Study of Corrosion Mitigation Behaviour of Caryota Urens Leaves Extract on Mild Steel in Citric and Hydrochloric Acids

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Abstract

The intent of this study is to establish the performance of Caryota Urens leaves extract (CUL) as a corrosion inhibitor on mild steel in citric acid and hydrochloric acid medium by weight loss method of corrosion monitoring. The inhibition efficiency was tested by varying the inhibitor concentration and time of immersion in 1M citric acid and 1M Hydrochloric acid, pH of the bath was also monitored. The results proved the adsorption of the inhibitor on mild steel surface and 2.5% V/V of CUL offered90% and 92% inhibition efficiency for 24 hour immersion at room temperature in Citric acid and Hydrochloric acid respectively. Hence CUL extracts can be used as green inhibitors in citric acid and hydrochloric acid pickling baths for mild steel corrosion mitigation.

Key words - *Mild steel, Corrosion inhibition, plant extracts, weight loss.*

I. INTRODUCTION

Growing population and modernisation of changing societies consume huge amount of metals and materials. Mild steel is the widely chosen structural materials owing to its materials properties. Metal processing and fabrication industries have to take care of the corrosion behaviour of their products. In order to offer corrosion protection protective coatings are applied on the metal surface. Pre treatment of the surface involves picklingprocess, in which many inorganic acids with additives are used as pickling baths. The pickling baths are added with chemical inhibitors to prevent the loss of base metal and to decrease acid fumes.[1]But the added chemical makes the pickling sludge more hazardous to the environment. The inorganic acids which are conventionally used as pickling baths in many industries can be replaced with organic acids. Hazardous inhibitors can be replaced with eco friendly green inhibitors from plant sources.

Intensive research in this field has lead to the identification of plant parts such as stems, roots, leaves, husk, nut shell, agro waste etc., for their suitability as corrosion inhibitors for mild steel, copper, aluminium and zinc in hydrochloric acid, sulphuric acid and phosphoric acid medium[4-10].The present effort studies the performance of caryota urens leaves extract (CUL) as an inhibitor in 1M citric acid and 1M hydrochloric acid medium on mild steel corrosion inhibition using weight loss method of corrosion testing

II. EXPERIMENT

A Materials

1. Mild steel Sample

Cold rolled Mild steel (MS) sheets of 1.5mm thickness was purchased from local market, was cut in to rectangular pieces of 5cmX1cm, length and breadth, with a holein one side for immersion testing. Upon elemental analysis, using optical emission spectroscopy,the sample contained, C = 0.123%, Si = 0.069%, Mn = 0.453%, P = 0.025%, S = 0.015% and the rest was Iron. The samples were cleaned to remove greases, surface impurities with emery papers of grades 400- 800, washed with tap water, degreased with acetone and stored in desiccators. The samples were accurately weighed in Shimadzu AY220 electronic balance of 0.0001g accuracy and exposed area was determined using Mitutoyo digimatic caliper.

2. Pickling acid

Hydrochloric acid was prepared by diluting as per standard procedure, viz. 12.1M HCl; 82.5ml of it was diluted to 1000ml to get 1M HCL using distilled water. 210g of citric acid was accurately weighed and made up to 1000ml to get 1M citric acid. The prepared acids were standardized before usage. Both the acids were purchased from local scientific company and HCl is of Qualigens make and Citric acid of NICE brand.

3. Inhibitor CUL extract

A tropical plant, Caryota Urens L. belongs to the Arecaeae (Palmae) family. Its common names are fishtail palm and Jaggery palm. The leaves of the plant was collected from nearby locality are identified and authenticated with a specimen at Botanical survey of India, Southern Regional Centre, Coimbatore, Tamil Nadu. The leaves were found to be rich in alkaloids, phenolics, flavanoids, glycosides, tannins and saponins asphytoconstituents which are rich in hetero atoms and unsaturation [2, 3].Matured Caryota urens leaveswere collected, dried in shade and finely ground and reserved in air tight containers. 50g of the powder was refluxed with 1000ml of 1M HCl for 3hours and left over night. The next day, extract was filtered and made up to one litre and maintained as stock solution. Similarly, CUL extract was prepared with 1M citric acid. The required concentrations of the inhibitor were prepared from the stock solutions.

