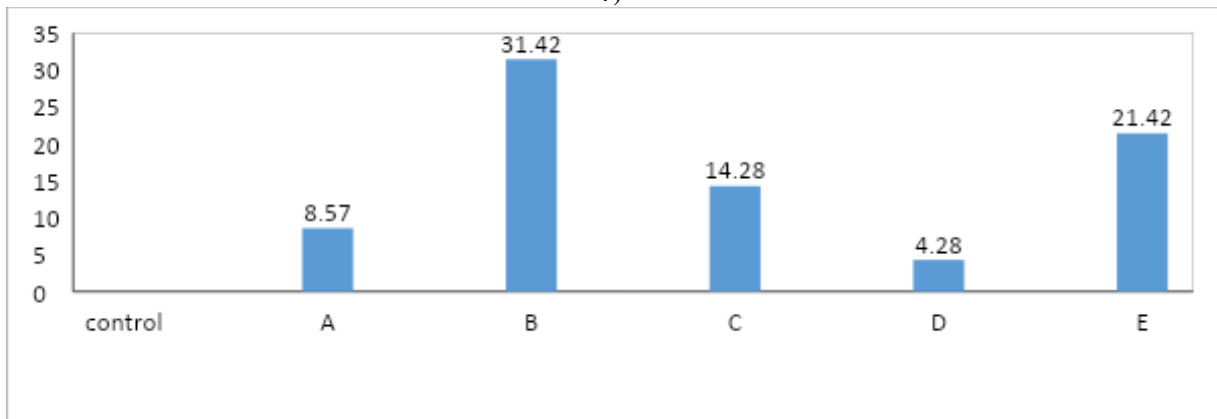




Effect of various Phenolic group of organic compounds on corrosion in 0.1N H<sub>2</sub>SO<sub>4</sub> (Table no. 7)

Compound	Initial weight (W <sub>1</sub> )	Final Weight (W <sub>2</sub> )	Loss in weight (ΔW)	% Loss in weight	I.E.( %)
Control	0.291	0.221	0.070	24.05	-
A	0.310	0.246	0.064	20.64	8.57
B	0.314	0.266	0.048	15.28	31.42
C	0.287	0.227	0.060	20.90	14.28
D	0.275	0.208	0.067	24.36	4.28
E	0.268	0.213	0.055	20.52	21.42

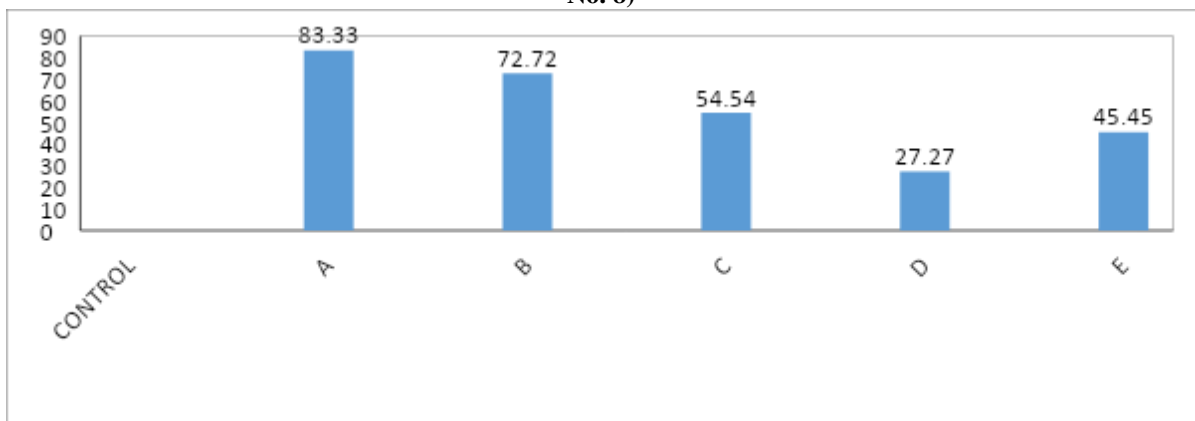
Fig: Variation of weight loss of mild steel in 0.1N H<sub>2</sub>SO<sub>4</sub> solution containing different phenolic group (Graph No. 7)



Effect of various Phenolic group of organic compounds on corrosion in 0.01N H<sub>2</sub>SO<sub>4</sub> (Table no. 8)

Compound	Initial weight (W <sub>1</sub> )	Final Weight (W <sub>2</sub> )	Loss in weight (ΔW)	% Loss in weight	I.E.( %)
Control	0.239	0.228	0.011	4.60	-
A	0.271	0.268	0.003	1.10	83.33
B	0.249	0.246	0.003	1.20	72.72
C	0.251	0.246	0.005	1.99	54.54
D	0.248	0.240	0.008	3.22	27.27
E	0.269	0.263	0.006	2.23	45.45

