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INVESTIGATION OF INHIBITION EFFICIENCY OF KOLA NUT PLANT LEAVES EXTRACT ON CORROSION OF MILD STEEL IN HYDROCHLORIC ACID SOLUTION

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ABSTRACT

Evaluation of the inhibitive ability of kola nut leaves extract on the corrosion of mild steel in 1.0 M Hydrochloric acid solution using weight loss measurement at temperature ranges of 30 – 60^oC was investigated. Chemical analysis of mild steel plate was carried out in National Metallurgical Development Centre (NMDC), Jos, Plateau State. The test media, plant extract and test coupons were prepared by standard methods. The coupons were immersed into the test media containing the extract in concentrations of 100, 300 and 500 ppm. After intervals of 7, 14, 21 and 28 days, the coupons were retrieved and percentage weight loss, corrosion rate and inhibition efficiencies of the extract were calculated. Kola Nut Leaves extract gave above 80% corrosion efficiency on the average depending on variables like temperatures, concentrations and exposure time. The corrosion rate varied between 1.586 to 0.654 x 10^{-3} mm/yr in the absence of the extract at all concentrations, temperature and exposure time respectively. Comparison of the inhibition efficiency of mild steel by Kola Nut extract and that of Miconazole Nitrate at 30^oC shows favourable values of 80% and 85% respectively.

Keyword: *Corrosion Inhibitor, Kola Nut leaves Extract, Miconazole Nitrate, Mild Steel and Hydrochloric Acid Solution.*

1.0 INTRODUCTION

Mild steel is a material of construction; it is extensively used in chemical industries for handling alkalis, acids and salt solutions [1]. Corrosion is one of major scientific issues that must be carefully addressed daily as far as there are intensive needs of metallic materials in all technological development. Poor corrosion resistance of mild steel is a serious concern in many industrial applications [2]. Many inorganic and organic compounds have been reported as corrosion inhibitors for components and equipment in service, but the toxic nature of many of them limits their application. Recently, there is an increased research on eco-friendly, non-toxic corrosion inhibitors for protection of steels and components exposed to aggressive deteriorating environments [3].

Plant extracts are naturally occurring compounds, some with complex molecular structures and having different chemical, biological and physical properties. The naturally occurring compounds are mostly used because they are environmentally friendly, cost effective and have abundant availability [4]. Currently several plant extracts have been used as corrosion inhibitors [5]. Naturally occurring compounds can be got from plants, some have complex molecular structures, chemical, biological and physical properties. Kola nuts are important economic cash crops grown mainly in the

southern part of Nigeria and have not been used as corrosion inhibitor to the best knowledge of the authors. Hence, this paper looks at the possibility of using kola nut leaves extract as corrosion inhibitor for mild steel in HCl solution.

2.0 MATERIALS AND METHOD

The composition of the steel was analyzed at the National Metallurgical Development Centre (NMDC), Jos, Plateau State, and the result presented in Table 1 below. A steel sheet of thickness 0.5 cm was obtained locally and was mechanically cut into coupons of 3 cm x 4 cm x 0.5 cm. A small hole of size 2 mm was drilled in the coupons for easy hooking and suspension of the steel coupons in HCl solution. The specimens were descaled, degreased, cleaned, dried and stored in desiccators. The extract was prepared in the Department of Agricultural and Food Engineering, University of Uyo, Uyo, Akwa Ibom State as indicated in [3]. Each coupon was polished using different grades of silicon carbide impregnated emery paper of 120, 400, 800 and 1000 grits.

The coupons were weighed using a digital balance. These weighed coupons were fully immersed in each of the beakers containing 100 ppm of solution with and without plant extract for seven (7) days. Weight loss measurements were carried out after the immersion period of every seven (7) days and repeated for different temperatures.

The corrosion rates of the mild steel in 1.0M of HCl solutions in the absence and presence of kola nut plant extracts were determined at room temperature. The equation for corrosion rate is expressed by [8].

$$CR = \frac{87.6W}{\rho At} \quad - \quad - \quad 1$$

Where CR = the corrosion rate in millimetre per year, W = weight loss (g), ρ = density of the mild steel 7.86 g/cm^3, A = total surface area in cm^2 and t = exposure time in hours.

