

## Anticorrosion of Mild Steel in Sea Water at Different Temperatures by Using Green Inhibitors “Posidonia Oceanica”

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### Abstract

The metallic corrosion is a spontaneous process that causes damage to a wide range of human activities. An example of these affected structures stand out: the pipelines for oil transportation, ships, offshore platforms, all can be extremely corroded due to expose to the sea water environment. The corrosion comes from a sea water environment leads to serious consequences of the corrosion problems by reaction with its environment process which has become a problem of worldwide. This research work related to the study of anticorrosion for mild steel in sea water in different temperatures by using green inhibitors sea grass “Posidonia Oceanica” collected from Alkhoms coast on the Mediterranean Sea of Libya. Sea water parameters such as salinity 5.8 g/L, total dissolved solids content (7.73 g/L TDS), resistivity, conductivity (EC 12.88 ms), pH 7.6 were analyzed at 250 °C and corrosion rate was determined. The result of immersion of mild steel coupons in sea water at different temperatures (40, 50 and 60 °C) and in different concentrations of green inhibitors (0, 2, 4, 6 and 8 vol%) has shown that the weight loss of mild steel coupons was brilliant effected.

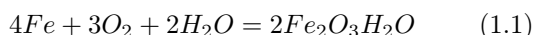
*Keywords:* Sea grass; mild steel; Alkhoms; temperature inhibitor.

### 1. Introduction

Corrosion is an unfavourable natural development that arises in the usage of metallic resources; hence, considerate labours prevent this marvel had continued throughout this period. Generality the composites presently consumed as corrosion inhibitor are costly to synthesize, toxic and non-degradable [1]. For that reason the feature ended the synthetic corrosion inhibitor. Utilize of green inhibitor in place of corrosion inhibitor in various media were advised [2, 3, 4, 5, 6, 7, 8, 9, 10, 11]. Reaction regulator of metal is on practical, cost-effective and ecofriendly significance. Consideration on corrosion inhibiting facilities of “Posidonia oceanica” leads in sea water by weight loss method. Several organic composts and some of the previous studies have pointed to the use of plants inhibitor corrosion [12, 13, 14, 15]. As of an engineering point of view the main concern in corrosion is the kinetics or rate

of corrosion. The main purpose for reviewing corrosion reaction kinetics are to progress, experimental affiliation that permit the estimate of corrosion rate under environments that are different from those originally engaged and to regulate the mechanism of the overall manners. Effective inhibitor are predictable to achieve under a wide assortment of conditions. The inhibition efficiency is influenced by on the parameters of the system (pH, duration, metal composition and temperature) and on the structure of the inhibitor molecule. Furthermost corrosion of steel could be deliberated by means of an electrochemical progression which takes place in phases. The primary attack occurs in anodic parts on the surface; somewhere ferrous ions go addicted to a solution. Electrons are permitted from the anode and transfer through the metallic structure of the neighbouring cathodic sites on the surface where they associate with water and oxygen to compose

hydroxyl ions. These react with the ferrous ions from the anode to produce ferrous hydroxide, which itself is further oxidized in air to produce hydrated ferric oxide: red rust. As shown in the following Equation 1.1:



*(Iron and steel) + (oxygen) + (water) = rust*

The present study was focused to reveal a substitute green corrosion inhibitor for mild steel in sea-water. To decrease the oxidization in the environment, inhibitor are to be used. Inhibitor are chemicals that often work by adsorbing themselves on the metal surfaces, protecting the metal surface by forming a film [16].

## 2. Material and Methods

### 2.1. Collection of Plant Materials

Sea grasses of "Posidonia oceanica" were collected from the White Mediterranean Sea, coast of Al khums City – Libya. In August 2015, Identification of "Posidonia oceanica" was by Plant Taxonomist of the Biology Department, Sciences College, El-Mergeb University, khums, Libya. The sea grass was washed, air-dried in shadow and then kept in an oven maintained at 50°C for constant weight to remove the moisture for 48 hours. Then grind to get a very fine powder and save it while in use.

### 2.2. Preparation of extract

20g crude fine powder of sea grasses was extracted in 400 ml sterile distilled water concentration by using the Soxhlet method since 6-8h and filtered. The extracts were stored in refrigerator at 4°C until further use.

### 2.3. Preparation of Test Solution

The test solution was natural sea water and it was collected directly from the Khums-coast, Mediterranean Sea, in the western region of Libya. Various properties of the sample (electrical conductivity, pH, total Dissolves substances (TDS) and salinity) were persevering compliant with the Standard Methods for the Examination of Water [17]. The immersion solutions consist of seawater mixed with Sea grasses of "Posidonia oceanica" crude extract (green inhibitor), with concentrations of 0, 2, 4, 6

and 8% respectively. The inhibitor was precisely weighed and dissolved in fresh sea water to obtain different inhibitor concentrations (0, 2, 4, 6, and 8%). The test solutions were prepared in dissimilar vessels to perform the corrosion investigate.