Fig: Variation of weight loss of mild steel in 0.01N H<sub>2</sub>SO<sub>4</sub> Solution containing different phenolic group (Graph No. 8)

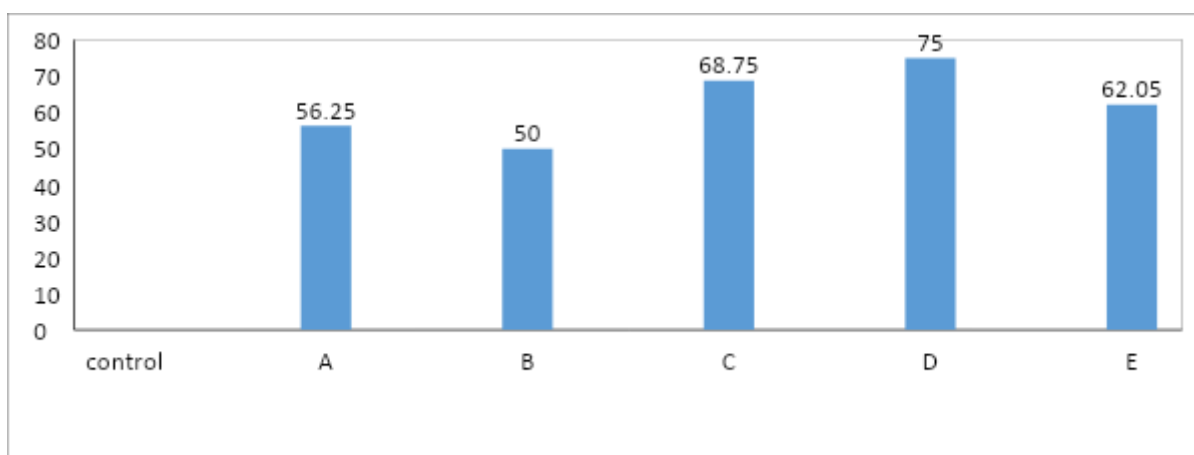




Effect of various Phenolic group of organic compounds on corrosion in 0.001N H<sub>2</sub>SO<sub>4</sub> (Table no. 9)

Compound	Initial weight (W <sub>1</sub> )	Final Weight (W <sub>2</sub> )	Loss in weight (ΔW)	% Loss in weight	I.E.( %)
Control	0.285	0.269	0.016	5.61	-
A	0.260	0.253	0.007	2.69	56.25
B	0.289	0.281	0.008	2.76	50
C	0.279	0.274	0.005	1.81	68.75
D	0.258	0.262	0.004	1.55	75
E	0.302	0.296	0.006	1.98	62.05

Fig: Variation of weight loss of mild steel in 0.001N H<sub>2</sub>SO<sub>4</sub> containing different phenolic group Graph No.9



A large number of research work have been done on the studies of corrosion of C-steel in acidic solutions. The present study aimed to investigate the efficiency of the phenolic group in organic compound as corrosion inhibitors for C-steel in various acidic solutions by weight loss method. Phenolic compound containing electron donating groups are more efficient than compound containing electron withdrawing groups. Compound (A) Resorcinol containing –OH group is less basic and minimum efficient. Than I.E. in 0.001N H<sub>2</sub>SO<sub>4</sub> is 83.33% and other acid dilution I.E. in 0.001N H<sub>2</sub>SO<sub>4</sub> and 0.01 N HCl is 56.25% and 55.55% respectively.

O-amino phenol containing –NH<sub>2</sub> group is more basic and more efficient than –OH group in compound (A), The I.E. in 0.01N HCl is 90.90% and 0.01N H<sub>2</sub>SO<sub>4</sub> is 72.72%. Similarly in other concentration 58.33% in 0.01N HNO<sub>3</sub> and 0.001N HCl is 57.14% and other acid dilutions I.E. below the 50% .Certain graphical and observation table represents the compound (C) Cresol the inhibition efficiency of 0.1N HCl is 78.53, 0.001N H<sub>2</sub>SO<sub>4</sub> is 68.75%. The minimum inhibition efficiency in this compound is 0.1N H<sub>2</sub>SO<sub>4</sub>, 14.28%.

The most effective corrosion inhibition for the steel binding wire was observed with P-chloro phenol (compound-D) inhibition factor up to 78.57% in 0.001N HNO<sub>3</sub> solution similarly other concentration of acids shows 75% in 0.001N H<sub>2</sub>SO<sub>4</sub>, 64.28%. in 0.001N HCl. P-chloro phenol exhibits 4.28% inhibition efficiency in 0.1N H<sub>2</sub>SO<sub>4</sub> which low value in all concentration of medium.The inhibition effects of 2- Nitro phenol on steel binding wire in various corrosive medium inhibition efficiency of 0.001N HNO<sub>3</sub> is 71.42 and inhibition efficiency of 0.001N H<sub>2</sub>SO<sub>4</sub> is 62.05%. Comparing with other phenolic compounds it shows less inhibition efficiency. Organic compound which are P- chloro phenol and O-amino phenol acts as excellent corrosion inhibitors for mild steel in HCl, HNO<sub>3</sub> and H<sub>2</sub>SO<sub>4</sub> medium respectively. By using out of five organic compounds 2-amino phenol compound (B) is good corrosion inhibitor.

