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Research Article

CORROSION INHIBITION OF MILD STEEL IN 1 N HYDROCHLORIC ACID SOLUTION BY PIPER BETELLEAVES

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A B S T R A C T

Mild steel is used commonlyas metal in many industrial applications and acid solutions are usedin various industrial processes like acid cleaning, descaling, pickling. In the present study, an attempt was made to study the anticorrosion behaviour of the aqueous extract of *Piper betel* leaves in hydrochloric acid medium using weight loss method. Corrosion rates and inhibitor efficiencies were determined for the effectiveness of the inhibitor. The results showed that increase of the inhibition efficiency with increasing the concentration of plant extract. The results confirmed that *Piper betel* leaf extract could serve as aneffective green corrosion inhibitor for mild steel in acid medium.

INTRODUCTION

Corrosion is the deterioration of a metal when it comes in contact with the surrounding environment. Mild steel are widely used as a constructional material in many industries because of its excellent mechanical properties, ductability, weld ability and low cost. However, it gets corroded when exposed to the corrosive industrial environment [1]. Based on corrosive environment, corrosion of the mild steel occurs and it leads to failure of the building structure, machine, process plants, power plants, etc. The corrosion inhibition of mild steel can be achieved by the addition of inhibitors to thesystem that prevent corrosion from taking place on the metal surface [2].

In several industries, acid solutions can be usedfor a variety of purposes, such as acid pickling, cleaning, descaling of metals. Because of the aggressive nature of acid solution, inhibitors are commonly used to prevent their corrosive attack [3,4,5]. Commonly used organic and inorganic inhibitors are synthetic compounds, which are costly and also lead to serious environmental problems. To avoid the problem of environmental hazards, the current researchers have focused their attention on using natural compounds, particularly plant extracts, as corrosion inhibitors [6].

In recent year, the use of green inhibitors has generated a lot of attention because these are not only cheap, easily available and eco-friendly but are also extracted with procedures at very low cast [7, 8].

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Most of the organic inhibitors are of plant origin and plant products containing varieties of organic compound such as amino acids, alkaloids, steroids, flavonoids, saponnins, essential oils and tannin as a green alternative for toxic and hazardous compounds [9,10].

So far no studies were reported using *piper betel* leaves as corrosion inhibitors for metals. Therefore, the present article is concerned with corrosion inhibition studies using piper betel leaves extract on mild steel in acidic medium using Mass loss measurements. *Piper betel* belonging to piperaceae family is one of the precious herbs found in India, Malaysia and south-east Asia. Scientific research on *betel* leaves reveals that it possesses many beneficial bioactivities and its extract has a great potential to be used in developing commercial products [11,12]. The aim of this study is to investigate the inhibitive effect of *piper betel* leaves extract as a cheap, nontoxic, readily available and novel corrosion inhibitor for the corrosion of mild steel in 1NHCl.

MATERIALS AND METHODS

Preparation of Specimens

The mild steel specimens used in this study were purchased in local market. The mild steel was cut into coupons of dimensions 5×2×0.1 cm. These coupons were abraded with different grades emery papers (grade 600 and 800) after that washed with distilled water, degreased with acetone, dried and weighed before experiments.

Preparation of Extract

Fresh *Piper betel* leaves were used to make the aqueous extract. *Betel* leaves purchased from local market andwashed with distilled water. An aqueous extract of *betel* leaves were prepared by grinding 10g of *betel* leaves, with double distilled water. The solid impurities were removed by filtration process. The extract of *betel* leaves obtained in this manner was used as an inhibitor. The extract was characterized by UV-Visible spectroscopy using a SHIMADZU UV-Visible 1800 spectrophotometer.

Weight Loss Measurement

Experiments were conducted under total immersion in stagnant aerated condition using 250 mL capacity beakers containing 200 mL test solution at 298 K maintained in a regulated water bath. The mild steel coupons were weighed and suspended in the beaker with the aid of rod and hook. The coupons were removed at interval, cleaned, dried and reweighed. The weight loss, (in grams), was taken as the difference in the weight of the mild steel coupons before and after immersion in different test solutions including the blank. The tests were performed in triplicate and the mean value of the weight loss was reported. Inhibition concentrations of 5, 10, 25 and 50 mL were used. From the weight loss values, corrosion rates, degree of surface coverage and inhibition efficiency were calculated accordingly using the following expressions:

$$IE\ (\%) = W_0 - W_i/W0 \times 100 \quad (1)$$

$$? = IE/100 \quad (2)$$

Where, W 0 and Wi are the weight loss of the mild steel specimens in absence and in presence of inhibitors, respectively while? is the surface coverage.

The corrosion rate (CR) of mild steel was calculatedusing the equation:

$$CR\ (mm/yr) = 87.6W/AtD \quad (3)$$

Where W is the corrosion weight loss of mild steel (mg),A the area of the specimen, t the exposure time (h) and Dis the density of mild steel (g/cm3).

RESULTS AND DISCUSSION

Piper betel leaves in 1N HCL for mild steel

The results obtained for the variation of weightloss with exposure time for the mild steel specimensimmersed in 1 N HCL with varied concentrations ofadded *Piper betel* leaf extract ispresented Fig. 1.

