

PASSIVATION OF STEEL BY FRUIT EXTRACTS

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Anima Upadhyay¹ and Chandrakala M².¹Assistant Professor, Department of Chemistry, Sir MVIT, Bangalore, Karnataka, India.²Research and Development Centre, Bharathiar University, Coimbatore, TN, India.

Abstract: The passivation of steel plates in fruit extracts was studied at room temperature by weight loss method. The fruit extracts employed were: lime, tamarind and aqueous solution of mango powder. The passivation behavior of fruit extracts was studied by immersing steel plates in the extracts over a period extending up to 120 hours. The loss in weight and the rate of corrosion after 24 and 120 hours of immersion was recorded. The results showed that after 24 hours the passivity was greatest in mango extract followed by tamarind and lime. However, after 120 hours the passivation was found to be least in mango extract and highest in tamarind extract and intermediate in lime extract.

Key words: Fruit extracts, Weight loss method, Passivation, Corrosion rate, Steel

I. INTRODUCTION

The destruction of metals or alloys by its surrounding environment is called corrosion. It is a natural phenomenon, but can be greatly reduced by using certain agents called retarders, inhibitors or passivating agents. Passivation is described as the formation of a thin layer of metal oxide on the metal surface which prevents further corrosion of the metal if the oxide layer is nonporous, uniform and inert. Several studies on the corrosion behavior of various metals and alloys [1-9] have been conducted but very little has been done in the direction of passivation by natural agents such as plants and fruit extracts. The aim of the present study is to reduce corrosion by the use of the natural passivating agents. For this study Lime juice that mainly contains *citric acid* with a little ascorbic acid [10-12]. Mango powder that contains, *ascorbic acid* [13-14] and Tamarind extract that contains *tartaric acid* [15-16] were selected and passivation behavior of these extracts on the metal through weight loss method was conducted.

II. MATERIALS AND METHODS**2.1 SAMPLE PREPARATION**

Square steel (length 3cm and height 3cm) plates were used as sample to study the passivation behavior in different fruit extracts. The plates were cleaned with double distilled water to remove dust, degreased by acetone, dried and weighed. [17]

2.2 NATURAL EXTRACTS

Lime, Tamarind and mango extracts were prepared from fruits using deionized water.

Lime extract: 1 lime was taken and its juice was extracted and made up to 70ml with double distilled water.

Tamarind extract: 11.5906g tamarind was weighed and an extract was made with double distilled water and diluted to 70 ml.

Mango extract: 2.5202g mango powder was weighed and an extract was made with double distilled water and diluted to 70 ml.

2.3 WEIGHT LOSS MEASUREMENTS

The weight loss method was adopted to study the passivation behavior of surface treated steel plates having surface area of 9 sq.cm. The previously weighed plates were immersed in 70ml fruit extracts of lime, tamarind and mango. The immersion was continued over a period of up to 120 hours at room temperature. After 24 hours plates were removed from the solution washed, dried and weighed. The plates were immersed again in the extracts for up to 120 hours after which they were removed washed, dried and weighed. The loss in weight of the steel plates after 24 and 120 hours is tabulated in (Table 1).

2.4 WEIGHT LOSS METHOD

Several authors have studied the corrosion of various metals / alloys using weight loss method [18-20] in different environments. The difference in the weight of the specimens before and after exposure is calculated.

The rate of corrosion is calculated as follows:

Weight loss (W) X Constant (K)

Corrosion rate (mmpy) = _____

Exposed area (A) X Density of the specimen (D) X Exposure time (T)

Where, $K = 8.76 \times 10^{-4}$ (constant), W = weight loss in g, A = area in sq.cm and $D = 7.78 \text{ gm / cm}^3$ (density), T = exposure time in hours.