B METHODS

1. Weight loss method

Corrosion rate measurement by weight loss method was carried out at room temperature by varying inhibitor concentration and time of immersion. The MS samples were accurately weighed and immersed in 100ml of acids, 1MHCl and 1M citric acid taken in beakers using glass hooks in triplicate. After the stipulated time of immersion, they samples were withdrawn, neutralized for excess acid and washed with tap water, dried and weighed. The same procedure was carried for immersion testing in presence of CUL extracts of different concentrations. The pH of the bath was monitored using Elico make digital pH meter. From the weight loss data, corrosion rate and inhibition efficiency were calculated using the following equations (1and 2)

$$corrosionrate = \frac{(Wo-Wi)k}{DAt} \quad (1)$$

$$InhibitionEfficiency = \frac{Wo-Wi}{Wo} x\ 100 \quad (2)$$

Where, W_o is the weight loss of the sample in acid in grams, and W_i is the weight loss in inhibited acid in grams; k is a constant, whose value depends upon the unit of area of the sample A, viz. A in $inch^2$, $k = 5.34 \times 10^5$, time of exposure is t in hours and D is the Density of mild steel, 7.89 g/cm^3. Corrosion Rate (CR) is expressed in mils per year and Inhibition efficiency (IE) is given as percentage.

III. RESULT AND DISCUSSION

1. Weight loss method

The results obtained from weight lossmethod for mild steel in citric acid and hydrochloric acid are presented in Table 1 and 2 respectively. Upon analysis of the results, it is observed that as CUL inhibitor concentration increases, the corrosion rate and metal loss decreases. It is attributed to the inhibition of corrosion by the CUL extract which adsorb on the metal surface and act as a barrier for base metal dissolution. It is also observed that with increase in immersion period, the corrosion rate decreased and inhibition efficiency increased. Upon monitoring the pH of the pickling bath it was noted that no drastic change in pH with inhibitor addition of varying concentration was noted and varying time of usage of the pickling bath also did not alter the pH on a wide scale, in both acids.

IV. CONCLUSION

The results revealed the performance of CUL as good inhibitor in citric acidas well as in hydrochloric acid. The suitability of the plant extract in organic acid suggests further scope of research and industrial adaptability. Inhibition efficiency increases with increase in inhibitor concentration and maximum inhibition efficiency was found to be 92% at optimum concentration of2.5 % V/V of CUL extract with 1M Hydrochloric acid and 90% with 1M Citric acid at room temperature for 24hour immersion test. The pH of the bath was not affected due to the presence of inhibitor.These studies help to proceed with electrochemical studies of corrosion testing and other methods of analysis of mechanism of inhibition to prove the performance of inhibitor.

Table.1 Weight Loss Method Data for Mild Steel in 1M Citric Acid

Time of immersion Hours	CUL concentration %V/V	Weight loss grams	Corrosion Rate mpy	Inhibition Efficiency %	pH
3	Blank	0.0133	194.580822	0	1.8
	0.5	0.0059	86.3178082	55.6390977	1.76
	1	0.0052	76.0767123	60.9022556	1.78
	1.5	0.0051	74.6136986	61.6541353	1.78
	2	0.0049	71.6876712	63.1578947	1.81
	2.5	**0.0046**	**67.2986301**	**65.4135338**	**1.79**
24	Blank	0.099	181.035546	0	2.51
	0.5	0.0158	28.8925416	84.040404	2.21
	1	0.0155	28.343949	84.3434343	2.24
	1.5	0.0138	25.2352579	86.0606061	2.23

	2	0.0107	19.5664681	89.1919192	2.23
	2.5	**0.0099**	**18.1035546**	**90**	**2.23**
48	Blank	0.2133	195.024656	0	2.1
	0.5	0.0277	25.32669	87.0135959	1.67
	1	0.0241	22.0351346	88.7013596	1.68
	1.5	0.0229	20.9379495	89.2639475	1.67
	2	0.0196	17.9206904	90.8110642	1.7
	2.5	**0.0185**	**16.9149373**	**91.3267698**	**1.69**

Table.2 Weight Loss Method Data for Mild Steel in 1M Hydrochloric Acid

Time of immersion Hours	CUL concentration %V/V	Weight loss grams	Corrosion Rate mpy	Inhibition Efficiency %	pH
3	Blank	0.0634	927.550685	0	0.3
	0.5	0.0072	105.336986	88.6435331	0.25
	1	0.0064	93.6328767	89.9053628	0.21
	1.5	0.0034	49.7424658	94.637224	0.2
	2	0.0042	61.4465753	93.3753943	0.19
	2.5	0.0034	49.7424658	94.637224	0.19
24	Blank	0.4677	855.255804	0	0.3
	0.5	0.0574	104.964044	87.7271755	0.23
	1	0.0629	115.021574	86.551208	0.18
	1.5	0.0407	74.4257243	91.2978405	0.1
	2	0.0321	58.6994042	93.136626	0.16
	2.5	0.0372	68.0254777	92.0461835	0.16
48	Blank	0.8917	815.299979	0	0.4
	0.5	0.124	113.375796	86.0939778	0.24
	1	0.1725	157.720362	80.65492879	0.23
	1.5	0.1429	130.656462	83.97443086	0.2
	2	0.1049	95.9122663	88.2359538	0.2
	2.5	**0.1106**	**101.123896**	**87.59672536**	**0.2**

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