

Synthesis of New Heterocyclic Compound Used as Corrosion Inhibitor for Crude Oil Pipelines

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Abstract

This study comprises synthesis of new heterocyclic compound through one of the most powerful methods in organic synthesis and which comprises formation of several bonds in a single transformation and all interaction materials have been combined in one pot since beginning of interaction. This compound contains on nitrogen, oxygen and sulfur atoms and is *3,5,12-trithia-1,7,14-triaza-tricycle [5.3.3.2^{7,10}] tetradeca-6(14),9-dien-8-one*, and its structure has been determined by using several techniques such as, Nuclear magnetic resonance spectrophotometer for proton ¹H-NMR and carbon ¹³C- NMR, Infra-red spectroscopy FT-IR, and Mass spectroscopy MS. The last part is the study and application of compound as a inhibitor for corrosion crude oil pipelines (N-80 type) in saline water as a corrosive medium and has been evaluated by using weight loss method, as well as has been evaluated through electrochemical techniques such as potentiodynamic polarization, electrochemical impedance spectroscopy EIS, and scanning electron microscopy- energy dispersive X-ray spectroscopy SEM/EDX. The effect of time and concentration on the corrosion rate have been studied and was observed that efficiency of inhibition increased with increase inhibitor concentration to attain a maximum values of 90.12%, 90.62%, 79.70%, 90.05% to weight loss method, polarization technique, impedance technique and energy dispersive X-ray technique respectively. Finally the prepared inhibitor was compared with some of disincentives commercial used in the south oil company such as, AS-101, WFT-9368, COIL GARD, HQI-85M and AL-600.

Keywords: Corrosion inhibitors; Crude oil pipeline; Heterocyclic compounds; SEM/EDX; EIS; Domino reactions; Weight loss method.

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1. Introduction.

Corrosion is the destructive attack for metal through chemical or electrochemical reaction with its environment [1]. Dissolved gases such as O₂, CO₂ and H₂S if found in water means the corrosion rate of water will be high, and if these gases decreased and escaped from water in neutral pH, corrosion will be reduced. Dissolved oxygen as a strong oxidizer agent plays an important role in corrosion processes, carbon dioxide and hydrogen sulfide gases dissolved in water have been considered as acidic factors and they decrease from water pH, and addition to these gases the oxygen plays an important role in it [2]. The major forms of corrosion are, sweet corrosion, sour corrosion, oxygen corrosion, galvanic corrosion, crevice corrosion, erosion corrosion, corrosion of microbiology, and stress corrosion [3]. Domino reactions or cascade reactions are defined as an processes of two or more bond-forming reactions under identical conditions[4]. Large numbers of organic compounds that contain nitrogen, sulfur and oxygen have been revealed to be good corrosion inhibitors [5]. L. Xiang-Hong and X. Xiao-Guang the inhibition effect of two pyrimidine derivatives on the corrosion of carbon steel in 1-5 mol·L⁻¹HCl have been studied and these compounds are, 2- hydroxyl pyrimidine (HP) and 2-mercaptopyrimidine (MP), and have been investigated through weight loss method, potentiodynamic polarization curves, and electrochemical impedance spectroscopy . The results showed that HP and MP are both a good corrosion inhibitors for carbon steel in 1 mol·L⁻¹HCl solution, and inhibition efficiency has been increases with inhibitor concentration increases and decreases with hydrochloric acid concentration increases[6]. H. Zarrok *et al* have been studied a new inhibitor namely 2-[Bis-(3,5-dimethyl-pyrazol-1-ylmethyl)-amino]-3-hydroxy-butyric acid towards the corrosion of carbon steel in 1 M of hydrochloric acid. Inhibition of corrosion has been evaluated through using weight loss method, electrochemical technique (Tafel plot) and electrochemical impedance spectroscopy (EIS). Inhibition efficiency was increases with inhibitor concentration increase, and polarization study has been showed that compound is inhibitor from a mixed-type in 1 M HCl [7].

The aim of this study is synthesis a new heterocyclic compound through new technique is domino reactions (include amine with formaldehyde and H₂S gas in one pot), and also was studied the inhibiting effect of this compound towards the corrosion of crude oil pipeline in saline water, and finally has been studied time effect on inhibition efficiency.

2. Experimental.

2.1 Used pipelines in this study.

That the pipeline of used in this study from type of carbon steel (N-80) and has been used as a working electrode, and it used in the south oil company as an petroleum pipes. and Its chemical composition (in wt%) of C 0.2; Mn 0.841; Si 0.366; Cu 0.190; Cr 0.152; S 0.024; and the remaining balance of Fe [8].

2.2 Instruments.

¹H and ¹³C NMR spectra have been recorded on a Bruker model AM 500 MHz spectroscopy with using CDCl₃ as solvent and TMS as internal blank. Mass spectrum has been recorded by using electron ionization technique

(70 eV), and helium has been used as a carrier gas and oven temperature program from 60 °C to 200°C at rate time 2.600 ->2.667 min, device model (6000N/5975B) USA. IR spectra were recorded on FTIR model 6000 Shimadzu in the 400-4000 cm⁻¹. SEM images and EDX spectra have been recorded by using device Japanese origin model INCA 400 at voltage 10kV. Potentiodynamic measurements have been carried using a device model K47 Gamry. EIS measurements have been carried using a device model CHI 660A. Melting point was taken in open capillary tubes using a Gallenkamp apparatus.

2.3. Weight loss method.

Carbon steel specimens (pipelines) have been cut into (4×2×0.5) cm for length, width and thickness respectively, total area for carbon steel specimen 22cm² (3.41 square inches). They have been polished by using a series of silicon carbide papers SiC (grade 160, 320, 800) then have been washed with distilled water and acetone and finally it was dried in a desiccator. After that, they have been weighed in a digital balance then have been immersed in saline water in absence and presence of inhibitor at different concentrations from 1X10⁻¹M to 1X10⁻⁵M. The experiments have been conducted at temperature 298 k in different times 1-4 days, then the specimens were taken out corrosive medium and have been cleaned by bristle brush under running water in order to remove products of corrosion then it was dried and re-weighed accurately according to ASTM method[9]. Corrosion rate has been calculated via the following equation[10].

$$CR \text{ (mpy)} = \frac{534 W}{DAT} \quad (1)$$

Where W is weight loss, D is density of carbon steel 7.86 g/cm³, A is area of carbon steel specimen in square inches 3.41 inh² and T is immersion period of specimens in corrosive medium (in hours). The percentage of inhibition efficiency %IE has been calculated via the following equation[11,12].

$$\%IE = \frac{CR_{\text{blank}} - CR_{\text{inhi}}}{CR_{\text{blank}}} \times 100 \quad (2)$$

Where CR_{inhi} and CR_{blank} are corrosion rate with and without inhibitor respectively.

