American Journal of Engineering Research (AJER)
E-ISSN: 2320-0847 p-ISSN: 2320-0936
Volume-8, Issue-2, pp-173-177
www.ajer.org
Research Paper Open Access

Performance of Mild Steel Coated with African Pear (Dacryodes Edulis) Resin in Mud Water

Tornubari, Sunday-Piaro
Captain Elechi Amadi Polytechnics, Rumuola, Port Harcourt, Rivers State, Nigeria
Corresponding Author: Tornubari

ABSTRACT: *This study investigated the performance of mild steel coated with African pear (dacryodes edulis) resin, which is exposed to mud water. This was done to finding an alternative solution to the corrosion of automobile parts in contact with mud water settling on potholes of dilapidated road. Coated and uncoated mild steel were immersed in mud water, and the rate of corrosion monitored for period of 56 days (8 weeks). The average weight loss in mild steel increased with exposure time, but the weight loss in the control specimens was by far higher than in the coated specimens. Conversely, the corrosion rate decreased with increased in exposure time, but from 7 to 14th day, the corrosion rate increased from 0.377 to 0.474MPY and 0.058 to 0.103MPY for uncoated and coated mild steel respectively, before gradually decreasing to 0.185MPY and 0.047MPY for uncoated and coated mild steel respectively at the 56th day. Similarly, the inhibition efficiency of African resin decreased with time. Thus, on the 7th day, the inhibition efficiency was 84.55%, while it reduced to 74.40% on the 56th day. However, the coated steel obtained from automobile reduced the rate of corrosion in mud water. Therefore, corrosion of steel component of automobile, vulnerable to salt and acid mud water can be reduced by coating with African pear, thereby improving the life cycle of automobile and also, reducing maintenance cost.*

KEYWORDS: *Mild Steel, Corrosion Rate, African Pear Resin, Mud Water,*

Date of Submission: 03-02-2019 Date of acceptance: 19-02-2019

---

1. INTRODUCTION

Steel is an important engineering material with wide applications, such as for production of beams, angle iron, rods, bars and sheets used in construction of pipelines, buildings, industrial facilities, bridges, medical instruments and automobile components amongst others [1] [2]. However, because of environmental factors or specialty, different grades or types of steels like stainless, carbon and mild steels are produced to fit into properly the area of its application.

Despite efforts taking to mitigate effect of environmental factor on steel exposed to the environment, corrosion attack still persist on steel materials, especially in harsh environment. Thus, environmental factors that influence the rate of corrosion of materials include temperature, radiation, alkalinity, electrode potential, impurities, oxygen content and exposure time [3] [4].

Deterioration of engineering and construction materials in natural environment has serious negative impact on the global economic [3]. Therefore, appropriate control measures must be put in place to prevention or reduce this challenge. Of course, efforts are continuous and many techniques to solving corrosion attack on metals ranging from inhibition of certain corrosion resistant components in metals during manufacturing or, in environment where the metal is to be used have been reported [5] [6] [7]. Similarly, corrosion process of metal can be monitored through regular inspection or, monitoring through prediction using mathematical models [1] [4] [8] [9]. In industry, various methods usually adopted to protect and prevent corrosion include painting, coating cementing and electrochemical process [5] [10].

One area that is of concern due to corrosion is the deterioration of automobile components. The is as a result of many factors such as atmospheric conditions and poor road network as in the case experienced in most Nigerian communities, especially in the Niger Delta region. The Niger Delta environment of Nigeria is very acidic and salty due to presence of seawater, rivers and industries which releases corrosion agents into the atmosphere; therefore, metals exposed to the environment of this region are susceptible to corrosion attack. Automobiles are also not left out because of the dilapidated road networks in the region. The asphalted surface of the roads in the Niger Delta region easily ware off, which creates pot-holes covered with pool of rain water and mud. When there is contact between the metallic components of car and the muddy waters, the metallic parts get corroded over time, subjecting the owner to unnecessary cost in maintaining or replacing the damage parts.