#### IV. CONCLUSION

The various phenolic group in organic compounds are efficient inhibitors for carbon steel dissolution in different concentration in acids. The results obtained from all data measurements showed that the inhibiting action increases with increases in acidic concentration. Weight loss study revealed that the various phenolic compounds shows





inhibition efficiency. In controlling corrosion of carbon steel immersed in different corrosive medium. 2-amino phenol shows inhibition efficiency 90.90% in 0.01N HCl. And act as good corrosion inhibitor due to the presence of denoting –NH<sub>2</sub> group. Also Resorcinol exhibits 83.33% corrosion efficiency in 0.01N H<sub>2</sub>SO<sub>4</sub>. P-chloro phenol observed less inhibition efficiency i.e., 4.28% in 0.1N H<sub>2</sub>SO<sub>4</sub> and it also shows 75 to 78% efficiency in 0.001N HNO<sub>3</sub> and 0.001N H<sub>2</sub>SO<sub>4</sub>. Cresol exhibits 78.53% efficiencies in 0.1N HCl in other acids concentration medium inhibition efficiency. In 2-Nitro phenol compound show 71.42% in 0.001N HNO<sub>3</sub> and in other acid dilution, observed low inhibition efficiency.

#### ACKNOWLEDGEMENT

The authors are thankful to the principal of shri Shivaji College, Parbhani for providing research facilities. Authors are also thankful to Head Department of chemistry providing necessary facilities and interpretation of corrosion activities.

#### REFERENCES

- 1] Khamis, A. Saleh, M. M. and Awad, M. I, Corrosion Science, 66,343, 2013.
- 2] Singh, A. Lin, Y.Liu, W.Kuanhai, D.Pan, J. Huang, B.Ren, C.Zeng, D.and Taiwan, J. Inst.Chem. Eng, 2014.
- 3] Bardez, E. Devol, I. Larrey, B. and Valeur, B. (1997): J. Phys. Chem. B, 7786, 101.
- 4] Amrishi Singh, Ahmad, I. Quraishi, M.A, Arab. J. Chem, 2012.
- 5] Ali, S.A. Almualllem, H.A., Rehman, S.U. and, Saeed, M.T, Bis-isoxazolidines: a new class of corrosion inhibitors of mild steel in acidic media, Corrosion Science, 50, 3070-3377, 2008.
- 6] Mernari, B. Attari, H.El. Traisnel, M. Bentiss, F. and Lagrenee, M, Inhibiting effects of 3, 5. Bis (n-pyridyl) .4-amino-1, 2, 4 –triazoles on the corrosion for mild steel in 1 M HCl medium, Corrosion Science., 40, 391-399, 1998.
- 7] Achouri, M-El, S.Kertit, S. Gouttya, H.M. Nciri,B. Bensouda Y. Perez. I.Infante,M.R, M.R. and K.ELK acemi ,Corrosion inhibition of iron in 1 m HCl by some Gemini surfactant's in the series of alkan diyl-a, x-bis-(dimethyl tetra decyle ammonium bromide ) , prog.org.coat.43,267-273,2001.
- 8] Bentiss, F. Lagrenee, M. Traisnel, M. and Hornez, J.C, The corrosion of inhibition of mild steel in acidic media by a new triazole derivative J. Corros. Sci.41 789 – 803,1999.
- 9] Bentiss, F. ,Lagrenee, M. and Traisnel, M,2,5 bis (n-pyridyl)1,3,4-oxadiazoles as corrosion inhibitors for mild steel in acidic media, J. Corros.,56,733-742,2000.
- 10] Bentiss, F. Lagrenee, M. and Traisne,M, 2,5 bis(4-dimethylaminophenol)1,3,4-thiadiazole on corrosion inhibitor of mild steel in acidic media, J. Appl. Electrochem,31,41-48,2001.
- 11] Quraishi, M. A.; Khan, M. A. Jamal, W. Ajmal, D. Muralidharan, M. and Iyer, S.V.K, Appl. Electrochem.26, 125,1996.
- 12] Quraishi, M. A.; Khan, M. A. Jamal, W. Ajmal, D. Muralidharan, M. and Iyer, S.V.K, Electrochem.13, 63,1995.
- 13] Khamis, E. Bellucci, F. Latanision, R.M. El Ashry, E.S.H,Corrosion 47,677,1991.



**Impact Factor:  
7.569**



# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 9940 572 462  6381 907 438  [ijirset@gmail.com](mailto:ijirset@gmail.com)



[www.ijirset.com](http://www.ijirset.com)

Scan to save the contact details