2.4 Potentiodynamic polarization spectroscopy.

In this technique specimens were cut into 2cm x 0.2cm for both diameter and thickness respectively. Experiments have been performed in a three-electrodes cell through using a saturated calomel electrode(SCE) Hg₂Cl₂ as a reference electrode, carbon electrode as an counter electrode and carbon steel N-80 as an working electrode (WE). Surface area of working electrode is 1.0 cm² and a scanning rate 0.1 mVs⁻¹. The polarization curves have been acquired by scanning of potential from - 0.25V to +0.25 V and duration of each experiment was 20 minutes. The percentage of inhibition efficiency has been calculated by the following equation[13].

$$\%IE = \frac{I_{corr}^o - I_{corr}^i}{I_{corr}^o} \times 100 \quad (3)$$

Where I_{corr}^o, I_{corr}^i are corrosion current density in the absence and presence of inhibitor respectively.

2.5 Electrochemical impedance spectroscopy (EIS).

The impedance measurements were carried by using the open circuit potential for every sample, and all samples in corrosion cell solution have been submerged at a frequency range of 100 kHz to 1Hz with a signal amplitude perturbation of 3 mV and a scan rate of 0.1 mVs⁻¹. Electrochemical impedance experiments have been performed in a corrosion cell consist from three-electrodes saturated calomel electrode Hg₂Cl₂ as a reference electrode, a platinum was used as an auxiliary electrode and carbon steel as an working electrode. The percentage of inhibition efficiency(%IE) has been calculated by using the following equation [14]

$$\%IE = 1 - \left[\frac{R_{ct}^o}{R_{ct}^i} \right] \times 100 \quad (4)$$

Where R_{ct}^o , and R_{ct}^i , are the charge transfer resistance in absence and presence of inhibitor respectively and direct have been calculated from Nyquis curves. Surface coverage(θ) has been calculated from the following equation [15]

$$\theta = 1 - \left\{ \frac{R_{ct}^o}{R_{ct}^i} \right\} \quad (5)$$

The double layer capacitance C_{dl} values for different of inhibitor concentrations can be calculated by using the following equation [16,17]

$$C_{dl} = \frac{1}{2\pi f_{max} R_{ct}} \quad (6)$$

Where f_{max} is the frequency at which give the maximum impedance.

2.6 Scanning Electron Microscopy-Energy Dispersive X-ray Spectroscopy (SEM/EDX).

The percentage of corroded iron in carbon steel submerged in saline water in absence and presence of inhibitor at optimum conditions has been investigated through using energy dispersive X-ray, and the surface morphology of the carbon steel has been evaluated using scanning electron microscopy. Analysis in this technique is quantitative and qualitative at the same time and percentage of corroded iron (%E loss) has been calculated by using the following equation[8,18].

$$\% E \text{ loss} = \frac{f - f^{\circ}}{f} \times 100 \quad (7)$$

Where f and f° are the percentage of iron in the polished carbon steel and percentage of iron after corrosion respectively. The percentage of inhibition efficiency ($\%IE$) has been calculated by using the following equation[8,18]

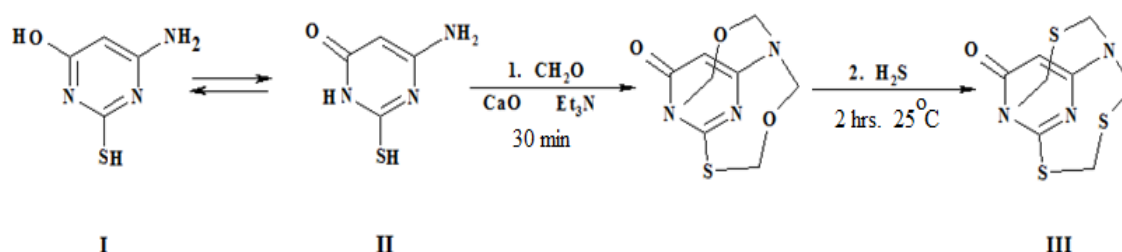
$$\% IE = \frac{L^{\circ} - L^i}{L^{\circ}} \times 100 \quad (8)$$

Where L^i and L° are the percentage of corroded iron with and without inhibitor respectively.

3. Synthesis and characterization.

3.1. Synthesis and characterization of heterocyclic compound 3,5,12- trithia-1,7,14-triaza-tricycle [5.3.3.2^{7,10}] tetradeca-6(14), 9-dien-8-one (III).

Consisted mixture of 40mmol from aqueous solution of 37 % formaldehyde, 100 ml water, 10mmol of 4- amino-6- hydroxy-2-mercapto pyrimidine monohydrate and 20mmol Et_3N with some drops from CaO solution with stirred at temperature $25^{\circ}C$ for 30 minute, then added H_2S gas for 2 hours. The mixture has been filtrated to produce white precipitate was collected and dried at $120^{\circ}C$, the yield is 90 % and its m.p. $188^{\circ}C$. Heterocyclic compound has been determined by using 1H -NMR, ^{13}C -NMR and mass spectroscopy techniques, the spectra are shown in Figures from 3 to 6 respectively. **1H - NMR** (500 MHz, $CDCl_3$): $\delta = 3.31$ (s,2H ,S- CH_2 -S); 4.331 (s ,6H, S- CH_2 -N); 6.90 (s, 1H, CH); and singl signal has been shown at 7.30 ppm for solvent ($CDCl_3$). **^{13}C - NMR** (500 MHz, $CDCl_3$): $\delta = 34.38$ (1C,S- CH_2 -S); 58.82 (3C, S- CH_2 -N); 170.10 (C=O); 150.00 (N-C-N),154.90 (C=N); 120.06(CH), and triplet signal has been shown at shift 76.64 - 77.88 for solvent ($CDCl_3$). **MS, m / z (I_{rel} (%))**: 259 $[M]^+$ (33.5); 192 $[C_5H_6NS_3O]^+$ (35.5); 241 $[C_8H_7N_3S_3]^+$ (31.9);218 $[C_6H_8N_3S_3]^+$ (100); 105 $[CH_3N_3SO]^+$ (25.4); 248 $[MH-C_7H_9N_3S_3O]^+$ (12.4); 128 $[C_3H_2N_3SO]^+$ (8.9); 91 $[CH_3N_2SO]^+$ (6.1); 175 $[C_4H_5N_3S_2O]^+$ (3.1). **IR (KBr/cm^{-1})** 2915.8 and 2885.15 CH stretching; 1645.92 C=C;1520.03 C=N; 1695.22 C=O; 1200.77 C-N; 595.26 C-S. Scheme 1 showed the one pot interactions of 4-amino-6-hydroxy-2-mercapto pyrimidine monohydrate (I) for produce 3,5,12- trithia-1,7,14-triaza-tricyclo[5.3.3.2^{7,10}] tetradeca-6(14), 9-dien-8-one , (III) [21-23].



