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CORROSION INHIBITOR STUDIES ON WESTERN OFFSHORE CRUDE OIL

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Abstract: **Corrosion, the oldest problem in oil and gas industry has many factors influencing his growth like temperature, pressure, humidity, mechanical actions and chemicals (CO2, H2S, Organic acid and scales). It can occur locally on the metal surface uniformly or it can be an intergranular attack of equipment. Although the fact that corrosion cannot be totally cured, there exist several methods to prevent or to reduce corrosion rate as cathodic protection, coating, material selection, corrosion inhibitor. Here in this work, we emphasis on the effect of corrosion inhibitor on corrosion rate for that we used water corrosion inhibitor and oil corrosion inhibitor. These inhibitors were either mixed with crude oil or produced water, and spread on metal surface. In this work oil from Western onshore field, India was collected in order to study the effect of corrosion inhibitor on metallic substrates.**

Keywords: - *Corrosion Inhibitor, Water Corrosion Inhibitor, Oil corrosion Inhibitor*

I INTRODUCTION

The method used to evaluate corrosion is weight loss analysis where we calculate corrosion rate and metal loss through these formulas:

$$\text{Corrosion rate} = \frac{weight\ loss(g) * K}{Allow\ density\left(\frac{g}{cm^3}\right) * Exposed\ area(cm^2) * Exposure\ time(hr)} \quad \text{(Eq1)}$$

$$\text{Metal loss} = \frac{Weight\ loss\ (g) * K}{Alloy\ density * Exposed\ area} \quad \text{(Eq2)}$$

Equation 1 Corrosion rate and Equation 2 Metal loss.

TABLE1: CORROSION RATE'S CONVERSION TABLE

Corrosion rate unit CR	Area Unit A	K-Factor
mils per year (mpy)	in^2	5.34×10^5
mils per year (mpy)	cm^2	3.45×10^6
millimeters per year (mmy)	cm^2	8.75×10^4

II EXPERIMENT AND METHODOLOGY

1. SAMPLES

Figure 1 Inhibitor sample.

- The products tested are water corrosion inhibitor (WCI) and oil corrosion inhibitor (OCI), which were spread on metal surface, these are organic inhibitors type.

TABLE 2: CRUDE SAMPLE PROPERTIES

Cambay Crude oil properties			
Density	***Water content***	***Pour point***	***API Gravity***
0.889 g/cm³	*34%*	42°C	*27.67°*

- Water sample used is produced water obtained from demulsification of crude sample

2. METALIC SUBSTRATES

- Carbon steel: mild steels (0.3% carbon): with a density of 7.85g/cm³

TABLE 3: CARBON STEEL SAMPLES

	initial weight	length	width
Coupon A	31.28g	7.2	4.1
Coupon B	29.79g	6.7 cm	3.9 cm

- Iron steel TMT bar: density of 7.87g

TABLE 4: IRON STEEL TMT BAR SAMPLE

	initial weight	Length	Diameter	Inhibitor's type
Coupon A	69.18g	6.7 cm	1.2 cm	without
Coupon B	60.49g	6.8 cm	1.3 cm	OCI
Coupon C	60g	6.5cm	1.1cm	WCI

3. COUPONS PREPARATION AND CLEANING

Coupon's cleaning and preparation is a crucial process for obtaining the useful data during the experiment, so the selection of cleaning method is an important step, here we followed ASTM G-1.

Following steps were made:

- The coupon surface (iron steel) was polished with sand paper and then rinsed (iron steel and carbon steel) with acetone solvent.

The sample is weighed with an electronic mass balance

4. METHODOLOGY

The method used for both iron steel and carbon steel were a little bit different and are given below:

- Carbon steel methodology

After the coupons surface has been cleaned with acetone solvent, they are weighed using an electronic mass balance. Coupon A is immersed in 100ml of crude oil at 45˚C temperature and at atmospheric pressure. The crude sample contains 2 droplets of oil corrosion inhibitor. The coupon is left immersed in crude oil during 72 hours, the oil sample is deep in water bath apparatus to maintain the temperature at 45˚C. The second coupon (B) in the other hand is immersed in 100ml of produced water at ambient temperature (around 31˚C) and at atmospheric pressure, the water sample contains 2 droplets of water corrosion inhibitor, the coupon is left immersed in water during 72 hours, kept outside. After the 72 hours of immersion the coupons are removed from oil and water sample respectively, coupon A is cleaned with toluene solvent to removed excess of oil in its surface and coupon B is washed with distilled water after that, the coupons are dried and weighed again.