Thus, in a study on corrosion behavior of mild steel in five different media: hydrochloric acid, soil, atmosphere, saltwater and freshwater, it was observed that the rate of mild steel corrosion differed, but was remarkable in saltwater [1]. Also, in another study, exposure of steel in seawater environment increased the corrosion rate of steel [11] [12]. Therefore, the high concentration of corrosive agents in the muddy waters of dilapidated roads in the Niger Delta regions, which have often caused significant attack on metallic components of automobiles, called for stringent measures to check the excessive corrosion effect.

Hence, as it was reported that corrosion inhibitors obtained from plants are less toxic, biodegradable and environmentally friendly [10], this study investigated the effectiveness of resin extracted from African pear (dacryodes edulis) as suitable coating material for corrosion reduction in automobile components in contact with mud environment. Plant extracts have excellent corrosion inhibition ability in structural materials and are eco-friendly [7] [13] [14] [15].

II. MATERIALS AND METHOD

2.1 Sample Collection and Preparation

The metal investigated in this study was mild steel obtained from automobile constantly exposed to muddy road in Port Harcourt, Rivers State of Nigeria. The mild steel was smoothened with the aid of silicon carbide abrasive paper, and then greased and degreased with petroleum ether to prevent further corrosion. It was thereafter washed thoroughly in distilled water and sundried. The dried metal was cut into six equal parts with dimensions 2cm by 3cm. Hole was drilled on the centre of each specimen where thread was tied as support. Mud water sample was collected from pothole in dilapidated road in Port Harcourt. The resin was extracted from African pear (dacryodes edulis).

2.2 Experimental Procedure

Each of the prepared specimens was weighed and then, three of the weighed specimens were coated with about 200µm of resin thickness, while the other three specimens were left uncoated, serving as control samples. This was done to ensure measurement was taken in triplicate, thereby minimizing error. Plastic bucket was filled with about 5 liters of the mud water and the specimens were immersed completely in the mud water sample. Every 7 days, each of the specimens was washed with distilled water, cleaned and dried. After drying, they were weighed, and then buried again in the mud water. This process was repeated until the 56th day (8th week).

2.3 Weight Loss and Corrosion Rate

The weight loss method was used in study. Thus, the weight loss over time was measured by subtracting the instantaneous weight from the initial weight of the specimen.

From the weight loss measurement, the corrosion rate of mild steel in mud water was calculated using the simple corrosion model described in the work of [9]. This is expressed as the weight loss of metal per surface area exposed to the corroding environment per material density per exposure time. It is stated as follow.

$$C_r = \frac{534\ \Delta w}{\rho A t} \qquad (1)$$

where:

$\Delta w =$ Weight loss (g)

$\rho =$ Density of material

$A =$ Cross-sectional area of metal (cm^2)

$t =$ Time (Day)

In equation (1), the corrosion rate, C_r is expressed in meter per year (MPY) and the density of for mild steel is given as 7.86 g/cm^3 [1], while the cross-sectional area of metal exposed to the corroding mud water is 6.0 cm^2.

2.4 Inhibition Efficiency

To determine the effectiveness of the resin in reducing the corrosion rate of mild steel in mud water, equation (2) was used to calculate the efficiency.

$$\mathrm{E} = \frac{w - w_r}{w} \times 100\% \qquad (2)$$

Where: $w =$ Weight loss in uncoated specimen (g) and $w_r =$ Weight loss in coated specimen (g).

III. RESULTS AND DISCUSSION

The ability of African pear resin in reducing the corrosion rate of mild steel used for automobile body has been investigated in mud water settling on potholes of a dilapidated road. The physicochemical analysis carried out on the mud water showed high concentrations salt of various compounds with pH of 5.48 (Table 1). This is an indication that the mud water is salty and as well acidic. It has also high concentration total dissolve solids (TDS) and salinity.

Table 1: Physicochemical Analysis of mud water

Parameter	**Salt**
Temperature (ºC)	27.5
pH	5.48
Conductivity (μs/cm)	631
Cl^{-1} (mg/l)	167.32
NO_3^- (mg/L)	1.61
PO_4^{3-} (mg/l)	0.05
SO_4^{2-} (mg/l)	112.39
Salinity (mg/l)	39.42
Acidity (mg/l)	0.65
Alkalinity (mg/l)	256.26
Iron (mg/l)	27.15
TDS (mg/l)	3174.06
DO (mg/l)	2.67

4.1 Weight Loss and Corrosion Rate

The examination of corrosion rate of mild steel coated with African pear resin was carried out through weight loss measurement. Thus, the average measured instantaneous weight loss and hence, the corrosion rate of the metal for the coated and uncoated as well as the inhibition efficiency is tabulated in Table 2.