Scheme 1: Shows the one pot reaction of heterocyclic compound.



Figure1: Interaction system before added H₂S gas.



Figure2: Interaction system after added H₂S gas.

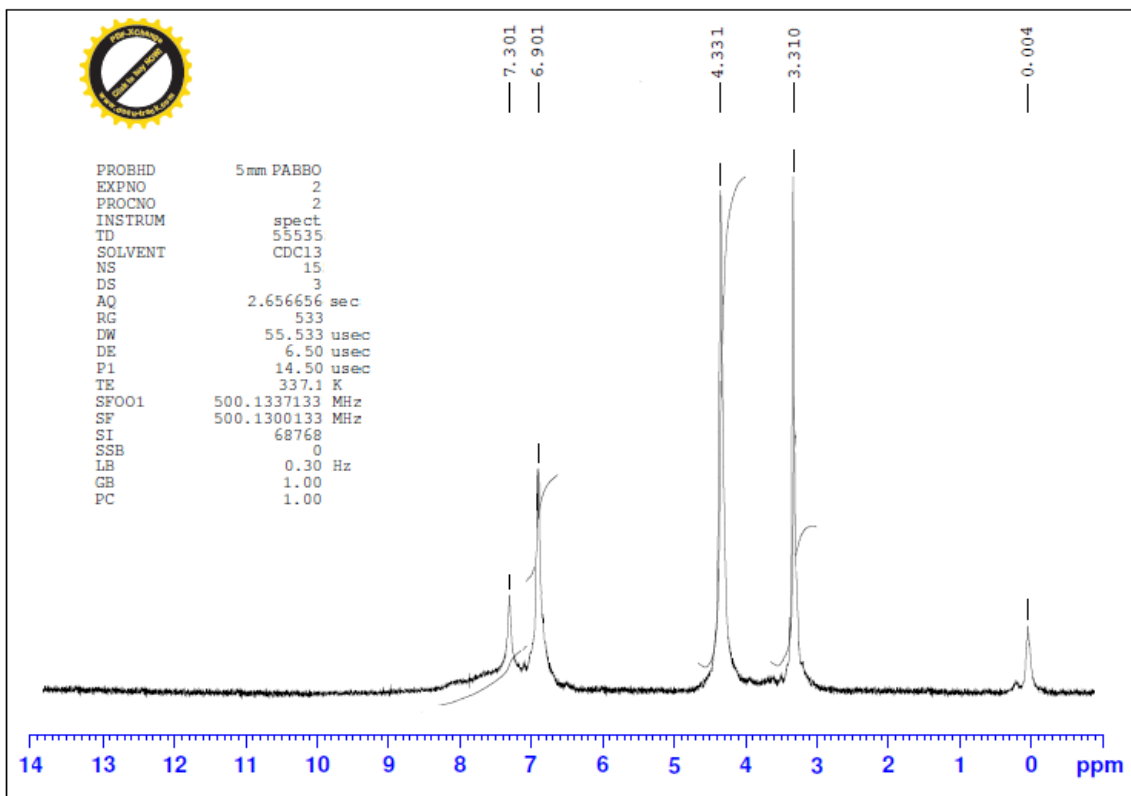


Figure 3: ¹H-NMR spectrum of inhibitor.

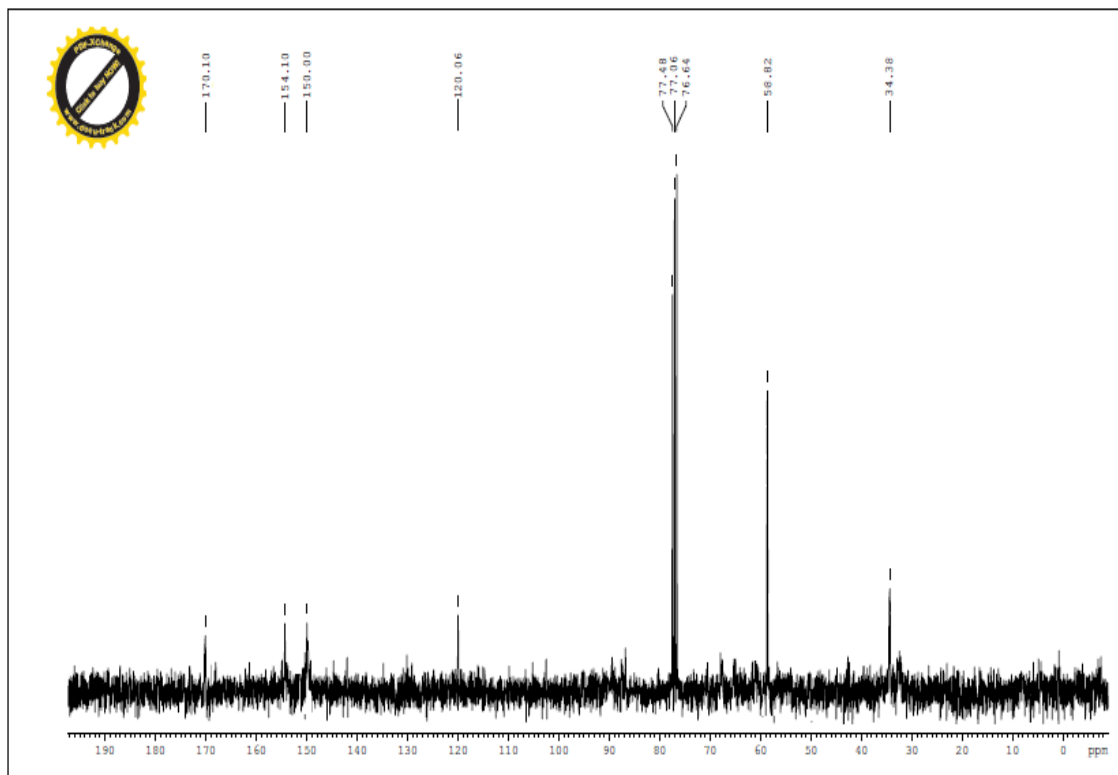


Figure 4: ¹³C-NMR spectrum of inhibitor.