The percentage (%) inhibition efficiency, IE was calculated using the relationship [7] and [11].

$$IE = \theta \times 100\% \quad - \quad - \quad 2$$

Where $\theta = \frac{(CR)_a - (CR)_P}{(CR)_a}$ - - 3

and $(CR)_P$ and $(CR)_a$ are the corrosion rates in the presence and absence of inhibitor respectively.

3.0 RESULTS AND DISCUSSION

The chemical microanalysis of the mild steel used in this experiment was obtained using Optical Emission Spectrometer (OES) SPAS-02 and manufactured by North-Western Manufacturing Company.

Table 1: Chemical Composition of Sample

S/No.	Chemical Element	Percentage Composition (%)
1	Carbon	0.133
2	Silicon	0.052
3	Manganese	0.331
4	Phosphorus	0.006
5	Sulphur	0.014
6	Chromium	0.019
7	Nickel	0.006

Temperature Effect on Corrosion of Test Coupons

Figure 1 shows the effect of temperature on the weight loss behaviour of coupons at different inhibitor concentrations in 1.0 M HCl solution.

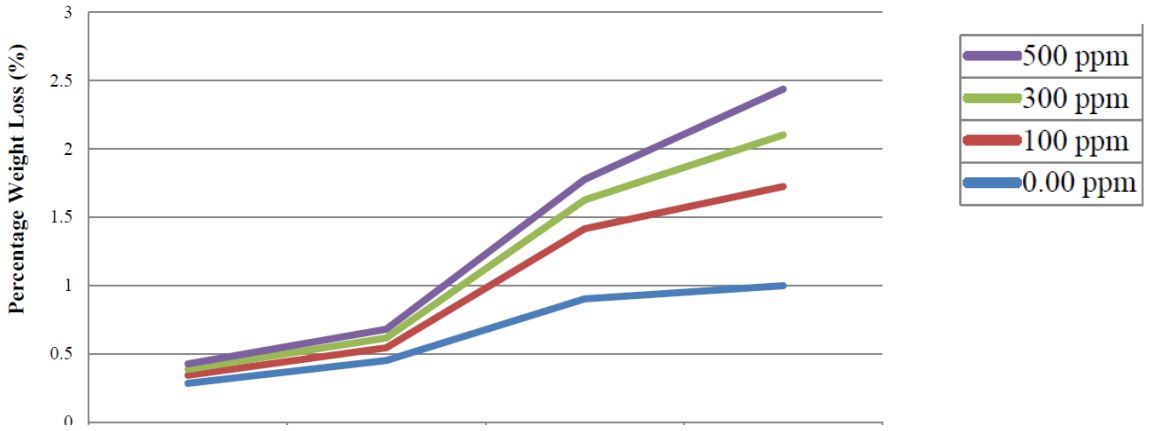

Figure 1: Effect of temperature on weight loss recorded and plotted for test coupons at different inhibitor concentrations of 0, 100, 300 and 500 ppm respectively.

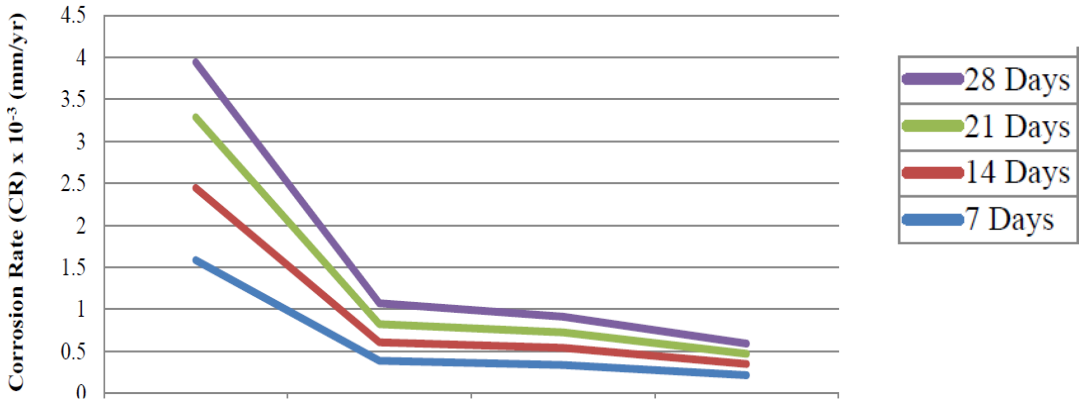

Figure 2: Effect of concentration on corrosion rate for test coupons after 7, 14, 21 and 28 days of exposure to solution containing 1.0 M HCl.