### 2.4. Preparation of Metal Specimen

Specimens of mild steel where the specimens were cut in the form of the dimension of 1cm x 4 cm x 1mm thickness (with a surface area of 4 cm<sup>2</sup>, one face), Previous all measurements, the exposed surfaces were polished with emery paper. Afterward this process, the specimens were rinsed with distilled water, decreased in ethanol, and finally dried with air, stored in desiccators before used, were then weighed and immersed in the test solution.

### 2.5. Experimental Work

#### 2.5.1. Temperature

Experiments were carried out at different temperature 40, 50 and 60°C.

#### 2.5.2. pH Value

pH was measured using a model HI 8014 USA Hanna Instrument, pH-meter. It was observed from the pH value that the aqueous extract sample was 5.13, and Sea water was 7.6.

#### 2.5.3. Measurements of Total Dissolves Solids (TDS), Electrical Conductivity (EC) and salinity

Solution of crude extract 20% (w/v) were suspended in deionizer water, Then total dissolved solids and electrical conductivity of each sample were analyzed triplicate, and the mean values were expressed in µS/cm and ppm, respectively, the deionizer water was determined to be less than 10µS/cm. [9] The electric conductivity/ TDS were determined by a model Jenway 4520 Conductivity Meter. It was observed from the pH value (Hanna Instrument, HI 8014, pH Meter) that the aqueous extract sample was for EC 72.3 µS/cm<sup>3</sup> and for the TDS 43.3 mg/lit. [18] Sea water considerations consistently salinity 5.8 g/l, total dissolved solids content (7.73 g/l TDS), resistivity, conductivity (EC 12.88 ms), pH 7.6 were analysed at 25 °C and corrosion rate was dogged. The result of immersion of mild steel coupons in sea water at different temperatures (40, 50 and 60 °C) and in different concentrations of green inhibitor (0, 2, 4, 6 and 8% by volume) has shown that the weight loss of mild steel coupons was intensely encouraged.

**2.5.4. Gravimetric measurements**

**Measurements of mass loss**

Diversified concentrations of prepared green inhibitor of sea water solutions (0, 2, 4, 6 and 8%) were measured into 5 separate beakers maintained at  $24 \pm 2$  °C. Previously weighed mild steel coupons were then immersed in the test solutions. Each coupon was retrieved after 24 hours progressively for 6 days. The initial and final weights of the dry coupons were taken in grams using an analytical weighing balance. The difference in weight of the coupons before and after immersion was taken as the weight loss and charted. The inhibition efficiencies of the inhibitor were calculated with the Equation 2.1 [19].

$$\%I.E = \left(1 - \frac{W_1}{W_2}\right) * 100 \quad (2.1)$$

Where  $W_1$  and  $W_2$  are the weight losses in grams for mild steel in the presence and absence of the inhibitor from “Posidonia oceanica” extract in the sea water at a specific temperature. [19] The corrosion rate of mild steel in the corrosion media was determined from the weight loss using the Equation 2.2 [20].

$$Corrosion\ Rate, CR(mpy) = 534w/DAT \quad (2.2)$$

Where  $w$  = weight loss (mg),  $D$  = density of the specimen (g /cm<sup>3</sup>),  $A$  = surface area of the specimen (cm<sup>2</sup>) and  $T$  = exposure time (hours).

**Temperature effect**

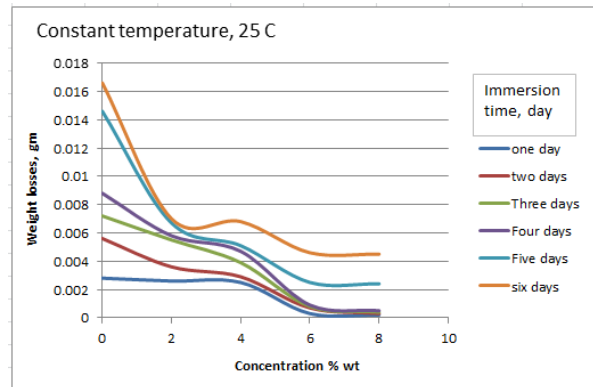
The mass loss experiments were also carried out at different temperature 40, 50 and 60 °C in the absence and presence of the extract (0, 2, 6 and 8%) to consider the effect of temperature on the grade of corrosion for an immersion period of 6h.

