*J. Appl. Environ. Biol. Sci.*, 7(3S)28-34, 2017



**ISSN: 2090-4274**
**Journal of Applied Environmental and Biological Sciences**
***www.textroad.com***

# Evaluation of Jatropha Curcas Oil as Corrosion Inhibitor of $CO_2$ Corrosion in Petroleum Production Environment

**Mysara Eissa Mohadyaldinn, Nurfarahin Azad Abul Kalam Azad**

Petroleum Engineering Department, Universiti Teknologi PETRONAS, Bandar Seri Iskandar, 31750 Tronoh, Perak, Malaysia

*Received: February 21, 2017*
*Accepted: May 14, 2017*

## ABSTRACT

Materials corrosion is widely encountered throughout all stages of oil and gas industry, starting from drilling up to refinery. In each of these stages, a corrosive environment is formed due to interaction between the piping components with the produced fluids in presence of corrosive agents such as carbon dioxide and hydrogen sulphide which are found as impurities in the produced fluids. In such a corrosive environment, well-known measures are normally adopted to avoid corrosion or to control it within safe limits. One of these measures is by adding corrosion inhibitor, a material that can decelerate corrosion rate when added to a corrosive environment with low concentration. Corrosion inhibitors used in oil and gas industry are normally chemical materials with high degree of hazardous to environment and relatively high cost. Therefore, in the recent years researchers are continuously trying to synthesize green corrosion inhibitors from plants to replace the conventional inorganic corrosion inhibitors. In this paper, crude oil erected from Jatropha Curcas plant is evaluated as a green corrosion inhibitor. Two methods namely rotating cylinder electrode (RCE) method and weight loss method have been used to evaluate the efficiency of this green inhibitor. All experiments have been conducted at room temperature using brine water with salinity 3% NaCl with carbon dioxide exposure. The results obtained showed acceptable inhibition efficiency of the Jatropha Curcas oil. The inhibition efficiency of Jatropha crude increases with the increase of its concentration but the trend of increase is not consistent. Combining the results obtained from the electrochemical measurement with those obtained from the weight loss method, it can be concluded that Jatropha crude performs best at concentration values between 100 and 150 ppm. At 150 ppm, it can provide inhibition efficiency as high as 80%.

**KEYWORDS:** Jatropha Curcas, Carbon Dioxide, RCE, Weight Loss, Green Inhibitor.

## INTRODUCTION

Piping and facilities used to transport, separate, and treat fluids produced from oil and gas fields always undergo chemical or electrochemical corrosion due to presence of undesired corrosive agents in the produced fluids. The corrosive agents are either organics or inorganic components present in the produced fluids or chemical compounds introduced to the formation fluids during drilling, workover or enhanced oil recovery operations. In instance, carbon dioxide ($CO_2$) upwardly flows with produced fluids or downwardly flows with injected fluids. Presence of $CO_2$ during both upward and downward flow will by no doubt cause internal corrosion of tubing and piping systems with turns in loss of produced fluids, pollution of the environment and impose additional cost due to replacement of the corroded component. To eliminate or minimize these consequences, different alternatives are adopted to control the magnitude of corrosion, the so-called corrosion rate. Examples of these alternatives are applying catodic protection, using corrosion resistance alloys (CRA), applying internal coating and/or external lining for the piping and injecting corrosion inhibitors. Corrosion inhibitors are materials that deactivate the corrosive agents by some recognized mechanisms. These mechanism as summarized by [9, 4] are increasing the cathodic and anodic polarization behaviour, decreasing the mobility of ions to the surface of the metal, raising the electrical resistance of the metallic surface and creating a barrier film on the surface of the metal. Using of corrosion inhibitors proofed high efficiency for acid solution corrosion protection. The chemical-origin nature of these inhibitors makes them source of some health and environmental related problems such as toxicity. Huge efforts are therefore devoted to invent environmental-friendly organic (green) corrosion inhibitors. It was declared by many researchers that the green corrosion inhibitors are inexpensive, readily available and renewable sources of materials, environmentally friendly and ecologically acceptable [1, 11].

