ORIGINAL RESEARCH PAPER

Biological Science

EVALUATION OF *CLEOME VISCOSA* SEED OIL AS A CORROSION BIOINHIBITOR FOR MILD STEEL IN ACIDIC MEDIA

KEY WORDS: Mild steel, bioinhibitor, *Cleome viscosa* , acidic media, SEM.

M. Rajakohila* Research Scholar (Reg No. 8492), Department of Biotechnology, Sri Paramakalyani College, Alwarkurichi, Affiliated to Manonmaniam Sundaranar University, Tirunelveli , Tamil Nadu, India. *Corresponding Author

P. Nagendra Prasad Department of Biomedical Sciences and Technology, Noorul Islam Centre for Higher Education, Noorul Islam University, Kumaracoil, Thuckalay, Kanyakumari District, Tamilnadu, India- 629 180.

K. Kalirajan PG and Research Department of Chemistry, Sri Paramakalyani College, Alwarkurichi, Tirunelveli Dist, TamilNadu, India. 627412

ABSTRACT

Mild steel is the most important engineering and construction material in the world. Corrosion of metal is a serious concern in industrial scale. The use of bioinhibitors is one of the most practical method to prevent corrosion effect. In the present investigation, *Cleome viscosa* seed neat oil is used as potential biodiesel resources were subjected to corrosion studies by using gravimetric method in mild steel specimen at different concentrations of inhibitor and different time intervals in 1 N HCl medium at room temperature. The inhibition efficiency is higher in HCl medium with addition of Cleome seed oil as bioinhibitor compared with those in the inhibitor free medium. The inhibition efficiency was increased with increase of inhibitor concentration but decreased with increasing exposure time. The surface morphology of corroded material before and after immersion in acid medium is analyzed using Scanning electron microscope. Therefore, the results indicate that the bioenergy crop *Cleome viscose* has potential be a corrosion inhibitor for mild steel in acidic media.

INTRODUCTION

Mild steel, an alloy of iron is widely used in petrochemical, chemical and metallurgical industries. However, this material has low corrosion resistance in acidic medium that leads to economic losses. Fuel tank, tubing system, connecting rod etc., are commonly made from mild steel. Therefore, it is important to investigate the corrosion behaviour of mild steel in petroleum fuels. The use of inhibitors is one of the most practical methods for protection against corrosion [1]. It is already proved that organic compounds having heteroatoms can be used as effective corrosion inhibitors for mild steel in acid medium [2]. Several researches have been made using corrosion preventive practices by the oils derived from various plants as an corrosion inhibitors [3,4]. Vegetable oil esters are receiving increasing attention as a non-toxic, biodegradable , ecofriendly and renewable alternative source diesel fuel. Many studies have shown that the properties of biodiesel are very close to diesel [5,6]. Therefore, biodiesel can be used in diesel engines with little or no modifications. Although there are many works on the preparation and characterization of biodiesel, there is little information on the corrosion behaviour of biodiesel on metallic diesel engine parts [7,8]. In the present study, the vegetable oil *Cleome viscosa Linn* (Dog mustard) seed oil used as a biodiesel resource was selected. The corrosion inhibition efficiency of this oil was analysed using mild steel specimens in acid medium with and without the presence of inhibitor at different concentrations (250,500,750 and 1000 ppm) and different time intervals (24,48, and 72 hours) at room temperature.

MATERIALS AND METHODS

A rectangular mild steel specimen of size 5 x 1.5 x1.5 cm was cut from a parent mild steel sheet. The specimens were pickled with pickling solution, washed with water, rubbed with cotton cloth and dried then mechanically polished, degreased with trichloroethylene and kept in a desiccators for 2 hours. These plates were used for the weight loss studies. The seeds of *Cleome viscosa* is collected from the natural habitat and processed. The oils were extracted by mechanical method. The bioinhibitors were added to the acid medium at different concentration and kept at room temperature for different time duration.