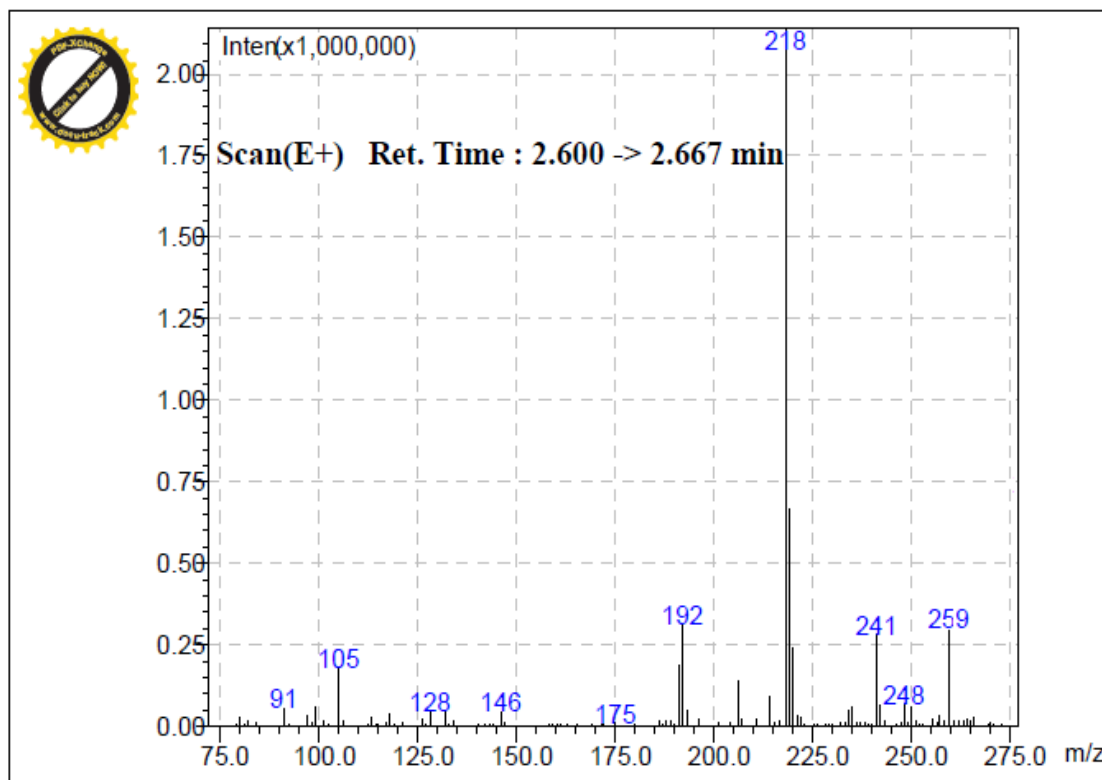


Figure 5: Mass spectrum of inhibitor.

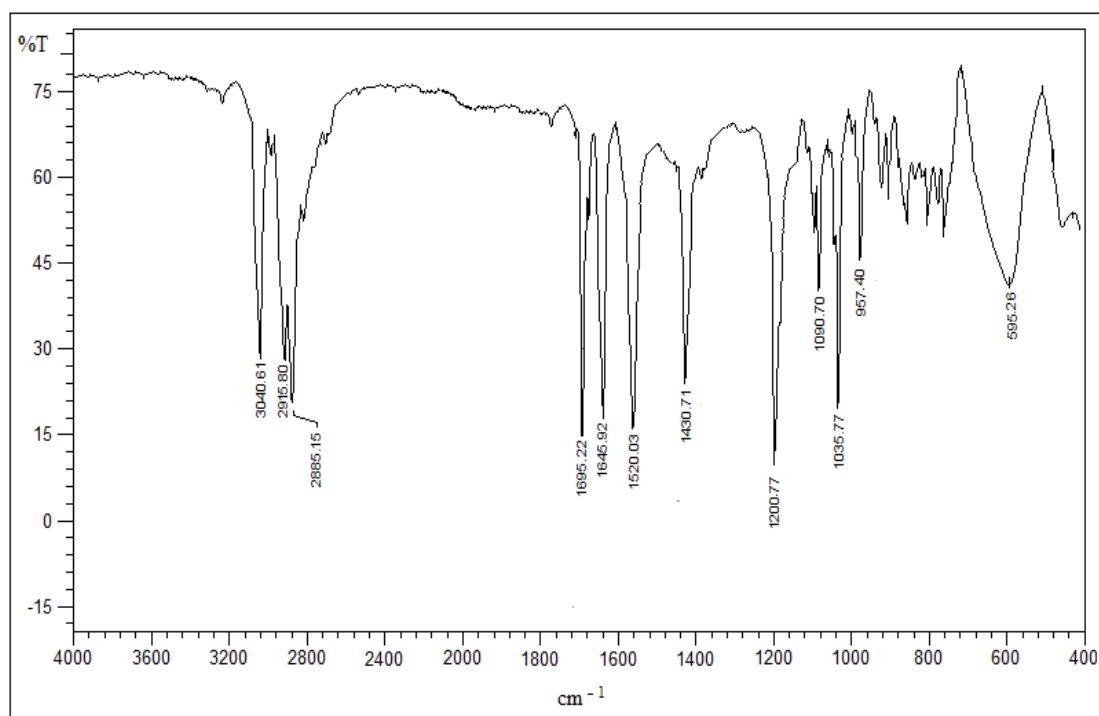


Figure 6: IR spectrum of inhibitor.

4. Results and Discussion.

4.1 Weight loss measurements.

Weight loss of carbon steel has been calculated in milligram and determined in various time intervals in the absence and presence of different concentrations of inhibitor (III). Table 1 illustrate the results of weight loss, corrosion rate and inhibition efficiency obtained in the saline water as a corrosive medium. According to the results, it can be noted that both weight loss and corrosion rate are decreased in case of increasing concentration[24] as well as, that weight loss and corrosion rate in saline water at absence of inhibitor have been noted more than with presence of inhibitor. Inhibition efficiency %IE has been increased with increasing inhibitor concentration at constant time as shown in Figure 7. Subsequently it can be concluded that the inhibitor has high efficiency for inhibition of pipeline in saline water and which reaching as a maximum to 90.12 % this may be due to the adsorption of inhibitor onto the carbon steel surface through non-bonding electron pairs for sulfur, nitrogen and oxygen atoms or through π - electrons in inhibitor molecule [25-26].