Table 1
Corrosion rate by weight loss method

Solutions employed	Weight loss after 24 hrs	% of weight loss after 24 hrs	Rate of corrosion after 24 hrs	Weight loss after 120hrs	% of weight loss after 120hrs	Rate of corrosion after 120hrs
Tamarind	0.0004	0.0277	0.0208	0.0017	0.1179	0.0177
Lime	0.0009	0.0613	0.0469	0.0024	0.1636	0.0250
Mango powder	0.0002	0.0142	0.0104	0.0038	0.2714	0.0396

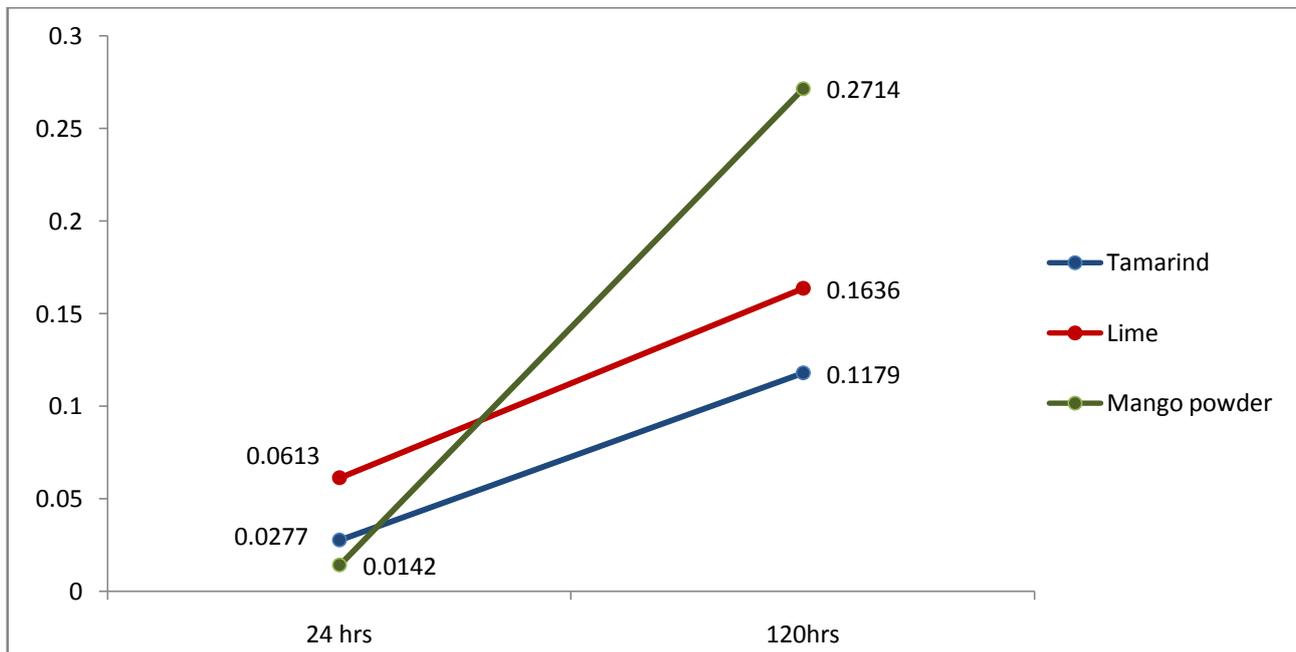


Fig 1 Graphical representation of % of weight loss of steel plates in various Fruit extracts

