International Journal of Engineering Technology Science and Research
IJETSR
www.ijetsr.com
ISSN 2394 – 3386
Volume 5, Issue 5
May 2018

Corrosion Inhibition Studies on Mild Steel Using Some Potential Biodiesel Resources

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ABSTRACT

Corrosion of metal is a major problem in industry where metal is used as a basic material. Inhibitors are used to protect the metals from corrosion. Recently, eco friendly green inhibitors are widely recommended because they are derived from natural products, cheap, nontoxic, biodegradable and readily available. In the present investigation, five different vegetable neat oils which are used as potential biodiesel resources were subjected to corrosion studies by using gravimetric method in mild steel specimen at different concentrations (250ppm, 500ppm,750ppm and 1000ppm) of inhibitors and different time intervals (24 hours, 48 hours, 72 hours, 96 hours and 120 hours) in 1 N HCl medium at room temperature. The inhibition efficiency is higher in HCl medium with addition of green inhibitor 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 green inhibitor Cloeme viscosa and Pongamia pinnata had higher inhibition efficiency compared to other three bio-inhibitors.

Key words: corrosion, green inhibitor, mild steel, weight loss, biodiesel.

INTRODUCTION

Corrosion of metal is a major economic and environmental problem in industry that has attracted a lot of researchers in recent years. Corrosion is a natural phenomenon involving a reversion from a metallic state to a complex compound state[1]. Metals and alloys are used in automobile industries, railways, ships, petroleum industries, refineries, oil pipelines, chemical industries etc[2,3,4]. When these materials are exposed to the environment, great economic and environmental losses occur. Mild steel, an alloy of iron is widely used in petrochemical, chemical and metallurgical industries. It is also used as a construction material owing to its excellent mechanical properties and cost effectiveness. However, it easily undergoes corrosion in various environmental conditions especially in acid medium. It is already proved that organic compounds having heteroatoms can be used as effective corrosion inhibitors for mild steel in acid medium [5]. Fuel tank, tubing system, connecting rod etc. are commonly made from mild steel[6]. So, it is important to investigate the corrosion behaviour of mild steel in petroleum fuels.

The use of inhibitors is one of the best options for protecting mild steel against corrosion. Several efforts have been made using corrosion preventive practices and use of green corrosion inhibitors[7]. The plant extract are rich sources of molecules which have appreciably high inhibition efficiency and hence termed as “green inhibitors”[8]. These inhibitors are biodegradable and do not contain heavy metals or other toxic compounds[9].The first patent in corrosion inhibition was to Baldwin, British Patent 2327, for using the natural product from molasses and vegetable oils for pickling sheet steel in acids medium[10].

In India, the major pollution is caused by the emission of toxic gases from automobile sector and are one of the causes of poor quality of air. According to WHO, air pollution in India is estimated to kill 1.5 millions of

people every year. The air pollution mainly caused by vehicular traffic and other causes include wood burning fires, fires on agricultural land, exhaust from diesel generators, burning garbage and industrial activity[11,12,]. To soive this, the reduction in atmospheric pollution can be achieved through usage of biofuel.

Vegetable oil esters are receiving increasing attention as a non-toxic, biodegradable, and renewable alternative diesel fuel. Many studies have shown that the properties of biodiesel are very close to diesel [13,14,]. 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 [15,16,17,18,19].

In the present study, the different vegetable oils used as a biodiesel resources are Argemone oil (*Argemone mexicana Linn.*), Dog mustard seed oil (*Cleome viscose Linn.*), Karanja oil (*Pongamia pinnata Linn*.), Rubber seed oil (*Hevea brasiliensis Muell. Arg.*,) and Soapnut oil (*Sapindus trifoliatus)* were selected and analysed for their corrosion inhibition efficiency by using mild steel specimens in acid medium with and without the presence of inhibitors at different concentrations (250,500,750 and 1000 ppm) and different time intervals (24,48,72,96 and 120 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. After pickling, the plates were mechanically polished, degreased with trichloroethylene and kept in a desiccators for 2 hours[20]. These plates were used for the weight loss studies.

The oils used for this study include Argemone oil, Dog mustard seed oil, Karanja oil, Rubber seed oil and Soapnut oil. The seeds are collected from the natural habitat and processed. The oils were extracted by mechanical method. The green inhibitors were added to the acid medium at different concentration and kept at room temperature for different time duration.

In the present study, the weight loss measurement was carried out for mild steel specimens in the presence and absence of inhibitors. 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, 72 hours, 96 hours and 120 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

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

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

Where,

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

I.S is the weight loss with inhibitor

Result and Discussion

In the present study, the vegetable oils of five different bioenergy crops used as potential biodiesel resources were investigated for corrosion inhibitors by gravimetric method. This method is probably the most widely used method of inhibition assessment[21]. All these five green inhibitors inhibit mild steel corrosion at all concentration and at different exposure time.

