Synergistic Effect of Potassium Iodide on Corrosion Inhibition of Mild Steel in HCl Medium by Extracts of *Piper betel* leaves

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ABSTRACT

The effect of Piper Betel leaf extract and the mixture of various concentrations of KI on corrosion of mild steel in 0.1M, 0.5M and 1.0 M HCl have been investigated using weight loss methods. The study revealed that mild steel is more efficiently inhibited by *P. betel* leaf extract in the presence of KI than pure extract of *P. betel* leaves. The inhibition efficiencies increased with increased concentration of the additives. The highest inhibition efficiency of 64.20% was observed with single *Piper betel* extract. An improved inhibition efficiency of 88.92% was observed with the mixture of leaf extract and KI in 0.5M HCl. Inhibition efficiency decreased with increase in temperature an effect attributed to synergism between *Piper betel* leaf extract and KI.

Keywords: Mild steel, *Piper betel* leaves, KI, Weight loss method, corrosion inhibition

Mild steel is one of the major construction materials, which is extensively used in chemical and allied industries for the handling of acid, alkali and salt solutions [1]. Hydrochloric acid is the most common acids and it is very corrosive to most of the common metals and alloys. Extreme care is required in the selection of materials to handle the acid by itself, even in relatively dilute concentrations or in process solutions containing appreciable amount of hydrochloric acid [2]. The researchers are using various methods to combating the corrosion of metals. One of the methods is adding inhibitor to the corrosion environment has been employed. The efficiency of these inhibitors is sometimes improved by the addition of some other compounds which act in synergism. Several studies have been carried out using synergistic effects of corrosion inhibitors [3]. In the search for more environmentally friendly and readily available inhibitors, researchers have reported the use of local plants for corrosion inhibition. In line with *Piper betel* leaf a local plant has also been reported as inhibitor for mild steel in HCl medium [4]. The inhibition efficiency of *Piper betel leaf* extract on mild steel in HCl medium as reported in previous work could be improved. Report [5,6];

have shown that inhibition efficiency of an inhibitor can be improved by the addition of halide ions to the inhibitor, a process referred to as synergism.

Synergistic inhibition effectively improves the inhibition efficiency of an inhibitor. It also results in decrease in amount of inhibitor used and diversification of application in corrosive media. Many investigations on synergistic inhibition are available in literature. Not much has been reported on the synergistic effects on naturally occurring inhibitors. Synergism between *Piper betel* leaf and halide ions is not available in literature. This paper investigates the synergistic inhibition between *P. betel* extract and KI in HCl medium using weight loss method.

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 and washed 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:

$IE (\%) = W_0 – W_i/W_0 \times 100$ (1)

$? = IE/100$ (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 calculated using the equation:

CR (mm/yr) = 87.6W/At D (3)

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

RESULTS AND DISCUSSION

Effect of corrodent concentration: It was confirmed that mild steel corrodes in HCl solution. As earlier reported weight loss depended on HCl concentration and temperature Fig. 1 show the variation of weight loss with time at different temperatures and concentrations.

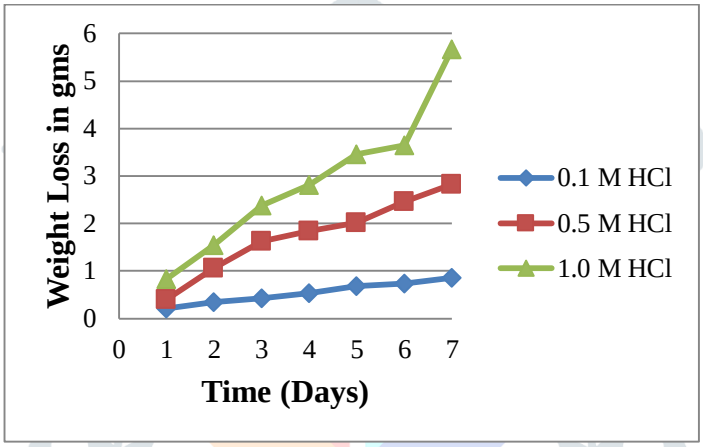

Fig. 1 Weight loss of mild steel in various concentrations of HCl at 30°C

Effect of addition of Piper betel leaf extract to corrosion medium: Corrosion inhibition studies were done in 0.1M and 0.5M HCl. It was observed that weight loss of coupon decreased when *P.betel* was added to the corrosion media. Corrosion rate also decreased as evident in Fig. 2.