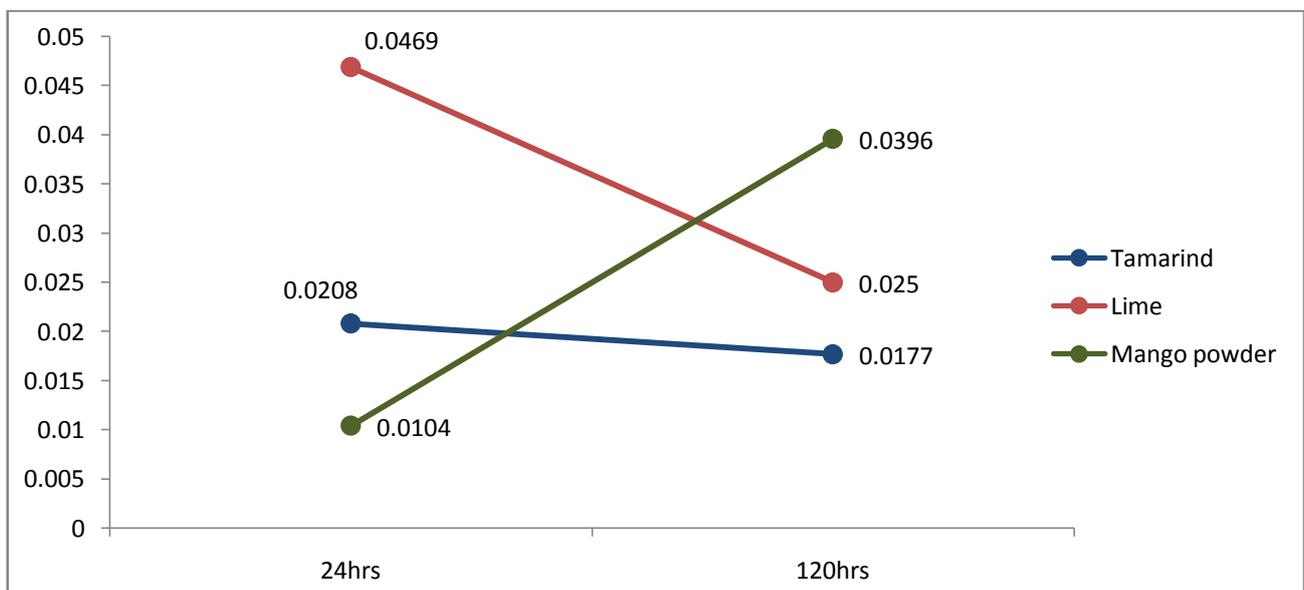


Fig 2 Graphical representation of passivation of steel plates in various Fruit extracts

III. RESULT AND DISCUSSION

The weight loss, percentage weight loss and rate of corrosion of steelin lime, tamarind and mango extracts are tabulated in table 1. The figure 1 shows that the percentage of weight loss of the steel plates after 24 hours was maximum in lime extract and minimum in mango extract. However after 120 hours there was a rapid percentage weight loss in mango extract which was followed by lime and tamarind. Thus, the passivation of steelin figure 2 after 24 hours was greatest in mango extract followed by tamarind and lime. But, after 120 hours the passivation was found to be least in mango extract and highest in tamarind extract and intermediate in lime extract.

Citric acid which is a strong passivating agent is present in very high concentrations in lime. In mango extracts ascorbic acid is the main constituent along with the presence of little citric acid too. Tamarind extracts however contains tartaric acid which is also showing to reduce corrosion and promoting passivation.

The passivation behavior of fruit extracts were found to be in the order of mango(ascorbic acid)>tamarind (tartaric acid)>lime (citric acid) after 24 hours of immersion. But, after a lapse of 120 hours the trend of passivation in extracts were found to be in the order of tamarind (tartaric acid) >lime (citric acid)>mango (ascorbic acid).

The dissolution of the metal in the beginning took place due to the mild corrosive behavior of the acids present in the fruit extracts. But as a result of dissolution formation of an oxide layer also took place on the surface of the metal. This oxide layer remained intact and inert in tamarind (tartaric acid) and Lime (citric acid) extracts leading to passivation of the metal plates whereas in the mango (ascorbic acid) extract it started dissolving resulting into rapid corrosion.

Hence mango extract can be used for passivation of steel only up to 24 hours beyond that it fails to protect the metal from corrosion. On the contrary tamarind and lime extracts showed inertness and passivation of steel for prolonged time thus preventing it from corrosion.

IV. CONCLUSION

Thus it can be concluded that the fruit extracts of tamarind (tartaric acid) showed maximum passivation. Lime extracts (citric acid) also showed fair passivation but mango extracts (ascorbic acid) were unsuccessful as passivating agents for the tinned material for long periods of time.

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