On the other hand it can be concluded the effect of time on the corrosion rate CR and efficiency of inhibition where it was noted was there not definite trend in the increase of CR or %IE and due to the fact that the values of weight loss are not equal with increasing time as shown in Table 1, or may be due to that products of corrosion which have been formed on the surface of the carbon steel are different at quantitative and qualitative[27].

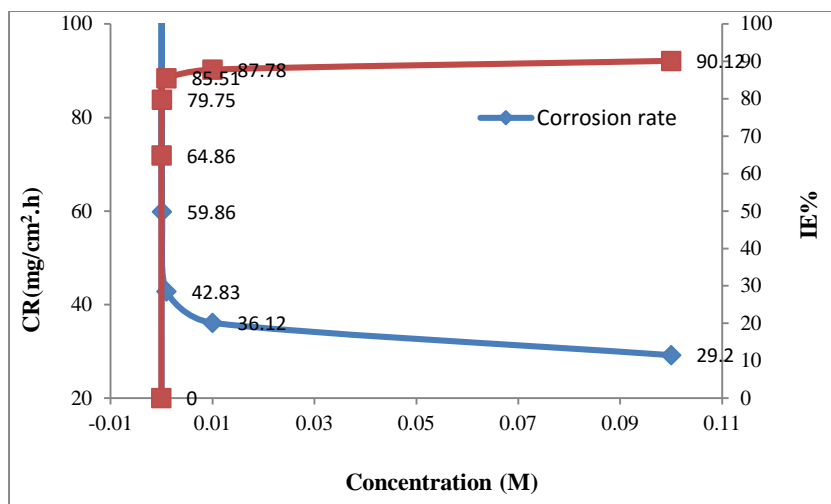


Figure 7: Variation of the corrosion rate and inhibition efficiency against the different concentrations of inhibitor at 2 days

Table 1: Table 1 shows weight loss, corrosion rate and inhibition efficiency of inhibitor in saline water at different times and temperature 298K.

Time	1 day			2 days			3 days			4 days			
	Con.(M)	Wt mg	CR mpy	IE%	Wt mg	CR mpy	IE %	Wt mg	CR mpy	IE %	Wt mg	CR mpy	IE %
Saline water		291.10	241.65	-----	712.20	295.60	-----	1120.2	309.97	-----	1890.31	392.30	-----
1x10 ⁻⁵		212.30	176.24	27.06	250.21	103.85	64.86	780.42	215.83	30.37	636.13	132.02	66.34
1x10 ⁻⁴		113.30	94.05	61.08	144.22	59.86	79.75	555.34	153.67	50.42	552.22	114.60	70.78
1x10 ⁻³		89.11	73.97	69.38	103.21	42.83	85.51	320.02	88.55	71.43	439.99	91.31	76.72
1x10 ⁻²		32.91	27.32	88.69	87.04	36.12	87.78	200.99	55.61	82.05	320.20	66.41	83.07
1x10 ⁻¹		31.22	25.91	89.27	70.33	29.2	90.12	119.32	33.01	89.35	276.71	57.42	85.36

4.2 Potentiodynamic polarization measurements.

Cathodic and anodic polarization curves of carbon steel have been recorded in saline water with the presence and absence of inhibitor as shown in the Figure 8. Table 2 was showed electrochemical corrosion parameters and included corrosion current density I_{corr} , corrosion potential E_{corr} , cathodic Tafel slope bc , anodic Tafel slope ba , polarization resistance R_p and inhibition efficiency %IE. It can be concluded that the anodic reaction for carbon steel corrosion has been reduced with the increase of inhibitor concentration this result suggests that the addition of compound (inhibitor) led to reduce in anodic dissolution and also has been reduced the cathodic reaction through blocking the carbon steel surface from oxygen by protective film formation[10,28]. Polarization curves showed that the shift in corrosion potential is positive shift (noble value) with added of inhibitor therefore the inhibitor could be classified as a anodic inhibitor at all concentrations except the concentration 10⁻² M if noted that the corrosion potential has been decreased to -0.461 mV therefore negative

shift occurred this result indicate that inhibitor in this concentration could be classified as a cathodic inhibitor [29-31]. The value of I_{corr} in absence of inhibitor is much larger than the I_{corr} in presence of inhibitor for all the concentrations which have been studied this implies that the corrosion start point start late or slowly in case the presence of inhibitor due to the increased protected fraction of metal surface through adsorption processes[32-33]. Furthermore each of corrosion rate CR and current density were decreased in presence of inhibitor this indicate that inhibitor has been adsorbed on the metal surface and hence inhibition occurred[34]. As well as, Table 2 showed that the cathodic Tafel slopes bc have been significantly decreased in presence of inhibitor, while anodic Tafel slopes ba have been decreased at higher of concentration only $10^{-1}M$ this further evidence on that the inhibitor is anodic inhibitor which reduces anodic dissolution and consequently reduce overall corrosion reaction [10,35].