**Corresponding Author:** Mysara Eissa Mohadyaldinn, Petroleum Engineering Department, Universiti Teknologi PETRONAS, Bandar Seri Iskandar, 31750 Tronoh, Perak, Malaysia, E-mail: mysara.eissa@petronas.com.my

The attempt of synthesis of green corrosion inhibitor can be dated back to 1960's when tannins and their derivatives were used to inhibit steel [3]. From then on, many plants extracts have been tested for inhabitation different materials at different environments.

An example of plants that used as a source of corrosion inhibitors extract is JatrophaCurcas. Jatrophacurcas is a valuable multipurpose plant that belongs to the family of Euphorbiaceae [8]. It has been reported that Jatrophacurcas extracts from seed husk is good corrosion inhibitor for mild steel in hydrochloric acid solution [6],whereas alcoholic extracted from its leaf can inhibit brass in hydrochloric acid and natural sea water [12]. The Jatrophacurcas leaves extract has shown efficient inhabitation on mild steel concentrated tetraoxosulphate (vi) acid solution [8]. Different parts of Jatropha plant has been used before for extracting corrosion inhibitors. In [5] has tested Jatropha leaves extract for corrosion inhibitors and reported corrosion inhibition efficiency of 93.69%. Other attempts to use leaves as the extract source have been done by [2, 10, 12]. An example of using Jatropha seed as source of corrosion inhibitor extract is the work done by [7]. They presented a detailed method of the extract preparation, characterization, and application as a corrosion inhibitor.

In this research, crude Jatropha oil has been experimentally tested to evaluate its efficiency as corrosion inhibitor. The test experiments has been conducted using two methods. The first method is the electrochemical corrosion measurement method using ACM potentiostat and the second method is the weight loss method. During each of the two methods, the test conditions will has been simulated using rotating cylinder electrode (RCE) device. The corrosion will be measured using weight loss method and electrochemical method.

## METHODOLOGY

A commercial Jatroph crude oil purchased from BATC Development BHD has been evaluated as corrosion inhibitor using electrochemical method and weight loss method. The target material used for the test is a piece of carbon steel A106. The corrosive electrolyte used for the experiments is 3% NaClbrine with $CO_2$ gas as a corrosive agent. The test duration for each run is 24 hours. Using the weight loss method, the target material was firstly exposed to corrosion under zero dose corrosion inhibitor. The desired parameters are controlled using the rotating cylinder electrode (RCE) apparatus (Figure 1), where the target material acts as a working electrode.