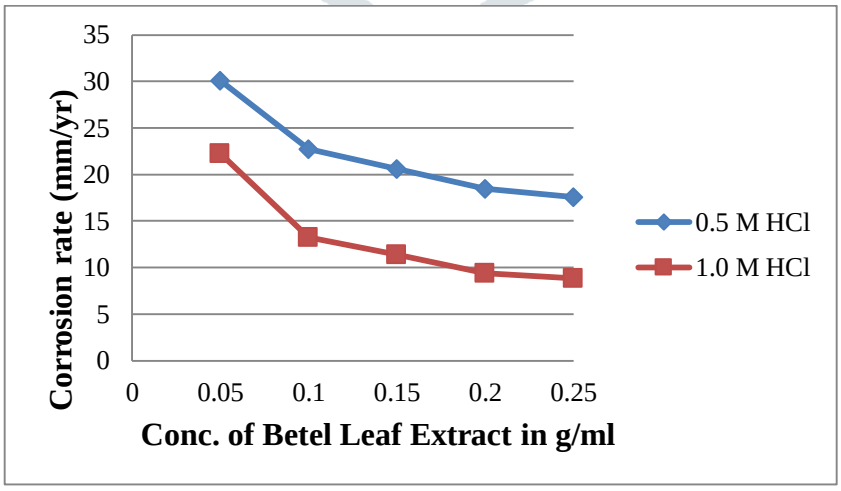

Fig. 2 Corrosion rate of mild steel with and without *P.betel* leaf extract in 0.1M and 0.5M HCl

Corrosion rate was calculated from the equation:

$$Cr = DAT/534W$$

W = weight loss (mg); D = density of coupon (gcm-1); A = Area of coupon (cm2); T = Exposure Time (hrs.)

The inhibition efficiency of *Piper betel* leaf extract was expressed in terms of percentage inhibition, calculated using the equation,

$$\%E = 100X\,[W_0\text{-}Wa/W_0]$$

W_0 = weight loss without additive; Wa = weight loss with additive

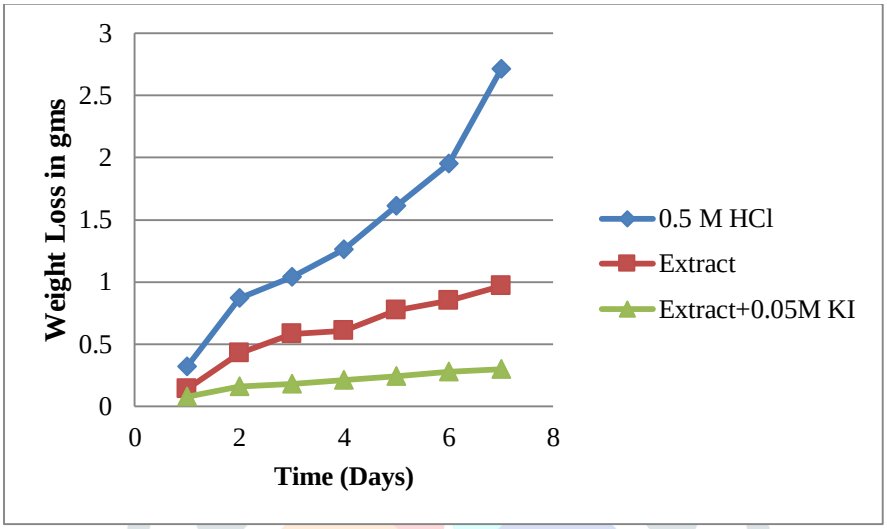

Fig. 3: Weight loss of mild steel in 0.5M HCl with various concentrations of additives at 30°C