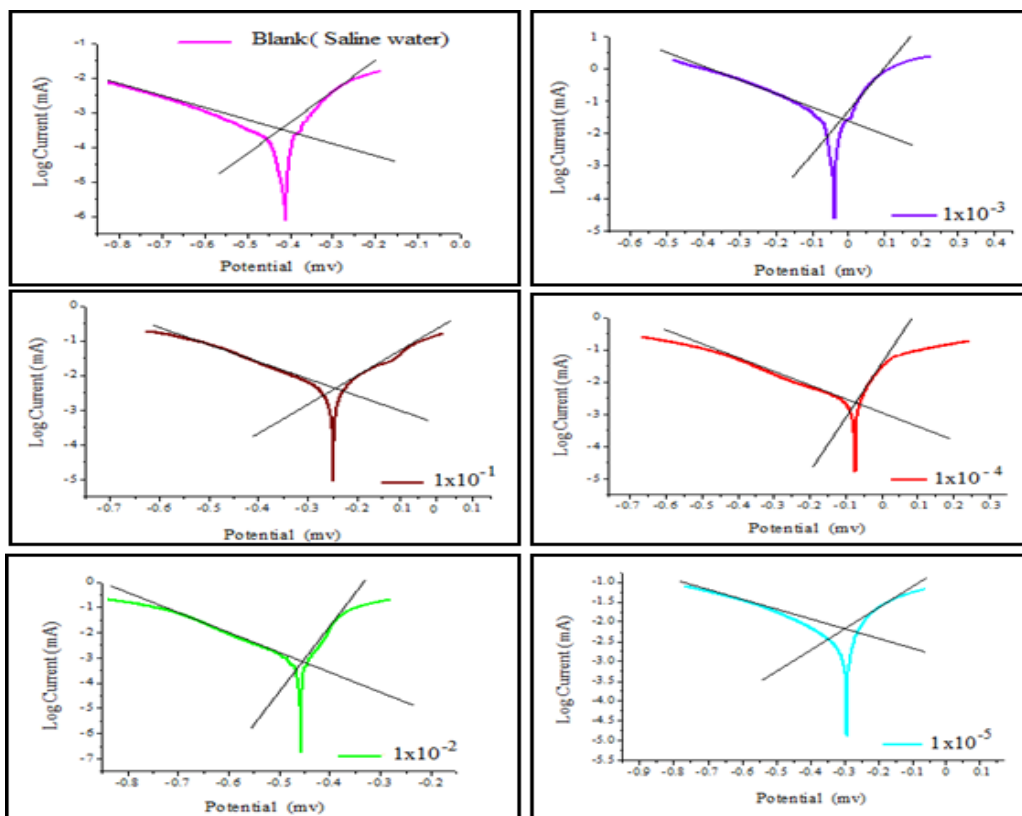


Figure 8: Polarization curves of carbon steel at different concentrations of inhibitor at 298 K.

Table 2: Corrosion parameters of carbon steel at different concentrations of inhibitor at 298K.

Inhibitor concentration (M)	I_{corr} mA.cm ⁻²	E_{corr} mV	R_p ohm	bc mV.dec ⁻¹	ba mV.dec ⁻¹	%IE
Saline water	3.2×10^{-5}	- 0.431	55.54	453	332	-----
1×10^{-5}	1.9×10^{-5}	- 0.301	108.11	119	500	40.62
1×10^{-4}	0.8×10^{-5}	- 0.081	188.81	105	421	75.00
1×10^{-3}	4.2×10^{-6}	- 0.025	210.11	99	391	86.87
1×10^{-2}	3.6×10^{-6}	- 0.461	220.16	80	357	88.75
1×10^{-1}	3.0×10^{-6}	- 0.245	287.19	67	201	90.62

4.3 Electrochemical impedance measurements

To evaluate the effect of inhibitor on the electrochemical corrosion behavior which occurs of carbon steel, the impedance curves have been recorded in the absences and presence of inhibitor at concentrations between 1×10^{-1} M to 1×10^{-5} M as shown in Figure 9. The impedance parameters namely the maximum frequency f_{max} , charge transfer resistance R_{ct} and double layer capacitance C_{dl} have been summarized in Table 3.

Table 3: Shows EIS results of carbon steel in saline water at different concentrations of inhibitor at 298 K.

Inhibitor concentration (M)	R_{ct} (Ω)	C_{dl} ($\mu\text{F}/\text{cm}^2$)	f_{max} (Hz)	Surface Coverage θ	%IE
Saline water	48.84	32.21	101.21	-----	-----
1×10^{-5}	99.62	24.47	65.32	0.5100	51.00
1×10^{-4}	100.62	24.32	65.05	0.5150	51.50
1×10^{-3}	111.50	23.04	61.98	0.5620	56.20
1×10^{-2}	210.11	18.09	41.88	0.7680	76.80
1×10^{-1}	240.33	16.99	38.99	0.7970	79.70

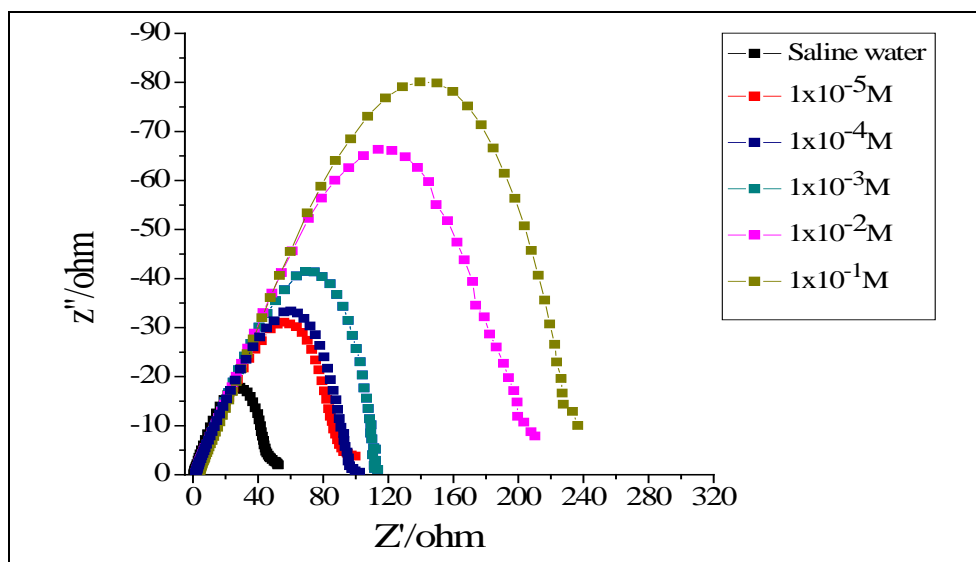


Figure 9: Shows Nyquist plots of carbon steel in saline water at different concentrations of inhibitor at 298 K.

It is clear from changes in impedance parameters that inhibitor has been adsorbed on the carbon steel surface. From the results shown in Table 3 and Figure 9 it can be concluded that charge transfer resistance has been increased from 48.84Ω in saline water (blank) to 240.33Ω in the presence of inhibitor at concentration 10^{-1} M,

while value of double layer capacitance was decreased from $32.21\mu\text{F}/\text{cm}^2$ in case of saline water to $16.99\mu\text{F}/\text{cm}^2$ in presence of inhibitor at concentration 10^{-1}M . The increase in charge transfer resistance values have been ascribed to formation of protective film on the carbon steel surface this in turn goes back to substitution of water molecules by inhibitor molecules [7,14,36], while decrease double layer capacitance value can be attributed to a decrease in local dielectric constant and/or an increase in the thickness of electrical double layer. From the results which previously mentioned that decrease in value of double layer capacitance means a decrease in dielectric constant this leads to increase the power of attraction by Coulomb's law thus increasing the charge transfer resistance and finally the inhibition efficiency increase as shown in Table 3. Furthermore, Nyquist curves are different in diameter capacity of loop as shown in Figure 9 this mean that two types of adsorption have been occurred, if the difference in diameter is large, such behavior may be considered chemical adsorption, while if the little difference in diameter this behavior may be considered physisorption [5,37-38]. The surface coverage and inhibition efficiency increases with increasing concentration of inhibitor and this may be due to the increasing the adsorption processes on surface of carbon steel.