Table 2: Weight loss and corrosion rate of mild steel

Time (day)	Weight loss (g)		Corrosion rate (MPY)		Inhibition Efficiency (%)
	Uncoated	Coated	Uncoated	Coated	
7	0.233	0.036	0.377	0.058	84.5494
14	0.586	0.127	0.474	0.103	78.3276
21	0.684	0.144	0.369	0.078	78.9474
28	0.731	0.168	0.296	0.068	77.0178
35	0.793	0.173	0.257	0.056	78.1841
42	0.815	0.184	0.220	0.050	77.4233
49	0.877	0.207	0.203	0.048	76.3968
56	0.914	0.234	0.185	0.047	74.3982

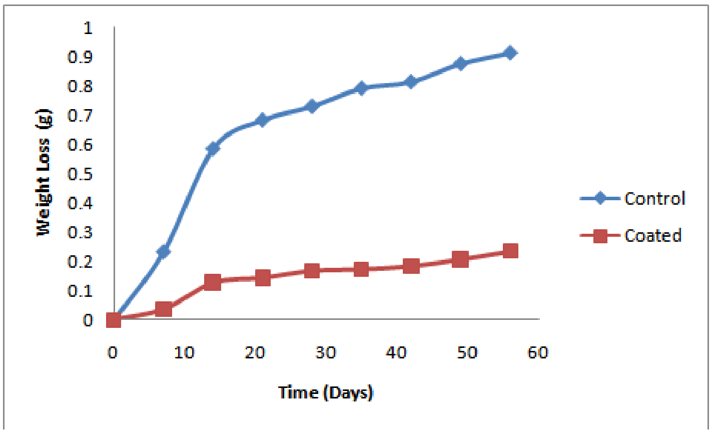

Figure 1: Weight loss of mild steel over the time

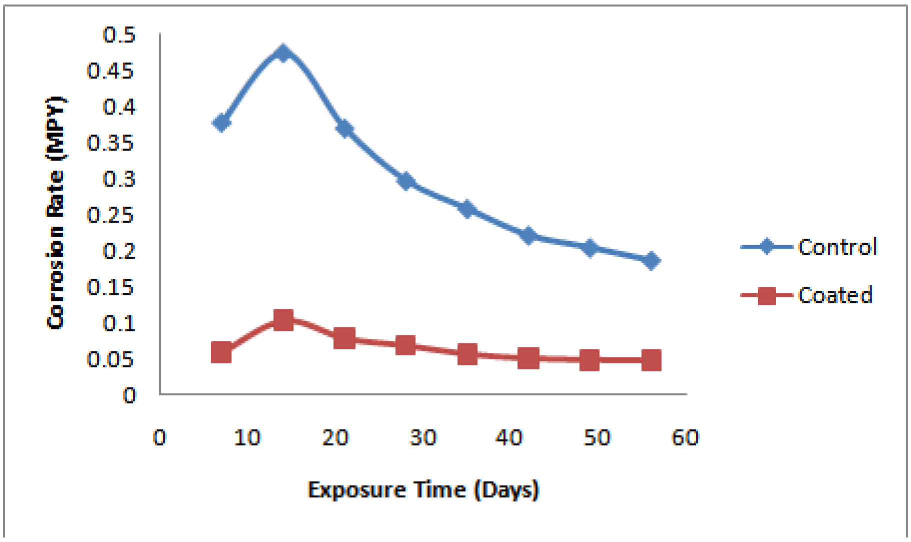

Figure 2: Corrosion rate of coated and uncoated specimen in mud water

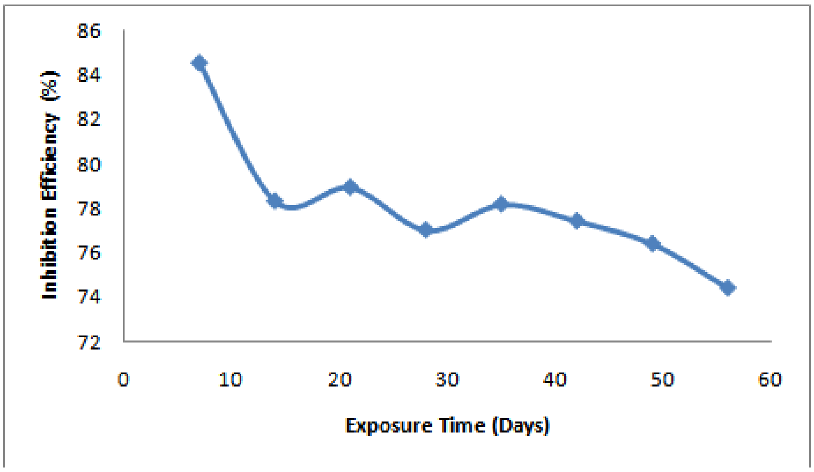

Figure 3: Inhibition Efficiency of African pear resin in mild steel exposed to mud water

The average weight loss in mild steel specimen over the period of investigation for uncoated (control specimen) and the resin coated specimen are shown in Figure 1. Weight loss increases with time of exposure. As expected, the weight loss in the control specimens is by far higher than the coated specimens. This is because the resin acted as a protective film, adsorbing aggressive ions and other corrosion agent that would have attacked the metal's surface easily like the non coated specimens. In a similar study, the high loss of weight in steel was attributed to high presence of SO_4^{2-} and Cl^- ions [8]. This showed that African pear resin posses the ability to reduce the rate of mild steel corrosion exposed to environment containing acid and salt, or other corrosion agents. The observations collaborated with earlier studies that investigated the corrosion of metals in acid or salt solution [9] [16].