The calculated value of corrosion rate at different concentration of inhibitors and different time duration was given in figure 1. It clearly revealed that, the corrosion rate of mild steel in 1N HCl acid was lower in the presence of biodiesel neat oil compared to the control. The minimum corrosion rate was observed in Cleome seed oil (0.0005g at 1000 ppm).The corrosion rate was decreased with increase of green inhibitor concentration and with increase of exposure duration. 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[5].

The inhibition efficiency of different biodiesel resources was calculated and presented in figure 2. The result indicates that, inhibition efficiency for all these resources 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. All bio-inhibitors show increase in inhibition efficiency with increase of exposure time (24 -72 hours) whereas decrease in inhibition efficiency was observed after 72 hours. It clearly indicate that, the increase in inhibition efficiency upto 72 hours reflects the strong adsorption of bio constituent present in inhibitor on the mild steel surface resulting in a more protective layer formed at mild steel-HCl interface. The decrease in inhibition efficiency after 72 hours, it may be due to dissolution of adsorbed compound.

Corrosion inhibition is initiated by the displacement of adsorbed water molecules by the inhibitor leading to specific adsorption on the metal surface. Some of these components may have heteroatoms in their molecules[22,23]. Thus, the corrosion of mild steel may be attributed to the adsorption of some components in the oils through these atoms that are regarded as centers of adsorption onto the metal surface thereby creating a barrier for mass and charge transfer and thus isolating the metal from further attack of the corrosive anions.

Conclusion

Nowadays a major problem of our country is atmospheric pollution that is caused by fossil fuels. In order to find a solution for this issue, recent researchers focussed on the green inhibitors. In the present investigation, among the selected biodiesel resources *Clome viscosa* and *Pongamia pinnata* were found to have higher corrosion inhibition efficiency than Rubber, Argemone and Soapnut. Hence using these neat oils as biodiesel resources is 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.

Acknowledgement

The authors are thankful to the Department of Science and Technology Govt. of India

(DST/TSG/AF/2012/01 dated on December 2012) for the financial support and encouragement. The authors are indebted to Chancellor, Vice Chancellor and the Management, Noorul Islam University Kumaracoil for their support in providing necessary facility.

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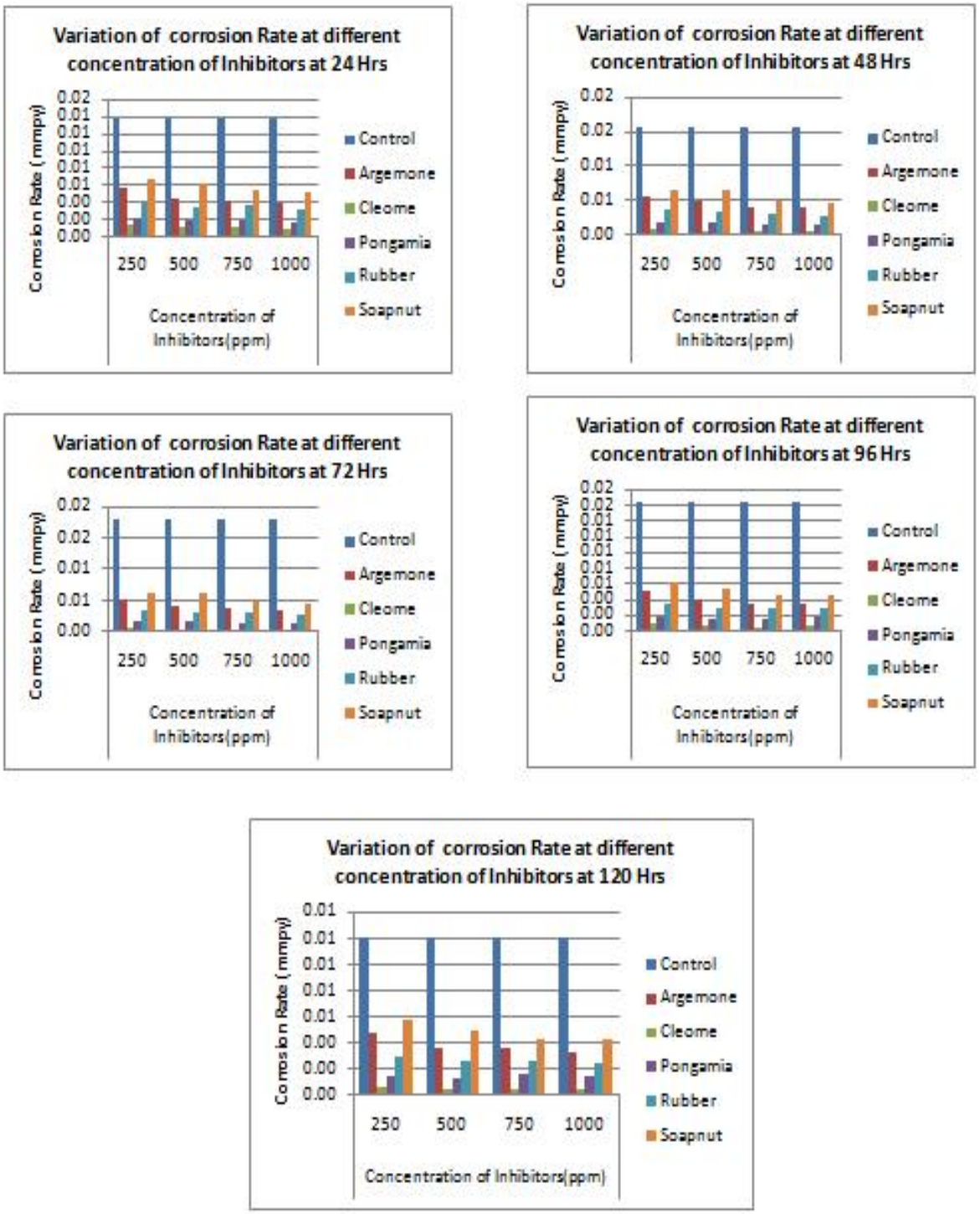