4.4 Scanning Electron Microscopy-Energy Dispersive X-ray Spectroscopy (SEM/EDX).

4.4.1 Scanning Electron Microscopy (SEM).

In order to analysis of surface morphology of carbon steel the scanning electron microscopy has been studied at optimum concentration of inhibition 10^{-1}M . The efficiency of inhibitor is clearly visible through SEM images. Scanning electron microscopy images have been recorded for surface of carbon steel in different situations are, surface morphology of polished carbon steel (**10a**), surface of carbon steel after immersion for 3 hours without inhibitor (**10b**) and surface of carbon steel after immersion for 3 hours with inhibitor presence at concentration 10^{-1}M (**10c**). SEM image for carbon steel surface in absence of inhibitor was showed occurrence of pitting corrosion with unprotected condition for carbon steel surface and noticeable distortions, while surface of carbon steel in presence of inhibitor has been more smoother compare with absence of inhibitor, on the other hand, surface of carbon steel with presence of inhibitor is similar to a large extent for polished carbon steel surface this indicates the occurrence of slight corrosion in event of inhibitor presence.

4.4.2 Energy Dispersive X-ray Spectroscopy (EDX).

The percentage of corroded iron for carbon steel in saline water after that immersion for 3 hours in the absence and presence of inhibitor at 298 K has been determined by using EDX technique, as well as, the percentage of iron in polished carbon steel was measured through EDX technique. X-ray data are the percentage of corroded iron, the percentage of remaining iron, percentage of carbon and percentage of oxygen as shown in Table 4. The EDX spectra have been recorded for each polished carbon steel (**11a**), carbon steel after immersion for 3 hours in absence of inhibitor (saline water **11b**) and carbon steel after immersion for 3 hours with presence of inhibitor at optimum concentration of inhibition (**11c**).

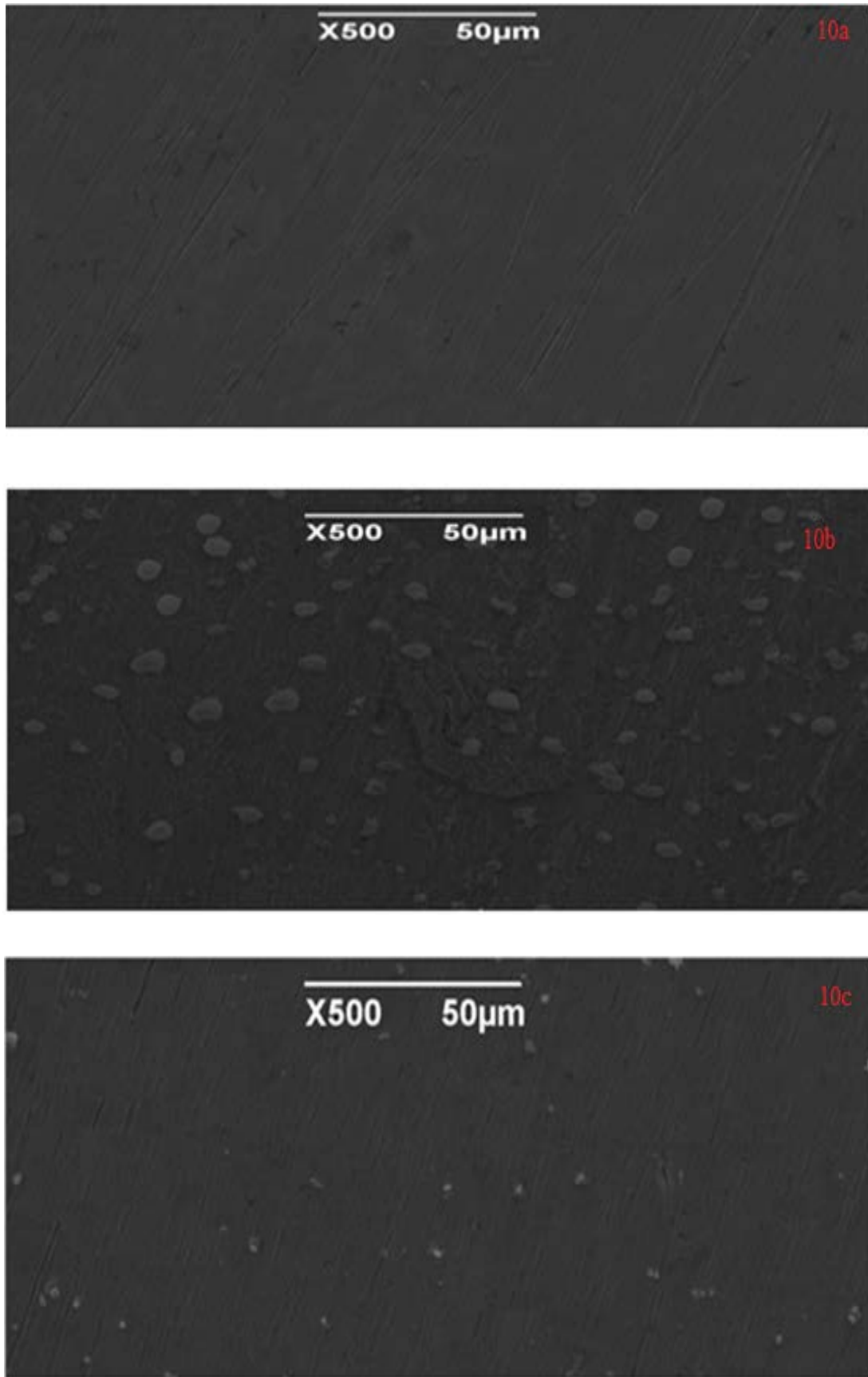


Figure 10: Shows SEM images for each of surface of polished carbon steel **10a** (reference); carbon steel surface in absence of inhibitor **10b** ; and carbon steel surface with presence of inhibitor **10c**.