Figure 2 shows the profiles of corrosion rate of mild steel in contact with mud water for uncoated and coated specimen. As shown in the Figure 2, corrosion rate decreases with exposure time, and it was higher for the uncoated specimens. Initially, the corrosion rate increased from 0.377 to 0.474MPY and 0.058 to 0.103MPY for both uncoated and coated mild steel as exposure time was increased from 7th to 14th day, but gradually decreased thereafter until the 56th day. The decrease in corrosion rate after the 14th day could be due to formation of corrosion products. In Hajar et al. [17] while using henna extract as inhibitor, reported that decrease in corrosion rate occur when current density is low. However, similar study has equally observed the initial increase in corrosion rate of steel [18]. The high disparity in corrosion rate of uncoated and coated mild steel implied again, that African pear resin is a good corrosion inhibitor, though the coating is weakened with time.

Finally, the inhibition efficiency of African resin is shown in Figure 3. The efficiency of the resin coated mild steel generally decreased as exposure time was increased. This also collaborated with previous study on inhibition efficiency of rubber leaf extract for mild steel expose to acid environment [9]. Thus, the inhibition efficiency of African resin decreased from 84.55% on the 7th day to 74.40% on the 56th day.

IV. CONCLUSION

The performance of African pear resin as corrosion inhibitor for mild steel component of automobile that is exposed to mud water on potholes of dilapidated road has been studied. Thus, the coated steel part of automobile with African pear resin reduced the rate of corrosion in the mud water. Further, the resin coated steel has high inhibition efficiency. Therefore, coating steel parts of automobile vulnerable to salt and acid mud water with resin will help reduce the accelerated rate of corrosion, thereby improving the life cycle of automobile and also, the maintenance cost.