Figure 1 : Variation of corrosion rate at different concentration of Inhibitors at different time duration

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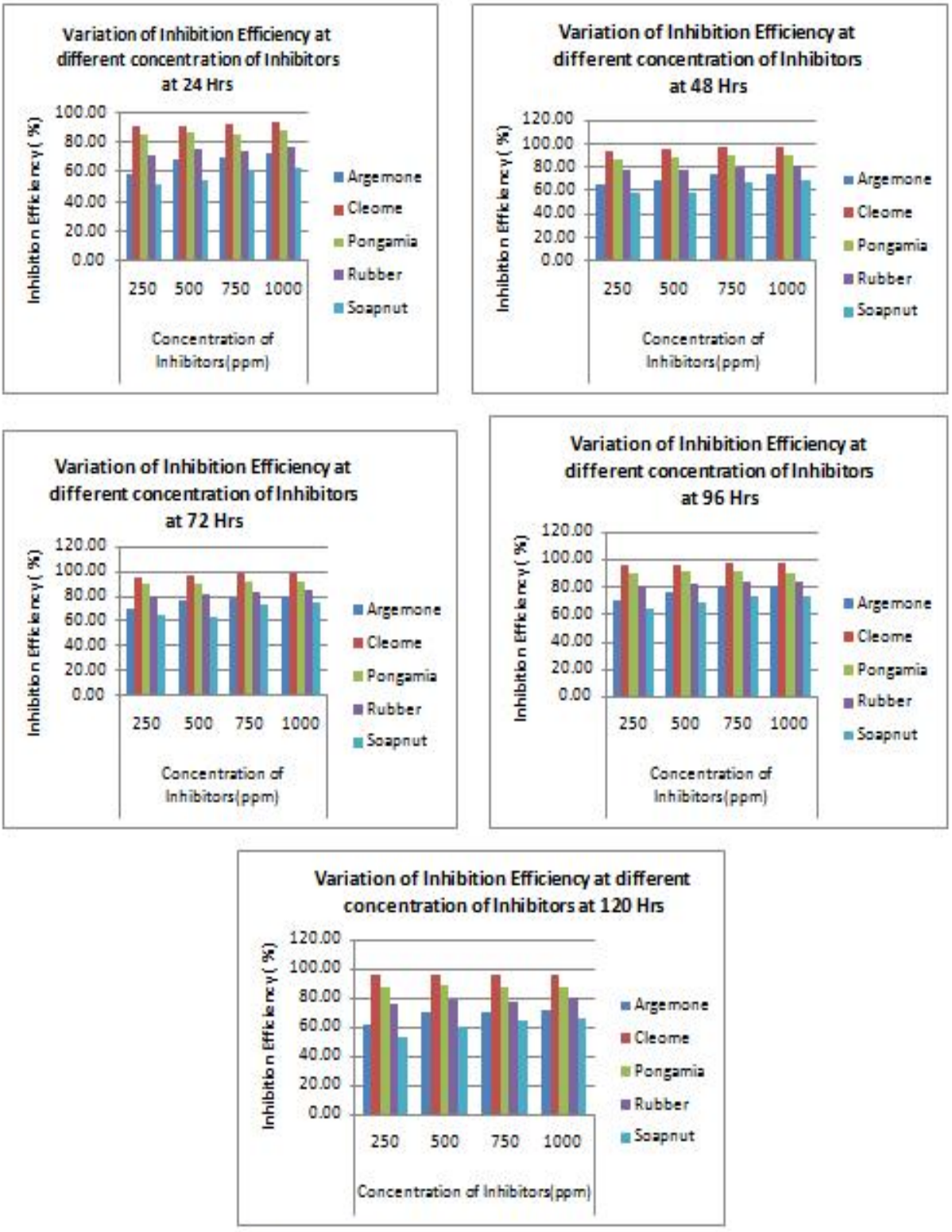