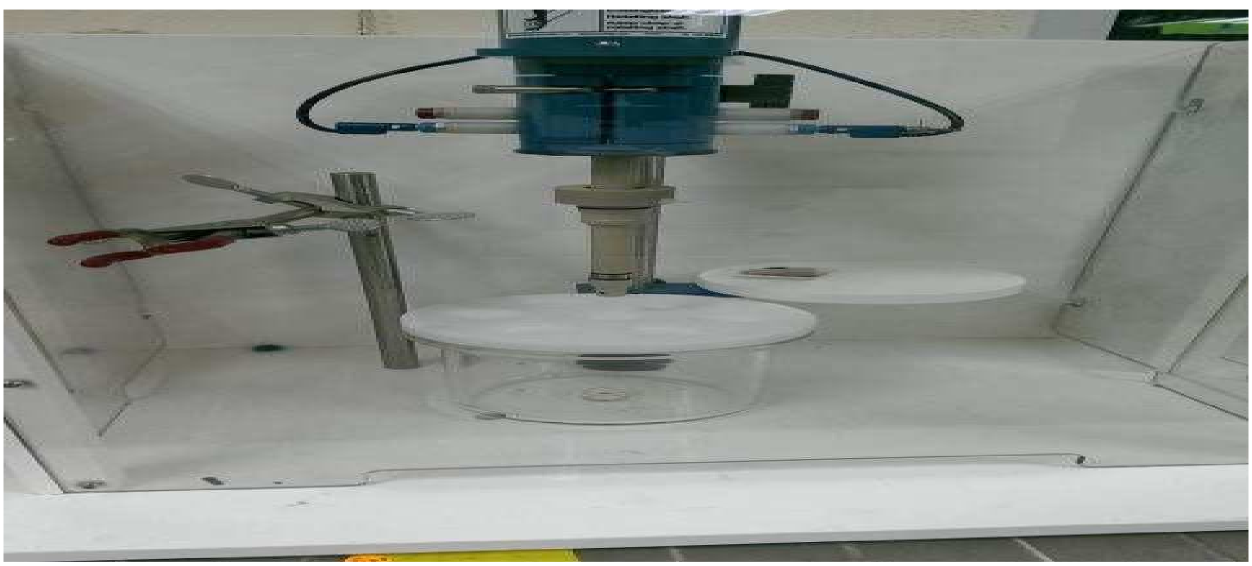

**Figure 1: Rotating cylinder electrode (RCE)**

The rotation of the working electrode is set to the desire round-per-minute (RPM), which is then converted to axial velocity of a pipe using available correlations. Weight has been measured twice before and after corrosion exposure and weight loss is calculated as the difference in the two measured values. Corrosion rate is then calculated using the following formula:

$$CR\left(\frac{mm}{y}\right) = C\frac{\Delta w}{t\rho A} \quad (1)$$

where$\Delta w$ = weight difference (kg), t = time (days), $\rho$ = specimen density (kg/$m^3$), a = surface area of the specimen ($m^2$) and c = conversion factor.

In the electrochemical measurement method, a measurement cell containing 3 electrodes is connected to a potentiostat, a device used to vary the potential and measure the corresponding current and resistance. The corrosion rate is then calculated from the corrosion current using reliable correlations. During the electrochemical measurement method, the dynamic condition is introduced as a rotation of the working electrode by the same way used for the weight loss method. Figure 2 shows the ACM potentiostat used for this work.

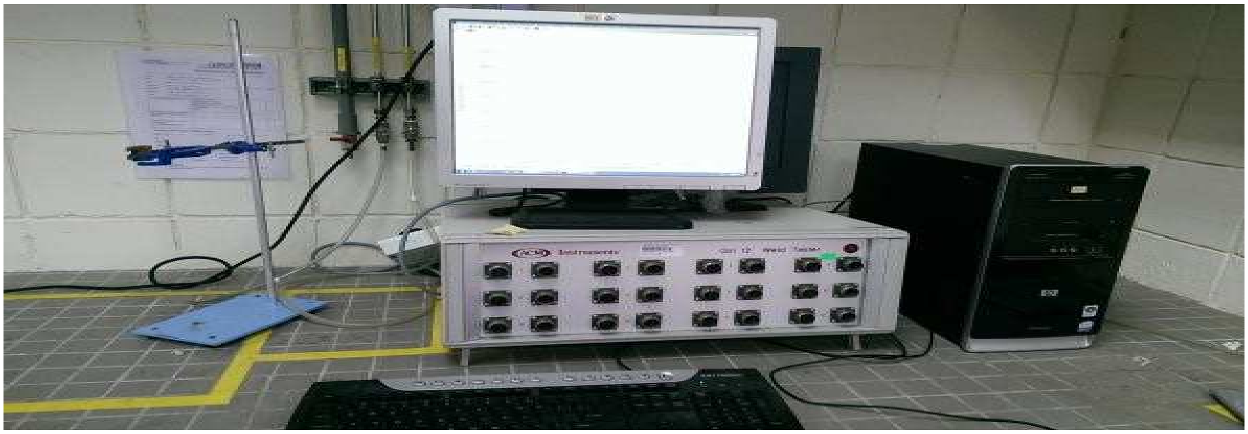

**Figure 2: ACM potentiostat**

Following evaluation of Jatropha oil as corrosion inhibitor as described above, Jatropha oil was further compared to the commercial corrosion inhibitor imadazoline at 50, 100 and 150 ppm concentrations.

