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EFFECT OF ACID EXTRACT OF DIFFERENT PARTS OF *TEPHROSIA PURPURIA* ON CORROSION OF IRON IN ACID

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ABSTRACT

Corrosion of iron in 1 N HNO_3 solution was studied by mass loss method in absence and presence of the acid extract of *Tephrosia purpuria* plant from the change in this electrochemical parameter. It was concluded that the inhibition increased with increase in the concentration of additive. This work was aimed at developing cheap, eco-friendly and biodegradable acid corrosion inhibitors.

Key words: Corrosion inhibitor, Iron, Acid, *Tephrosia purpuria*.

INTRODUCTION

Corrosion intrudes in almost every part of our lives. It causes huge losses to buildings, automobiles, industries and their services and possibly the greatest consumer of metal today. A great deal of study has been devoted to corrosion in multidisciplinary fields of chemistry, engineering and metallurgy. Corrosion can be defined as the destructive result of chemical reaction between metal or metal alloy and environment[1].

Metallic corrosion is a very common but a serious problem, causing considerable revenue loss throughout the whole word. Mitigation of corrosion requires the application of various engineering techniques and scientific knowledge on the role of the alloying elements in the reduction of the corrosion losses and the application of film forming inhibitors are well known[2].

However, iron when left open to surroundings to corrode, the corrosion of iron in atmosphere is affected by various factors like humidity, temperature, metal composition, the presence of pollutants like sulphur dioxide; for buried structures, the moisture, type of soil[3], etc. influence the corrosion rate and therefore, the life of the article.

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Iron is used widely for mechanical and structural engineering purposes in bridgework, structural reactors, boiler plates, automobiles etc. It is the material of choice for most of the tank, pipeline and buried structures. It is commonly used for ship hulls, offshore drilling platforms and other immersed structures.

The organic compound having hetero atoms like O, N, S are found to have higher basicity and electron density and thus, assist corrosion inhibitor[4]. Oxygen, nitrogen and sulphur are the active centers for the process of adsorption on the metal surface. There are numerous naturally occurring substances like *terminalia chebula*, beet-root[5,6], *eucalyptus* leaves[7], *annona squamosa*, *pongamia glabra*[8], henna[9], *acacia conciana*[10], *swertia aungustifolia*[11], *prosopis joliflora*[12], *egenia imbolans*[13], *ficus rligeousa*[14] and *tephrosia purpuria*[15,16] as well as very popular Ayrvedic powder Mahasudarshana Churna have been evaluated as effective corrosion inhibitors.

Tephrosia purpuria grows as common wasteland weed. It is used traditionally as folk medicine. In many parts, it is under cultivation as green manure crop. According to Ayurvda, this plant is digestive, anthelmintic, antipyretic, cures asthma and diseases of lever, heart, blood, leprosy etc.

The importance of the study lies in the fact that naturally occurring plant products are environmentally compatible, non-polluting, less toxic, easily available, bio-degradable and are cheaper corrosion inhibitors.

EXPERIMENTAL

Specimen preparation

Rectangular specimen of iron dimension 1.5 × 2.5 × 0.036 cm. with a small hole of about 2 mm diameter near the upper edge were employed for the determination of mass lass measurements.

The chemical composition of test specimen used was C = 0.12%, Mg = 0.40%, Si = 0.14%, S = 0.04% and Fe remainder. The mirror finish was produced with the help of emery paper cleaned specimen and was then degreased with acetone. Each specimen was suspended by a glass hook and immersed in a beaker containing 50 mL of test solution at 299 ± 2 K and left exposed to air. Evaporation losses were made up with distilled water. After this, the test specimens were cleaned with benzene[17]. Duplicate experiments were performed in each case and mean values of the mass were calculated.

Test solution preparation

The solution of the 1N HNO_3 was prepared using doubly distilled water. The *Tephrosia purpuria* extract was obtained by boiling 5 g dry powder of roots, branches, leaves and seeds in 100 mL 1N HNO_3 for 1/2 hrs. on a water bath at 500ºC and then kept overnight. Next day, the filtrate volume was made 100 mL using distilled water to make 1 N concentration of 5% of w/v *Tephrosia purpuria* content. The acid solution was prepared from A.R. grade reagent.

The percentage inhibition efficiency was calculated as[18] -

$$I.E. = 100 (\Delta Mu - \Delta Mi)/ \Delta Mu \quad \ldots(1)$$

Where Δ Mu and ΔMi are the mass loss of the metal in uninhibited acid and inhibited solution, respectively.

The degree of surface coverage can be calculated as[19] -

$$\theta = (\Delta Mu - \Delta Mi)/ \Delta Mu \quad \ldots(2)$$

Where θ is the surface coverage and Δ Mu and ΔMi are the mass loss of the metal in uninhibited acid and inhibited solution, respectively.

The corrosion rate in mmpy (milli meter per year) can be obtained by the following equation -

$$\text{Corrosion rate (mmpy)} = \frac{\text{Mass loss x } 87.6}{\text{Area x Time x Metal density}} \quad \ldots(3)$$

Where mass loss is expressed in mg, area in inch of metal surface exposed, time in hours of exposure, and metal density in g/cm^3.

RESULTS AND DISCUSSION

Inhibitor concentration

Effect of inhibitor concentration on inhibition efficiency (I.E.) was calculated from the mass loss measurement for 1N HNO_3. It was found that efficiency increases with the increase of inhibitor concentration for seeds, leaves, braches and roots extracts from 0.5% to 5%.