Figure 2 : Variation of Inhibition Efficiency at different concentration of Inhibitors at different time duration

References:

1. Shrein LL. Corrosion. Newness, Butterworths, London ,1978.
2. Yingwei Song, Dayong Shan, Rongshi Chen, Fan Zhang and En-Hou Han. Formation mechanism of phosphate conversion film on Mg–8.8Li alloy. Corros. Sci, 51,2009, 62–69.
3. Metikos-Hukovic M and Babic R. Some aspects in designing passive alloys with an enhanced corrosion resistance. Corros. Sci.,51, 2009, 70–75.
4. Omar Hatamleh, Preet M Singh and Hamid Garmestani. Corrosion susceptibility of peened friction stir welded 7075 aluminum alloy joints. Corros. Sci , 51, 2009, 135–143.
5. 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.
6. Quraishi MA and Danish Jamal. Corrosion inhibition by fatty acid oxadiazoles for oil well steel (N-80) and mild steel, *Materials Chemistry and Physics*. 71, 2001, 202–205.
7. Anuradha K, Vimala R, Narayanansamy B, Arockia Selvi J, Rajendran S. Inhibition of carbon steel in low chloride media by an aqueous extract of *Hibiscus rosa-sinensis linn.* Chem.Eng.Commun.195, 2008,352-366.
8. Bothi Raja.P, Sethuraman MG. Natural products as corrosion Inhibitors for metals in corrosive media- A review. Materials Letters.62, 2008,113-116.
9. Sharma S.K., Ackmez Mudhoo, Gargi Jain, Jyothi Sharma. 2009. Inhibitory effects of Ocimum tenuiflorum (Tulasi) on the corrosion of Zinc in Sulphuric acid: A green Approach. RASAYAN Journal of chemistry. 2, 2009, 332-339.
10. Putilova IN, Balezin SA and Barannik VP. Metallic Corrosion Inhibitors (Translated from the Russian by Ryback). Pergamon Press, New York (As cited by Gupta, D.V. and Green, S., 2004, Inhibitors – Where are we. Proceedings of Corrosion 2004, paper number 04406. NACE International, Houston, 2004).1960.
11. Bengali, Shashank. To fight the world's worst air polution, New Delhi forces cars off the roads. La Times. Jan 4 2016. retrieved dec 7, 2017.
12. HT Correspondent. A history of Delhi's air pollution: can road rationing even the odds?. Hindustan Times. Jan 4 2016. retrieved dec 7, 2017.
13. 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.
14. 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.
15. 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.
16. Haseeb ASMA, Fazal MA, Jahirul MI, Masjuki HH. Compatibility of auto-motive materials in biodiesel: a review. Fuel .90,2011,922-31.
17. 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.
18. Fazal MA, Haseeb ASMA, Masjuki HH. Effect of temperature on the corrosion behavior of mild steel upon exposure to palm biodiesel. Energy. 36,2011,3328-34.
19. Díaz-Ballote L, L_opez-Sansores JF, Maldonado-L_opez L. Corrosion behavior of aluminum exposed to a biodiesel. Electrochem Commun. 11,2009,41-44.
20. Talati JD and Modi RM. Inhibition of corrosion of aluminum-copper alloy in NaOH. Trans. SAEST. 11,1986, 255-260.
21. Musa AY, Khadom AA, Kadhum A, Mohamad H, Takriff MS. J.Taiwan Ins.Chem.Eng.41, 2010,126.
22. Solmaz R, Mert ME, Kardas G, Yazici B, Erbil M. 2008. Adsorption and corrosion inhibition effect of 1,10 – thiocarbonyldiimidazole on mildsteel in H_2SO_4 solution and synergistic effect of iodine ion. Acta Physco-chim. Sin. 24,2008,1185-1191.
23. 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 H_2SO_4 solution. Arabian journal of chemistry ,idoi; 10.1016/j.arabic.2010.09.006.