In this investigation, the gravimetric weight loss measurement was carried out for mild steel specimens in the presence and absence of inhibitor. The initial weight of the specimens was noted as W1. 250ml of 1N HCl was taken in a beaker, the specimens were dipped in the solution for 24 hours, 48 hours and 72 hours with and without the presence of green inhibitor at the concentrations of 250,500,750 and 1000ppm and kept at room temperature. At different intervals, the specimens were taken from the solution and dried and the final weight was noted as W2. The difference between the initial weight and final weight gave the actual weight loss of the specimens (W). The experiments were carried out in triplicates. From the weight loss, the corrosion rate was determined using the formula

$$\text{Corrosion rate (mmpy)} = \frac{87.6 \times W}{D\,A\,T}$$

Where,

W is the weight loss in grams ; D is the density in g/cc ; A is the area of exposure in cm^2 T is the exposure time in hours; mmpy is the millimeter per year.

The effectiveness of the inhibitor was assessed in terms of its inhibition efficiency (I.E %) by the following formula

$$\text{I.E (\%)} = \frac{\text{(weight loss) B.S} - \text{(weight loss) I.S} \times 100}{\text{(Weight loss)B.S}}$$

Where,

B.S is the weight loss without inhibitor (blank solution) ; I.S is the weight loss with inhibitor

The surface morphological characteristics of pre and post corroded mild steel samples were analyzed using Scanning electron microscope (Hitachi S-4800)

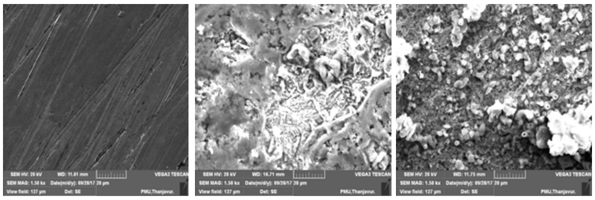
RESULT AND DISCUSSION

Table 1. Variation of corrosion rate (mmpy) at different concentration of Cleome viscosa seed oil bioinhibitor at different time duration

Concentration of inhibitor (ppm)	Time duration in hours		
	24 HRS	48 HRS	72 HRS
Control	0.0137	0.0157	0.0179
250ppm	0.0012	0.0010	0.0008
500 pmm	0.0011	0.0007	0.0005
750ppm	0.0009	0.0006	0.0005
1000ppm	0.0005	0.0005	0.0004

Table 2. Variation of corrosion inhibition efficiency (%) at different concentration of Cleome viscosa seed oil bioinhibitor at different time duration

Concentration of inhibitor (ppm)	Time duration in hours		
	24 HRS	**48 HRS**	**72 HRS**
250ppm	91.240	93.630	95.530
500 pmm	91.970	95.541	97.206
750ppm	93.430	96.178	97.304
1000ppm	96.350	96.815	97.765



1a)Polished mild steel

1b) Uninhibited mild steel in 1NHCl

1C) inhibited mildsteel with *cleome viscosa* seed oil

Figure 1a-1c. Scanning electron micrograph of polished mild steel (1a) and Mild steel after 96 hours immersion in 1 N HCL without (1b) and with (1c) *Cleome viscosa* oil bioinhibitor

In the present study, the vegetable oil of *Cleome viscosa* bioenergy crop was used as potential biodiesel resources were investigated for corrosion inhibitors by gravimetric method. The calculated value of corrosion rate at different concentration of inhibitors and different time duration was given in Table 1. It clearly revealed that, the corrosion rate of mild steel in 1N HCl acid was lesser in the presence of biodiesel neat oil compared to the control. The minimum corrosion rate was observed at the concentration of 1000 ppm (0.0004 mmpy). It indicates the corrosion rate increased with increase of exposure duration meanwhile the dissolution rate was decreased with increase of bioinhibitor concentration. This behaviour is ascribed to the fact that the extent of adsorption and the coverage of inhibitor on mild steel surface increased with inhibitor concentration.

The percentage of inhibition efficiency against various concentration of of *Cleome viscosa* seed neat oil for mild steel was calculated and given in Table 2. It shows that, inhibition efficiency increased with increasing the inhibitor concentration. The increased inhibitive action with increase in concentration can be attributed to blocking of active site of metal surface by the inhibitors. Cleome bio-inhibitor shows increase in inhibition efficiency with increase of exposure time from 24 to 72 hours (91.2 % to 97.7%) at 250 to 1000 ppm. It clearly indicate that, the increase in inhibition efficiency at different duration reflects the strong adsorption of adequate amount of phytoconstituent present in inhibitor on the mild steel surface resulting in the formation of protective layer at the surface of metal which suppressed the further corrosion attack. The observed results was higher than that earlier report of Lin seed oil [9]. Many researchers explained that the heteroatoms present in the bioconstituents of inhibitor initiate the displacement of adsorbed water molecules and effectively adsorped on the active site of metal surface thus forms a barrier layer and reduce the corrosion attack [10,11].