Effect of addition of KI Piper betel leaf extract to corrosion media*:* As shown in Fig. 3, introduction of KI to *P.betel* leaf extract reduced further the weight loss of mild steel coupons in the acid medium. Whereas a weight loss of 0.0097 g was recorded with only 0.25gdm-3 of *betel* leaf extract, the weight loss reduced to 0.003g with the addition of KI at the same temperature of 30°C. Same was true for all the concentrations studied. In 0.1M HCl an inhibition efficiency of 64.21% was obtained for only *P,betel* leaf but the inhibition efficiency increased to 88.93% with the inclusion of KI to *betel* leaf extract. The inhibition power of the mixture was found to be more effective at higher concentrations (0.25gdm-3 *P.betel* leaf extract + 0.05M KI) as 88.93% than at lower concentrations 0.05gdm- 3 + 0.01M KI) 75%. The observations clearly establish that the addition of KI improved the corrosion inhibition power of *Piper betel* leaf extract.

As shown in Fig4, the maximum percentage inhibition of 88.93% and 64.21% were recorded for 0.5M Hcl, 0.05M KI and with and without *P.betel* leaf extract respectively at 30°C. Inhibition efficiency was observed to increase with increase in concentration of *betel* leaf extract and decrease with increasing temperature.

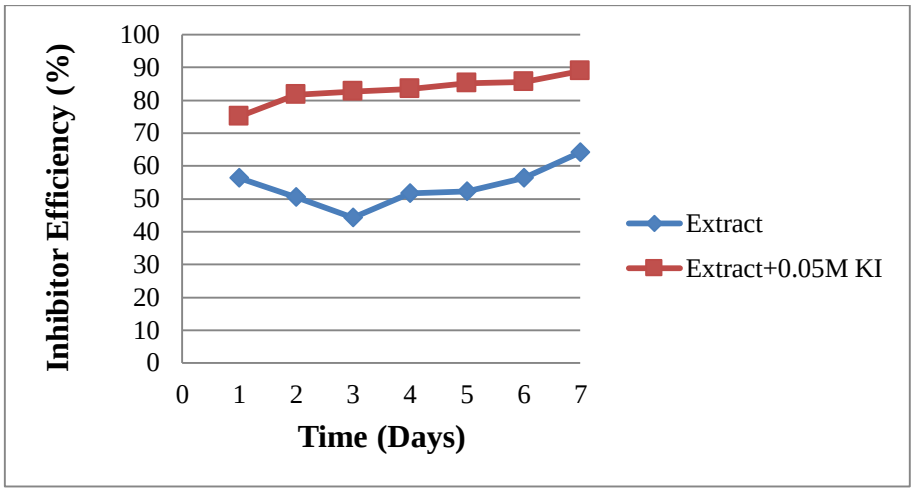

Fig. 3 Variation of inhibition efficiency with concentration of additives in 0.5M HCl at 30ºC

Conclusion

1. *Piper betel* leaf extract was found to be an inhibitor for mild steel corrosion in HCl.

2. Inhibition efficiency (%I) of the extract increased with an increase in concentration of *P.betel* leaf extract and with increase in temperature. On the other hand, inhibition efficiency (%I) synergistically increased on addition of potassium iodide but decreased with increase in temperature.

3. The adsorption of the *P.betel* leaf extract alone and in combination with the potassium iodide can be approximated by the Langmuir adsorption isotherm. This present study provides new information on the inhibiting characteristics of *Piper betel* leaf extract under specified conditions. The environmentally friendly inhibitor could find possible applications in metal surface anodizing and surface coating in industries.

References

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