REFERENCES

[1]. Chuka,C.E., Odio, B.O., Chukwuneke, J.L. and Sinebe, J.E. (2014). Investigation of the Effect of Corrosion on Mild Steel in Five Different Environments, International Journal of Scientific & Technology Research, 3(7), 306-310.
[2]. Otunyo, A.W. and Charles, K. (2017). Effect of Corrosion on Flexural Residual Strength and Mid-Span Deflection of Steel (Coated with Resins/Exudates of Trees) Reinforced Concrete Beams under Sodium Chloride Medium, European International Journal of Science and Technology, 6(7), 77-87.
[3]. Muslim, Z.R., Jaafer, H.I. and Fahem, M.Q. (2014). The Effect of pH Level on Corrosion Rate of Aluminium and Copper, International Journal of Basic and Applied Science, 2(4), 89-92.
[4]. Adikari, M. and Munasinghe, N. (2016). Development of a Corrosion Model for Prediction of Atmospheric Corrosion of Mild Steel, American Journal of Construction and Building Materials, 1(1), 1-6.
[5]. Chigondo, M. and Chigondo, F. (2016). Recent Natural Corrosion Inhibitors for Mild Steel: An Overview, Journal of Chemistry. Retrieved from: http://dx.doi.org/10.1155/2016/6208937 [14th June, 2018].
[6]. Hou, X., Gao, L., Cui, Z. and Yin, J. (2018). Corrosion and Protection of Metal in the Seawater Desalination, IOP Conf. Series: Earth and Environmental Science 108. Retrieved from: https://doi.org/10.1088/1755-1315/108/2/022037 [14th November, 2018].
[7]. Verma, C., Ebensoa, E.E., Bahadura, I. and Quraishi, M.A. (2018). An Overview on Plant Extracts as Environmental Sustainable and Green Corrosion Inhibitors for Metals and Alloys in Aggressive Corrosive Media, Journal of Molecular Liquids. Retrieved from: https://doi.org/10.1016/j.molliq.2018.06.110 [17th December, 2018].
[8]. Iyasara, A.C. and Ovri, J.E.O. (2013). Corrosion Inhibition of Stainless Steel (314l) Using Molasses, The International Journal of Engineering and Science, 2(1), 346-352.
[9]. Okewale, A. O. and Olaitan, A. (2017). The Use of Rubber leaf Extract as a Corrosion Inhibitor for Mild Steel in Acidic Solution, International Journal of Materials and Chemistry, 7(1), 5-13.
[10]. Papavinasam, S. (1999). Corrosion Inhibitors, Uhlig's Corrosion Handbook (Second Edition), Canada: John Wiley & Sons, Inc.
[11]. Zakowski, K., Narozny, M., Szocinski, M. and Darowicki, K. (2014). Influence of Water Salinity on Corrosion Risk-The Case of the Southern Baltic Sea Coast, Environ Monit Assess, 186, 4871-4879.
[12]. Sandu, A. V., Ciomaga, A., Nemtoi, G., Abdullah, M. M. A. and Sandu, I. (2015). Corrosion of Mild Steel by Urban River Water, Instrumentation Science and Technology, 43, 545-557.
[13]. Amise, A.F., Lennox, J.A and Agbo, B.E. (2016). Antimicrobial Potential and Phytochemical Analysis of Dacryodes edulis Against Selected Clinical Bacterial Isolates, International Journal of Pharmacognosy and Phytochemical Research, 8(11), 1795-1800.
[14]. Otunyo, A.W. and Charles, K. (2018). Effectiveness of Resins/Exudates of Trees in Corrosion Prevention of Reinforcement in Reinforced Concrete Structures, Nigerian Journal of Technology, 37(1), 78-86.
[15]. Ezeugo, J.O. (2019). Optimization of Polycondensation Process of Alkyd Resin Synthesis from Modified Picralima Nitida Seed Oil Suitable for Surface Coating of Metal, World Scientific News, 116, 62-90.
[16]. Fouda, A.S, Emam, A., Refat, R. and Nageeb, M. (2017). Cascabela Thevetia Plant Extract as Corrosion Inhibitor for Carbon Steel in Polluted Sodium Chloride Solution, Journal of Analytical & Pharmaceutical Research, 6(1), 168-177.
[17]. Hajar, H.M., Zulkifli, F., Suriani, M.J., Mohd-Sabri, M.G. and Wan-Nik, W.B. (2016). Lawsonialnermis Extract Enhances Performance of Corrosion Protection of Coated Mild Steel in Seawater, MATEC Web of Conferences, 78, 1091-1098.
[18]. Feng, C., Zhu, L., Cao, Y. Di,Y. Yu, Z. and Gao, G. (2018). Performance of Coating Based on APTMS/GO/Epoxy Composite for Corrosion Protection of Steel, International Journal of Electrochemical Science, 13, 8827- 8837.

Tornubari" Performance of Mild Steel Coated with African Pear (Dacryodes Edulis) Resin in Mud Water" American Journal of Engineering Research (AJER), vol.8, no.02, 2019, pp.173-177