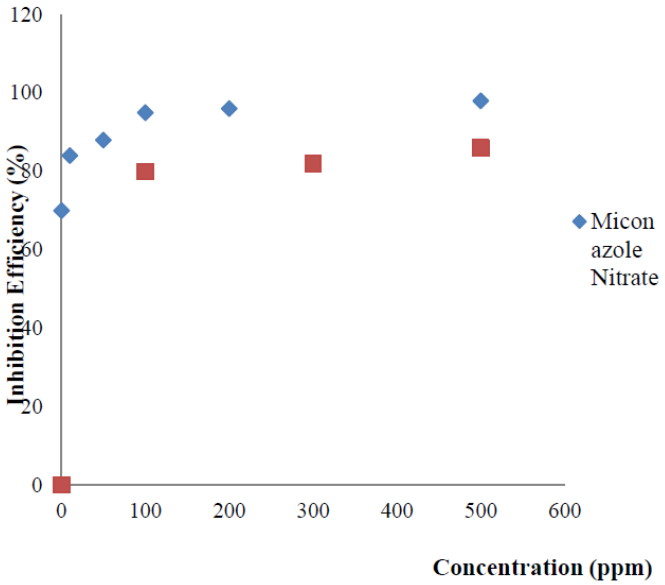

Figure 3: Comparison between inhibition efficiency of Miconazole Nitrate and Kola Nut Leaf Extract at 0, 100, 300 and 500 ppm

4.0 DISCUSSION

Table 1 shows the chemical analysis of the Test Piece and contains 0.13 % of carbon, 0.05 % of Silicon, 0.33 % of Manganese, 0.006 % of Phosphorus, 0.014 % of Sulphur, 0.019 % of Chromium and 0.006 % of Nickel. This is indicative that the test coupon was mild steel [3].

Figure 1 shows the percentage weight loss of mild steel in 1.0 M HCl test media at temperatures of 30^{o}C, 40^{o}C, 50^{o}C and 60^{o}C respectively, each having varying concentration of inhibitor {0 ppm (blank), 100 ppm, 300 ppm and 500 ppm}.

The results in Figure 1 indicates that increase in temperatures from 30^{o}C to 60^{o}C increases the percentage weight loss as the concentration of the inhibitor also increases, with the blank (0ppm) having the highest percentage weight loss. This could be attributed to higher reaction rate at higher temperatures as corroborated by [6] and [7].

Figure 2 indicated that the corrosion rate (CR) decreases with increase in the concentration of the extract, with the blank having the highest corrosion rate. This Figure also shows the effect of concentration of the inhibitor after 7, 14, 21 and 28 days of exposure of the coupon. The results indicate that the corrosion rate of the mild steel decreases with increase in the concentration of the inhibitor in acidic media. This decrease continues to 100 ppm, after which it is stabilized, that is, an increase in concentration results in little or no increase in corrosion rate. This could be attributed to passivation of the mild steel. This result is corroborated in the work of Yawas*et al* [9].

Comparison of obtained results and that of Miconazole Nitrate is shown in Figure 3. This Figure shows that an increase in concentration of the inhibitor increases the inhibition efficiency. However, there is a slight difference in their efficiencies. At 100 ppm and 500 ppm, the differences in their efficiencies were 14.89% and 13.92% respectively. From obtained result, Kola Nut leaf extract as an inhibitor can be considered effective as it competes favourably with the standard inhibitor.

5.0 CONCLUSION

Based on the result obtained the following conclusions were drawn:

i. The efficiency of the extract was established to be above 80 % on the average depending on variables like temperature, exposure time and concentration.
ii. The Kola Nut extract in acidic medium provides appreciable level of corrosion inhibition to mild steel and can be considered effective as it competes favourably with the standard inhibitor in efficiency.

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