The scanning electronic micrographs of polished mild steel in the absence and presence of neat oil in 250 ml of 1.0 N hydrochloric acid were depicted in Figure 1a-c. The surface morphology view of polished mild steel before immersion (Fig 1a) represent a surface free from corrosion products with few scratches line due to metal polishing process, however after immersion in aggressive media without inhibitor (Fig 1b) shows high degree of corrosion attack with precipitated corrosion compound on surface that illustrate severe damage of metal by corrosive media. SEM image of metal immersed in 250 ml of 1.0 N Hydrochloric acid containing 0.5 ml of cleome oil as bioinhibitor (Fig 1c) revealed a protective film formation by inhibitor molecules around the surface of mild steel blocks the active site and provide protection thus indicating the inhibiting property of Cleome seed oil.

CONCLUSION

The results of the weight loss measurement and scanning electron microscope analysis showed that *Cleome viscoae* seed oil is a potential bioinhibitor against corrosion of mild steel in acid medium. The inhibition efficiency was increased when higher concentration of Cleome seed oil was added to the acidic medium. SEM micrographs showed in the presence of inhibitor dissolution of corrosion rate was reduced. Hence using these neat oils as biodiesel resources is also safe to the engine from the point of corrosion and as well as safe to the environment due to biodegradable and non-toxic nature to the environment.

REFERENCES:

1) Raja PB, Ismail M, Ghoreishiamiri S, Mirza J, Ismail MC, Kakooei S, Rahim AA. Reviews on corrosion inhibitors: A short review. Chemical engineering communications. 203,2016,1145-1156.
2) Obot IB, Obi-Egbedi NO. Adsorption behaviour and corrosion inhibitive potential of xanthenes on mildsteel /Sulphuric acid interface. Aarabian journal of Chemistry. Doi:10.1016/j.arabic, 2010.
3) Bouyanzer B, Hammouti B. A study of anticorrosive effects of Artemisia oil on steel. Pigment and resin technology. 33,2004,287-92.
4) Halambek J, Berkovic K, Vorkapic-Furac J. The influence of Lavandula angustifolia L. oil on corrosion of Al-3Mg alloy. Corrosion Science. 52,2010,3978-83.
5) Chang DYZ, Van Gerpen JH, Lee I, Johnson LA, Hammond EG, and Marley SJ. 1996. Fuel properties and emissions of soybean oil esters as diesel fuel. JAOCS, 73(11), 1996,1549-1555.
6) Freedman B, Pryde EH. Fatty esters from vegetable oils for use as a diesel fuel. In Vegetable Oils Fuels -- Proceedings of the Int. Conf. on Plant and Vegetable Oils as Fuels. 1982,117-122.
7) Haseeb ASMA, Masjuki HH, Ann LJ, Fazal MA. Corrosion characteristics of copper and leaded bronze in palm biodiesel. Fuel Process Technol 2010;91:329-34.
8) Kaul S, Saxena RC, Kumar A. Corrosion behavior of biodiesel from seed oils of Indian origin on diesel engine parts. Fuel Process Technol. 88,2007,303-7.
9) Yang ZN, Liu YW, Chen Y. Linseed oil based amide as Corrosion inhibitor for mild steel in hydrochloric acid. International Journal Of Electrochemical Science. 13,2018,514-529.
10) Edouk UM, Umoren SA, Udoh AP. Synergistic inhibition effects between leaves and stem extracts of sida acuta and iodine ion for mild steel corrosion in 1M H2SO4 solution. Arabian journal of chemistry ,idoi; 10.1016/j.arabic.2010.09.006.
11) Elazzouzia M, Aountia A, Tighadouina S, Elmsellema H, Radia S, Hammoutia B, El Assyryb A, Bentiss F, Zarrouk A. Some hydrazine derivatives as corrosion inhibitors for mild steel in 1.0 m HCl: Weightloss, Electrochemical, SEM and theoretical studies. Journal of Molecular Liquids. 221,2016,633-641.