## RESULTS AND DISCUSSION

### Comparison of Jatropha Oil with Imadazoline Corrosion Inhibitor at Static Condition

Figure 3 and Figure 4 show the corrosion rate of the target material (carbon steel A 106) at zero RPM (static condition). Figure 3 indicates that Imadazoline will impose significant corrosion inhibition on the environment. After injecting the Imadazoline, the corrosion rate falls down to values less than 0.5 mm/year compared to 1 mm/year for a blank environment. The highest corrosion inhibition has been attained at Imadazoline concentration of 100 ppm which reduce the corrosion rate to values lower than 0.2 mm/year.

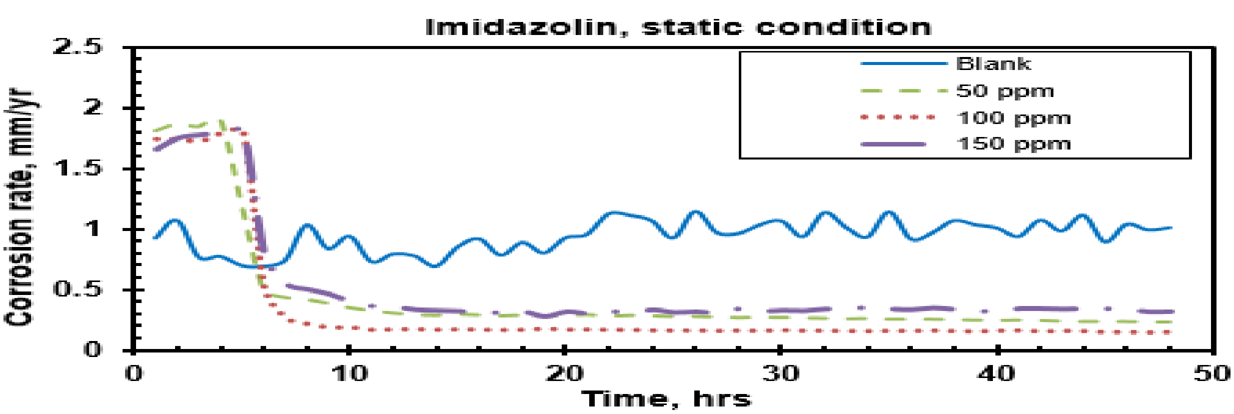


**Figure 3: Static condition of blank, 50ppm, 100ppm and 150ppm imidazoline concentration for LPR test**

Figure 4 shows the corrosion rate for the same environment with using Jatropha crude instead of Imadazoline. It is clear that Jatropha crude oil significantly reduces the corrosion rate to values less than those attained by using Imadazoline. It has been able to reduce the corrosion rate from initial value of 1 mm/year at the instance of exposure to less than 0.1 mm/years after less than 10 hours exposure. The highest corrosion inhibition has been attained at 100 ppm and 150 ppm.