**3. Results and Discussion**

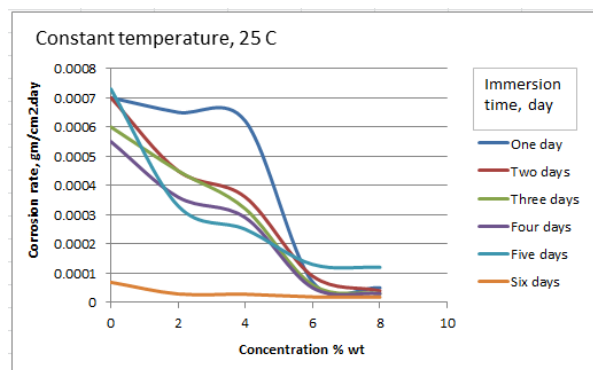
The corrosion rate of mild steel in sea water and different concentration solution of green inhibitor “Posidonia oceanica” were studied by weight loss method in the absence and presence of an extract of the plant at different temperatures in addition percent inhibition efficiency was estimated. As is obvious from Table 3.1 and Likewise, Figure 3.1 that the difference in weight loss of mild steel in the sea water as in the absence of inhibitor there was an increase in weight loss during the 24-hour

(gm 0.0028) to 6 days (gm 0.0166) compared with presence of green inhibitor this focus, the increase has reduced with a cumulative concentration of inhibitor (2, 4, 6 and 8%).

Figures 3.1, 3.2 and 3.3 as well Table 3.1 also showed the variation of corrosion rate, percent inhibition efficiency and surface coverage with varying concentration of inhibitor. From the data it was observed that corrosion rate was significantly lowered down in the presence of inhibitor. The corrosion rate was found dependent on the concentration of inhibitor. With the increase in concentration the corrosion rate decreased gradually.



**Figure 3.1:** Weight Loss-time Curves for the Corrosion of Iron, Steel in Sea Water in the Absence and Presence of Different Concentrations of “Posidonia oceanica” Extract at Constant Temperatures

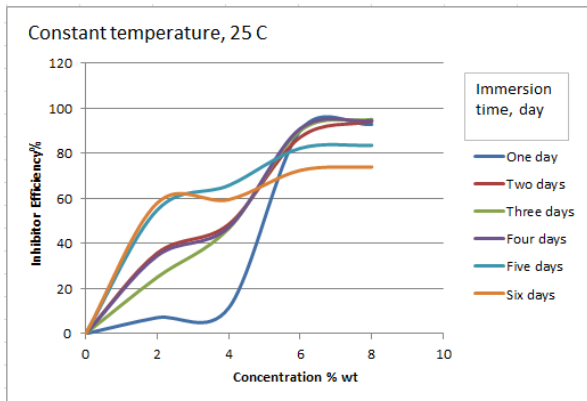


**Figure 3.2:** Evolution of Corrosion Rate for Iron, Steel in Sea Water with and without Green Inhibitor with the Immersion Time at Constant Temperature

Table 3.2 also Figure 3.4 shows the variation of weight loss in absent and with the presence of differ-

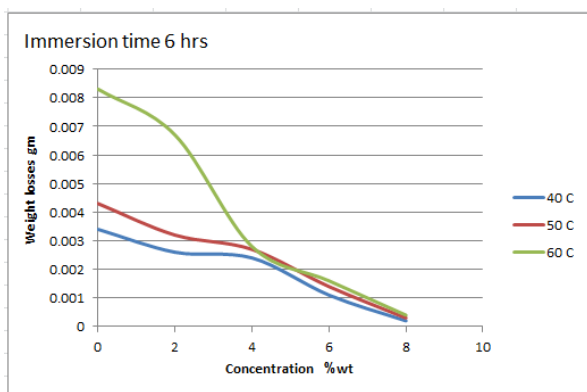
Table 3.1: Results of weight loss in absent and with different concentration of Inhibitor