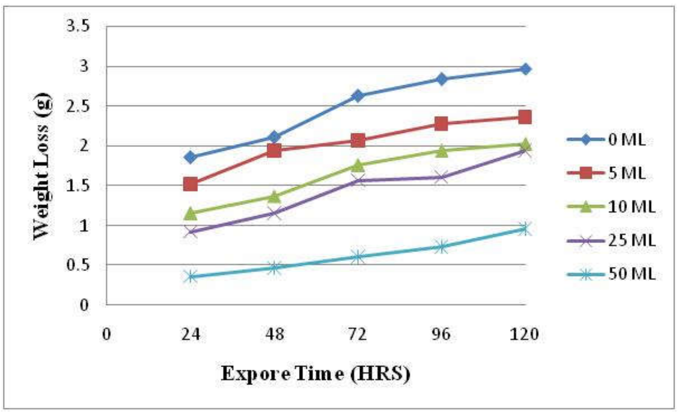

Fig 1 Variation of weight loss with exposure time for betel leaf (Piper betel) extract

The result obtained show a great value of weightloss for the test media without *Piper betel* leaf extract. The addition of *betel leaf* extract tothe test media resulted in reduction of weight loss. The difference in weight loss for the test media with and without *betel* leaf extract was not much for the 24 hrs interval, but from 24 to 120hrs there was an increasein weight loss for the media without *Piper betel* leaf extract (control experiment) and a decrease in weight loss for the media with *Piper betel* leaf extract. The*Piper betel* leaf extract shows good inhibition behaviour on the weight loss of mild steel in 1Nhydrochloric acid [13].

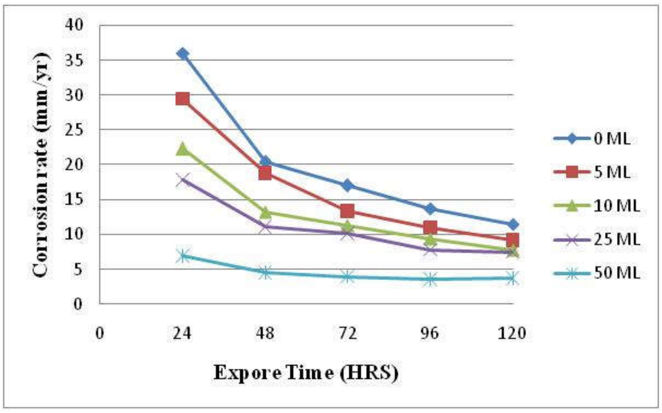

Fig 2 Variation of corrosion rate with exposure time for betel leaf (*Piper betel*) extract

Figure 2 shows the variation of corrosion rate withexposure time for mild steel immersed in 1N HCL andaddition of different concentrations of betel leaf (*Piper Betel*). Corrosion rates were calculated with the four different *Piper betel* leaf extract concentrations achieving values ranging from 29.45, 18.79, 13.36, 11.04 and 9.14mm/year (for 5 mL), 22.28, 13.27, 11.37, 9.40 and 7.83 mm/year (for 10 mL), 17.82, 11.14, 10.14, 7.80 and 7.52mm/year (for 25 mL) to 6.97, 4.55, 3.94,3.54 and 3.72mm/year (for 50 mL). The control experiment gave higher corrosion rate values throughout the experimental period (36.04, 20.44, 16.98, 13.76 and 11.51mm/year). These results confirm that plant extract of the *Piper betel* possesses corrosion inhibiting property. It is not certain, however, whether the optimum concentration needed for more effective corrosion inhibition have been reached with any of thethree concentrations used.

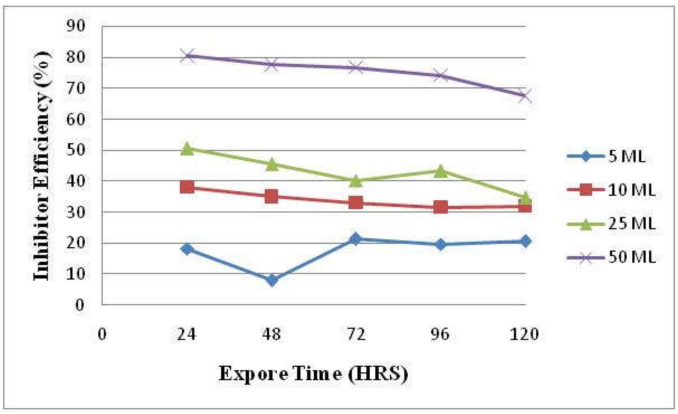

Fig. 3 Variation of inhibitor efficiency with exposure time for betel leaf (Piper betel) extract

Figure 3 shows the graph of variation of inhibitor efficiency with exposure time. The highest inhibitor efficiency of 80.65% for the concentration of extracts was obtained with the 50 mL concentration of *Piper betel* on after 24 h of the experiment but this came down to just 74.29 and67.68%, respectively on after 96 and 120 hrs of the experiment. For the 5 mL concentration there was increasing inhibition efficiency for the 72hrs and a decrease inthe 96-120 hrs. The 10 mL concentration showed stable inhibition efficiency from 38.18 to 31.98% for 24-120 hrs experimental periods. The 25 mL concentration showed unstable inhibition efficiency throughout the experimental period. This trend may be attributed to the leaching of *Piper betel* leaf extract molecules into the inhibitive solution when the concentration of extracts reaches beyond critical, thus resulting to reduced metal inhibitor interaction [14, 15]. One of the possible mechanisms employed by the plant molecules is to adhere to the metal surface there by retarding the aggressive liquid from coming in contact with the metal surface.

CONCLUSION

The potential of natural plant is still largely unexplored for potential green corrosive inhibitors. The present investigation shows *Piper betel* leaf extract acts as inhibitor for mild steel corrosion in 1N HCl. The inhibition efficiency is increased with increase in inhibitor concentration at constant temperature. The inhibiting effect of the *Piper betel* leaf extract could be attributed to the presence of phytochemical ingredients present in the extract which is adsorbed on the surface of the mild steel. The plant extract can be considered as an eco-friendly and effective green corrosion inhibitor for mild steel in acid medium. We further recommend studies through impedance spectroscopy, Tafel polarization and surface analysis through high resolution microscopy on the material surfaces to get insights into the mechanism aspects of green corrosion inhibition.

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