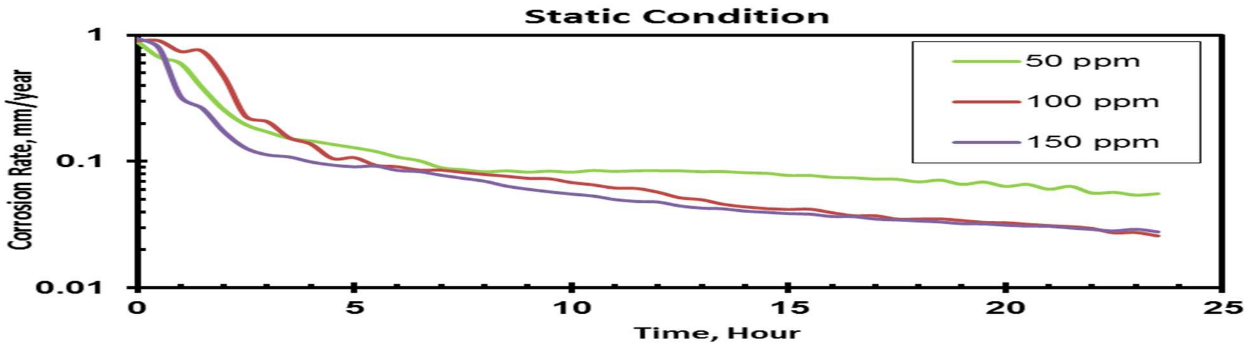


**Figure 4: Static condition of 50ppm, 100ppm and 150ppm Jatropha oil concentration for LPR test**

**Comparison of Jatropha Oil with Imadazoline Corrosion Inhibitor at Dynamic Conditions**

Figure 5 and Figure 6 show the results of evaluating the inhibition of Imadazoline and Jatropha respectively at 500 rpm condition. Figure 5 shows the corrosion rate at 0, 50, 100 and 150 ppm Imadazoline corrosion inhibitor. For all concentrations, corrosion rate starts very high and then starts to decline with the time of exposure. The reduction of corrosion rate with time is a result of the passivation of the material due to accumulation of the iron carbonate corrosion product. The interested finding from this curve is that 50 ppm concentration results in the highest inhibition efficiency, whereas 100 ppm and 150 ppm result in corrosion rate higher than that generated from blank environment. At 100 ppm, there is re-increase of corrosion rate stating after 15 hours from the time of exposure.

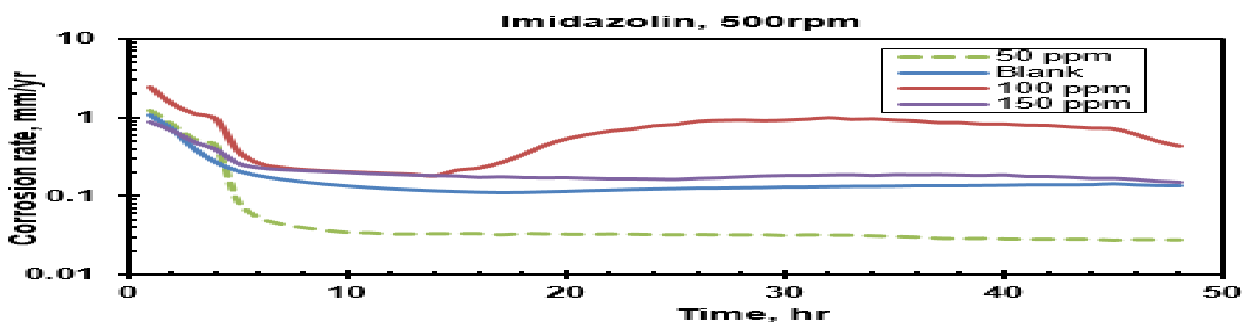


**Figure 5: Result of blank test and 50, 100, 150-ppm imadazoline**

Figure 6 shows the variation of corrosion rate with time under the same flow condition with using Jatropha crude oil at concentrations of 50, 100, and 150 ppm. Concentrations of 50 and 100 ppm initially impose higher inhibition efficiency as compared to Imidazoline. The corrosion rate however continue increasing with time for the 50 ppm till it exceeds 1 mm/year. The 100 ppm Jatropha decreases the corrosion rate to values lower than 0.5 mm/year and it almost maintains this value throughout the exposure time. From Figure 3 and Figure 4, it can be concluded that Jatropha crude oil at 100 ppm can exhibit higher corrosion inhibition efficiency as compared to the commercial Imadazoline corrosion inhibitor.