Immersion time (days), Corrosion rate (gr/cm <sup>2</sup> *day) and Inhibition Efficiency (%)	Weight loss (gm)/(Blank Sea Water)0%	Weight loss (inhibitor) 2%	Weight Loss (inhibitor) 4%	Weight loss (inhibitor) 6%	Weight loss (Inhibitor) 8%
<b>Day 1</b>	<b>0.0028</b>	<b>0.0026</b>	<b>0.0025</b>	<b>0.0003</b>	<b>0.0002</b>
Corrosion rate (gr/cm <sup>2</sup> *day)	0.0007	0.00065	0.00062	0.00007	0.00005
Inhibition Efficiency (%)	0.00	7.1	11.4	90.0	92.8
<b>Day 2</b>	<b>0.0056</b>	<b>0.0036</b>	<b>0.0029</b>	<b>0.0007</b>	<b>0.0003</b>
Corrosion rate (gr/cm <sup>2</sup> *day)	0.0007	0.00045	0.00036	0.00009	0.00004
Inhibition Efficiency (%)	0.000	35.7	48.5	87.1	94.2
<b>Day 3</b>	<b>0.0072</b>	<b>0.0055</b>	<b>0.0039</b>	<b>0.0008</b>	<b>0.0004</b>
Corrosion rate (gr/cm <sup>2</sup> *day)	0.0006	0.00045	0.00032	0.00006	0.00003
Inhibition Efficiency (%)	0.00	25.0	46.6	90.0	95.0
<b>Day 4</b>	<b>0.0088</b>	<b>0.0058</b>	<b>0.0047</b>	<b>0.0009</b>	<b>0.0005</b>
Corrosion rate (gr/cm <sup>2</sup> *day)	0.00055	0.00036	0.00029	0.00005	0.00003
Inhibition Efficiency (%)	0.00	34.5	47.2	90.9	94.5
<b>Day 5</b>	<b>0.0146</b>	<b>0.0067</b>	<b>0.0051</b>	<b>0.0025</b>	<b>0.0024</b>
Corrosion rate (gr/cm <sup>2</sup> *day)	0.00073	0.00033	0.00025	0.00013	0.00012
Inhibition Efficiency (%)	0.00	54.8	65.7	82.2	83.5
<b>Day 6</b>	<b>0.0166</b>	<b>0.0070</b>	<b>0.0068</b>	<b>0.0046</b>	<b>0.0045</b>
Corrosion rate (gr/cm <sup>2</sup> *day)	0.000069	0.000029	0.000028	0.000019	0.000018
Inhibition Efficiency (%)	0.00	57.9	59.4	72.4	73.9



**Figure 3.3:** Variations of Inhibition Efficiency with Different Concentrations of “Posidonia oceanica” Extract at Constant Temperatures for Mild Steel Corrosion in Sea water

ent concentration of Inhibitor at different temperature in addition the data revealed that in the absence of inhibitor the weight loss, increasing (0.0034, 0.0043 and 0.0083) with increasing of temperature rate (40, 50 and 60 °C) But stimulating in the presence of green inhibitor weight loss decreasing with increase of temperature.



**Figure 3.4:** Weight Loss of “Posidonia oceanica” Extract for Mild Steel in Sea Water at Different Temperatures (40, 50 and 60 °C)

Moreover the effect of exposure time on potential the samples showed a potential decrease with increasing of inhibitor concentrations and temperature rising. May be the presence of heteroatoms and double bonds in some compounds in the extract of “Posidonia oceanica” make them electron rich and are able to effectively inhibit corrosion by providing that location of adsorption decreased

**Table 3.2:** Results of weight loss in absent and with different concentration of Inhibitor and different temperature (Immersion Time 6 hr)

Temperatures °C	40	50	60
Weight loss inhibitor wt0%	0.0034	0.0043	0.0083
Weight loss inhibitor wt2%	0.0026	0.0032	0.0067
Weight loss inhibitor wt4%	0.0024	0.0027	0.0028
Weight loss inhibitor wt6%	0.0011	0.0014	0.0016
Weight loss inhibitor wt8%	0.0002	0.0003	0.0004

when the “Posidonia oceanica” extract was added to the corroding, when compared to a corroding without an additive (blank), also as it is obvious from Figure 3.4. It is supposed that the additive (inhibitor) presumably on condition that the electrons for reduction of H<sup>+</sup> of hydrogen gas through the double heteroatoms and bonds. This inhibitor reduced corrosion by adsorbing on the metal surface [21, 22], Accordingly protecting the superficial by creating a barrier film on the surface, its adsorption reduced the transmission or effort of ions to the metallic surface, in addition to the ionization of the metal [23]. The corrosion rate in sea water is controlled by an oxygen reduction reaction, and higher corrosion rates are perceived in splash areas and in the places where waving is superior in consequence of increased oxygenation and enriched oxygen immigration to the structure’s surface [24]. Sea water parameters such as salinity were 5.8 g/l, total dissolved solids content (7.73 g/l TDS), resistivity, conductivity (EC 12.88 ms) and pH 7.6 were analysed at 25°C and corrosion rate was determined. Weather Corrosion species attacking influenced by resistivity, Were electrolyte conductivity rises with the temperature by reason of enhanced ion association, It could remain assumed that the inconsequential the electrolyte electric resistance remains, the minor the corrosion rate occurs.

Even as the TDS parameter numerate formed by inorganic and organic composites in the colloidal states or ionic, particle, Water can be considered fresh (TDS<1,500 ppm), brackish (1,500<TDS<5,000) or saline (TDS>5,000) [25]. Nevertheless, salinity mainly prompting water resistant, also, dissolved salts, particularly Cl<sup>-</sup>, are

repellent for ineffective metals and may reason local inactive layer failures introducing usual as competitors corrosion [26].

#### 4. Conclusion

The result authorizes that in the extract of "Posidonia oceanica" achieves as a usefulness inhibitor for the corrosion of mild steel in sea water, and was found to be a good environmentally friendly inhibitor as the corrosion control.

#### 5. Acknowledgment

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