Effect of immersion period

The effect of immersion period on inhibition efficiency (I.E.) was also calculated from the mass loss measurement for 1 N HNO_3. It was found that inhibitor efficiency decreases up to 3 hours for seeds, leaves, branches and roots extracts in 0.5% to 5% concentration.

Effect of acid solution

It was found that the roots, branches, leaves and seeds extracts in 1 N HNO_3 have a good property to inhibit the corrosion of iron, even when the exposure time is also large.

Root extracts for 1 N HNO_3 acid shown the inhibitor efficiency from 6.31% to 30.20% for 1 hr. whereas after 3 hr. duration, the efficiency was obtained in range of 3.79% to 13.19% for 0.5%-5% concentration (Table 1).

Table 1: Inhibition efficiencies for iron in 1 N HNO_3 with *Tephrosia purpuria*

Roots concentration (%)	Inhibitor efficiency η (%)		
	1 hr.	2 hr.	3 hr.
0.5	6.31	5.79	3.97
1.0	8.19	6.78	5.40
1.5	8.87	8.60	6.04
2.0	10.40	10.59	6.99
2.5	12.79	11.58	8.42
5.0	30.20	21.19	13.19

Branches extracts for 1 N HNO_3 acid show the inhibitor efficiency from 6.99% to 31.39% for 1 hr. whereas after 3 hr. duration, the efficiency was obtained in range of 6.20% to 20.98% for 0.5%-5% concentration (Table 2)

Table 2: Inhibition efficiencies for iron in 1 N HNO_3 with *Tephrosia purpuria*

Branches concentration (%)	Inhibitor efficiency η (%)		
	1 hr.	2 hr.	3 hr.
0.5	6.99	7.61	6.20

Cont...

Branches concentration (%)	Inhibitor efficiency η (%)		
	1 hr.	2 hr.	3 hr.
1.0	8.19	6.78	4.76
1.5	9.38	9.68	6.99
2.0	12.79	12.14	7.94
2.5	15.18	13.41	9.37
5.0	31.39	26.18	20.98

Leaves extracts for 1 N HNO_3 acid show the inhibitor efficiency from 20.98% to 33.78% for 1 hr. whereas after 3 hr. duration, the efficiency was obtained in range of 8.58% to 20.19% for 0.5%-5% concentration (Table 3).

Table 3: Inhibition efficiencies for iron in 1 N HNO_3 with tephrosia purpuria

Leaves concentration (%)	Inhibitor efficiency η (%)		
	1 hr.	2 hr.	3 hr.
0.5	20.98	12.58	8.58
1.0	22.18	14.40	13.19
1.5	24.40	15.39	13.99
2.0	25.59	18.21	15.42
2.5	29.18	20.19	18.91
5.0	33.78	26.98	20.91

Seeds extracts for 1 N HNO_3 acid show the inhibitor efficiency from 23.37% to 39.24% for 1 hr. whereas after 3 hr. duration, the efficiency was obtained in range of 18.60% to 34.81% for 0.5%-5% concentration (Table 4).

Table 4: Inhibition efficiencies for iron in 1 N HNO_3 with *Tephrosia purpuria*

Seeds concentration (%)	Inhibitor efficiency η (%)		
	1 hr.	2 hr.	3 hr.
0.5	23.37	23.25	18.60
1.0	25.58	24.17	23.52

Cont…

Seeds concentration (%)	Inhibitor efficiency η (%)		
	1 hr.	2 hr.	3 hr.
1.5	26.74	26.98	24.31
2.0	29.01	27.64	25.59
2.5	31.39	30.79	27.82
5.0	39.24	36.53	34.82

Table 5: Effect of acid extracts of root, branches, leaves and seeds of *Tephrosia purpuria* on mass loss data for iron in 1 N HNO_3

Effective area of specimen = 7.50 cm^2 Temperature = 299 ± 2 K Immersion time = 3 hrs

Inhibitor concentration (%)	Mass loss (mg)	Corrosion rate (mmpy)	Inhibitor efficiency η (%)	Surface coverage (θ)
Uninhibited	1258	619.9		
Root				
0.5	1208	595.3	3.97	0.0397
1.0	1190	586.4	5.40	0.0540
1.5	1182	583.3	6.04	0.0604
2.0	1170	576.6	6.99	0.0699
2.5	1152	567.7	8.42	0.0842
5.0	1092	538.1	13.19	0.1319
Branches				
0.5	1180	581.5	6.20	0.0620
1.0	1198	590.4	4.76	0.0476
1.5	1170	576.6	6.99	0.0699
2.0	1158	570.6	7.94	0.0794
2.5	1140	561.8	9.37	0.0937
5.0	0994	489.8	20.98	0.2098

Cont…

Inhibitor concentration (%)	Mass loss (mg)	Corrosion rate (mmpy)	Inhibitor efficiency η (%)	Surface coverage (θ)
Leaves				
0.5	1150	566.7	8.58	0.0858
1.0	1090	537.1	13.19	0.1319
1.5	1082	533.2	13.99	0.1399
2.0	1064	524.3	15.42	0.1542
2.5	1042	513.5	18.91	0.1891
5.0	1004	494.7	20.19	0.2019
Seeds				
0.5	1024	504.6	18.60	0.1860
1.0	0962	474.0	23.52	0.2352
1.5	0952	469.1	24.31	0.2431
2.0	0936	461.2	25.59	0.2559
2.5	0908	447.4	27.82	0.2782
5.0	0820	404.1	34.82	0.3482

CONCLUSION

The acid extract of *Tephrosia purpuria* was found to be effective inhibitors in acid up to 39% efficiency and can be safely used without hydrogen damage, toxic effect and pollution problems.

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