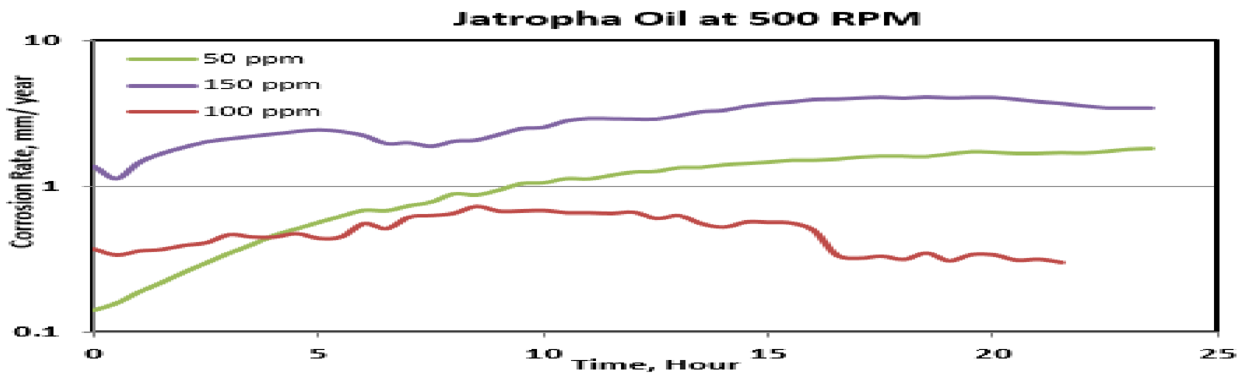


**Figure 6: Result of blank test and 50, 100, 150-ppm Jatropha oil**

Figure 7 shows the variation of corrosion rate with time at Imadazoline concentration values of 0, 50, 100 and 150 ppm at 1500 rpm condition. If compared with the previous test at 500 RPM, this result shows similar trend and magnitudes. Imidazoline works the best at concentration 50 ppm. From his experiment, imidazoline work best in lower concentration between (5-25ppm) at lower temperature.

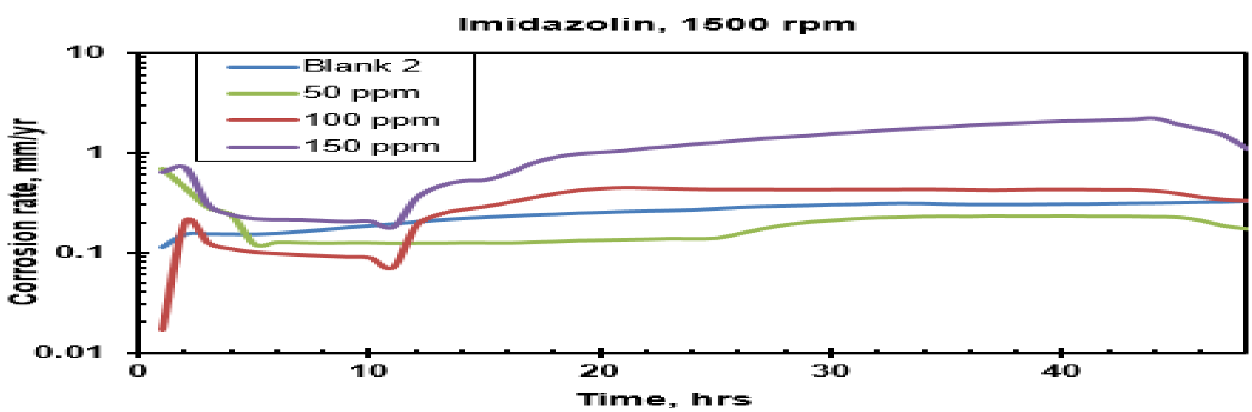


**Figure 7: LPR blank, 50, 100, 150-ppm imidazoline 1500 RPM**

Figure 7 shows the variation of corrosion rate with time at Jatropha concentration values of 50, 100 and 150 ppm at 1500 rpm condition. It is clear that Jatropha works the best at 150 ppm.