Figure 2 Coupon A being immersed in oil sample

Figure 3: Coupon B being immersed in oil sample containing 2 droplets of WCI

Iron steel TMT bar

Here we made an experiment on three iron steel coupons where coupon A was tested without inhibitor, coupon B with oil corrosion inhibitor and coupon C with water corrosion inhibitor.

After the coupons have been cleaned following steps have been done:

- For coupon A after cleaning, it has been exposed to sun for a period of 2 hours
- Coupon B after cleaning, a mixture of crude oil and water corrosion inhibitor is spread at coupon surface and left in an opened space exposed to sunlight for five hours
- A mixture of produced water and water corrosion inhibitor was spread on the surface of Coupon C and left outside during five hours

After the five hours have passed the coupons are cleaned with toluene and weighed for a second time, after that the coupons surface was polished with sand paper to remove the resulted rust. The temperature was about 31˚C to 33˚C.

III RESULTS

- Carbon steel

After the five experimental days the coupons was cleaned and weighed for a second time, their final weight is recorded in the following table:

TABLE 5: FINAL DATA OF CARBON STEEL SAMPLES

	initial weight	**length**	**width**
Coupon A	31.28g	7.2	4.1
Coupon B	29.79g	6.7 cm	3.9 cm

Figure 4: Coupon A state after being exposed 72 hours of immersion

Figure 5: Coupon B state after being exposed 72 hours of immersion

- Iron steel TMT bar

After being exposed during 5 hours in an opened space exposed to sunlight, following data are obtained by using (Eq1) and (Eq2):

TABLE 6: RESULTS OBTAINED AFTER 5 EXPERIMENTAL HOURS

	Coupon A	Coupon B	Coupon C
Final weight	60.45g	59.66g	58.65g
Weight loss	8.73g	0.83g	1.35g
Corrosion rate	15.22 mmy	1.23 mmy	2 mmy
Metal loss	8.7 mm	0.70 mm	1.14 mm

Figure 6 Coupon A after being exposed

Figure 7 Coupon B after being exposed

Figure 8 Coupon C after being exposed

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As we can observe there is no change between the initial data (table 1) and the final data (table 6). We only observed few changes in the coupons color but no material loss occurred during the experiment. Here we can assume that for steel to corrode the environment must be aggressive, then if we keep oil and water under low temperature and low pressure their corrosion on carbon steel will be relatively low.

- **Iron TMT bar**

By using table 6 the graph below is obtained:

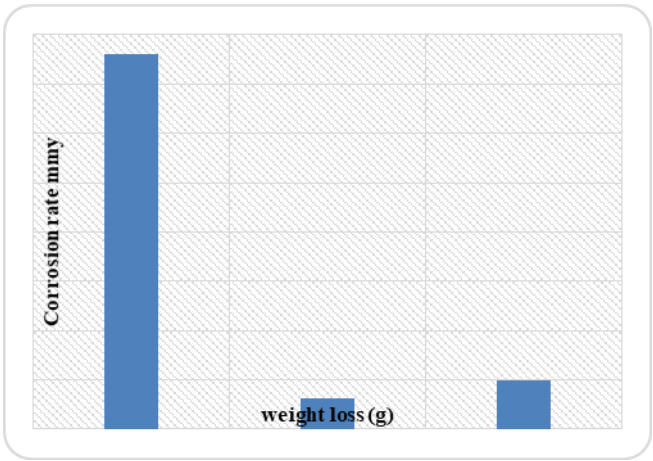

Figure 9 Graph representing the variation of corrosion rate depending on weight loss

According to the data obtained and the graph, we can see the effect of corrosion inhibitor on metal loss. The inhibitor reduces the corrosion rate of the coupons. But now we have to introduce the right inhibitor dose. We observe that corrosion inhibitor does not totally avoid corrosion it reduces the corrosion rate.

IV CONCLUSIONS

Corrosion inhibitors are used in oil and gas industry to prevent or to inhibit the corrosion effect of corrosive agents present in crude or added for some purpose. According to results obtained, these corrosion inhibitors (organic type) used during the experiment would be recommendable for transportation and storage purpose of crude oil having 27.67˚ as API gravity and it would be preferable to use carbon steel material instead of iron steel material.

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