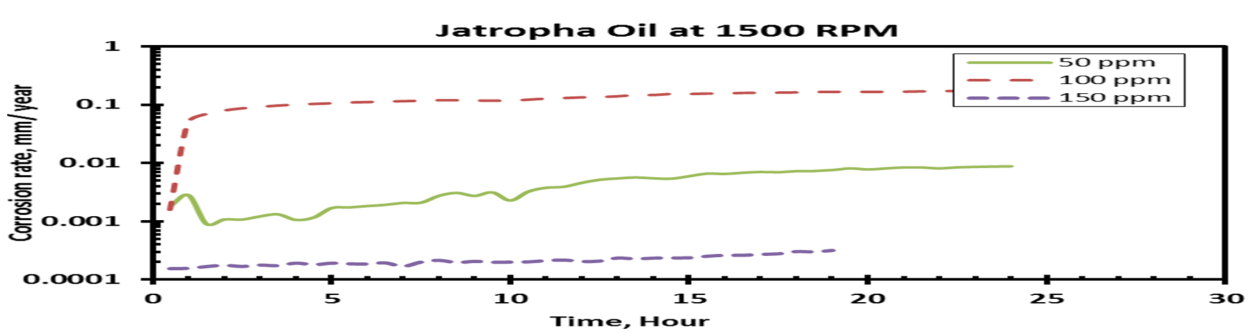


**Figure 8: LPR blank, 50, 100, 150-ppm Jatropha oil 1500 rpm**

**Weight Loss Results**

The weight loss method as described in the material and methodology section has been followed to evaluate Jatropha inhibition efficiency. Figure 9 shows the average corrosion rate at 0, 50, 100 and 150 ppm Jatropha crude oil. This result confirm the inhibition efficiency of Jatropha crude and agrees with the electrochemical results discussed above. Table 1 shows the inhibition efficiency of Jatropha at different concentration.

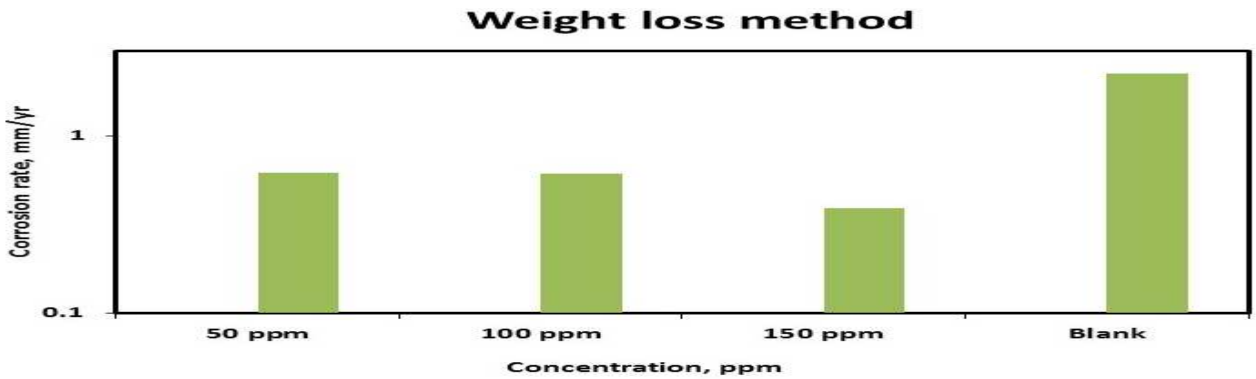


**Figure 9: Corrosion rate at 0, 50, 100 and 150 ppm Jatropha using weight loss method**

**Table 1: Corrosion rate and inhibition efficiency at 0, 50, 100 and 150 ppm Jatropha using weight loss method**

| Concentration, ppm | Corrosion Rate, mm/y | Reduction in Corrosion Rate, mm/y | Efficiency, % |
|---|---|---|---|
| 0 | 2.24 | 0 | 0 |
| 50 | 0.62 | 1.62 | 72 |
| 100 | 0.61 | 1.63 | 0.727 |
| 150 | 0.39 | 1.85 | 82.6 |

## CONCLUSION

Jatrophacarcus extracted crude oil has been evaluated as corrosion inhibitor using electrochemical measurement method and weight loss method. Jatropha crude oil exhibited good corrosion inhibition of carbon steel A 106 at both statics and dynamics conditions. When it is compared with Imadazoline, Jatropha crude shows higher inhibition efficiency. The inhibition efficiency of Jatropha crude increases with the increase of its concentration but the trend of increase is not consistent. Combining the results obtained from the electrochemical measurement with those obtained from the weight loss method, it can be concluded that Jatropha crude performs best at concentration values between 100 and 150 ppm. At 150 ppm, it can provide inhibition efficiency as high as 80%.

## REFERENCES


1. Abdel-Gaber, A.M., B.A. Abd-El-Nabey and M. Saadawy, 2009. The Role of Acid Anion on the Inhibition of the Acidic Corrosion of Steel by Lupine Extract. Corrosion Science, 51(5): 1038-1042.
2. Ajayi, O.M., J.K. Odusote and R.A. Yahya, 2014. Inhibition of Mild Steel Corrosion Using Jatropha Curcas Leaf Extract.Journal of Electrochemical Science and Engineering, 4(2): 67-74.
3. Buchweishaija, I. and G.S. Mhinzi, 2008. Natural Products as a Source of Environmentally Friendly Corrosion Inhibitors: The Case of Gum Exudates from Acacia Seyal Var.Seyal. Portugaliae Electrochimica Acta, 26(3): 257-265.
4. Chetouani, A., B. Hammouti and M. Benkaddour, 2004. Corrosion Inhibition of Iron in Hydrochloric Acid Solution by Jojoba Oil. Pigment and Resin Technology, 33(1): 26-31.
5. Olusegun, S.J., B.A. Adeiza, M.O. Bodunrin and K.I. Ikeke, 2013. Jatropha Curcas Leaves Extract as Corrosion Inhibitor for Mild Steel in 1M Hydrochloric Acid. Journal of Emerging Trends in Engineering and Applied Sciences, 4(1): 138-143.
6. Kumar, K.V., M.S.N. Pillai and G.R. Thusnavis, 2010. Inhibition of Mild Steel Corrosion in Hydrochloric Acid by the Seed Husk Extract of Jatropha Curcas.Journal of Material Environment Science, 1(2): 119-128.

7. Mokhtari, O., I. Hamdani, A. Chetouani, A. Lahrach, H. El Halouani, A. Aouniti and M. Berrabah, 2014. Inhibition of Steel Corrosion in 1M HCl by Jatropha Curcas Oil. Journal of Materials and Environmental Science, 5(1): 310-319.

8. Odusote, J.K. and O.M. Ajayi, 2013. Corrosion Inhibition of Mild Steel in Acidic Medium by Jathropha Curcas Leaves Extract. Journal of Electrochemical Science and Technology, 4(2): 81-87.

9. Oguize, E.E., B.N. Okolue, C.E. Ogukwe and A.I. Onuchukwu, 2004. Studies on the Inhibitive Action of Methylene Blue Dye on Aluminium Corrosion in KOH Solution. Journal of Corrosion Science and Technology, 1(1): 88-91.

10. Omotoyinbo, J.A., D.T. Oloruntoba and S.J. Olusegun, 2013. Corrosion Inhibition of Pulverized Jatropha Curcas Leaves on Medium Carbon Steel in 0.5 M $H_2SO_4$ and NaCl Environments. International Journal of Science and Technology, 2(7): 510-514.

11. Raja, P.B. and M.G. Sethuraman, 2008. Natural Products as Corrosion Inhibitor for Metals in Corrosive Media-A Review. Materials Letters, 62 (1): 113-116.

12. Rani, P.D. and S. Selvaraj, 2011. Comparative Account of Jatropha Curcas on Brass (Cu-40 Zn) in Acid and Sea Water Environment. Pacific Journal of Science and Technology, 12(1): 38-49.