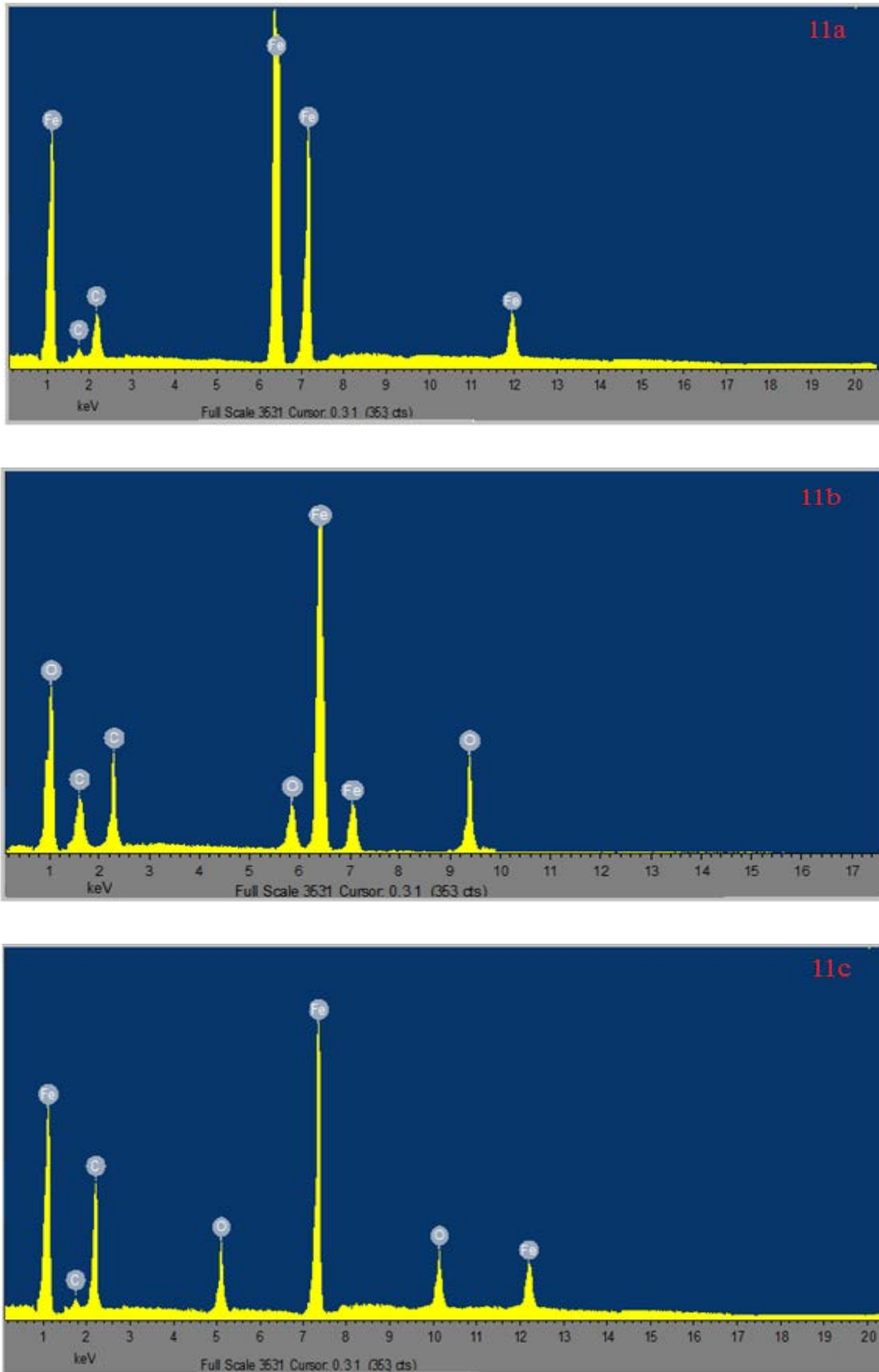


Figure 11: Shows EDX spectra for polished carbon steel **11a**(reference); Carbon steel without inhibitor **11b**; Carbon steel with inhibitor **11c**.

From the data in Table 4 and EDX spectrum in saline water we concluded that the value of both oxygen and carbon are high 22.54% and 11.81% respectively, due to occurrence a significantly corrosion process on the carbon steel and turned of iron to hydroxide then gradually changed to iron oxides[29]. Besides, data in Table 4 and EDX spectrum (11c) showed that oxygen value and carbon in presence of inhibitor have been significantly reduced to 4.92% and 6.03% respectively, while in absence of inhibitor they are high 22.54% and 11.81% respectively, these results means low of content for each of oxygen and carbon in presence of inhibitor, small oxygen percentage (4.92%) has been interacted with Fe to form iron oxides as a corrosion products[10].

In other words slight corrosion has been occurred when using inhibitor, and EDX spectrum with inhibitor is similar approximately for EDX spectrum of polished carbon steel. The percentage of corroded iron are 31.88% and 3.17% in absence and presence of inhibitor respectively where has been noted that the difference in remaining iron is 28.71% thus explains the high of inhibition efficiency % *IE* to reach the high value 90.05%. On the other hand, the percentage of remaining iron are 66.91% and 95.11% in absence and presence of inhibitor respectively this mean that the inhibitor is excellent for inhibiting corrosion process.

Table 4: Shows corrosion parameters of carbon steel in absence and presence of inhibitor through EDX

Elements(%)	Percentage of remaining iron	Percentage of corroded iron	Percentage of carbon	Percentage of oxygen	Inhibition efficiency
Polished carbon steel (references)	98.227	-----	0.20	-----	----
Carbon steel in saline water (Blank)	66.91	31.88	11.81	22.54	-----
Carbon steel in saline water with inhibitor	95.11	3.17	6.03	4.92	90.05

After to proved efficiency of heterocyclic compound as inhibitor for crude oil pipeline corrosion by very efficiently through several techniques, it has been compared with some of the disincentives commercial namely, AS-101, WFT-9368, COIL GARD, HQI-85M and AL-600 through weight loss method according to international standards of America in ASTM. Pipelines samples which are used for comparison have been cut into (7, 2.5, 0.3) cm for length, width and thickness respectively, and used concentrations in this comparison are 0.1%, 0.2% at three-hour time at 25°C. Where became clear from results that corrosion rate of carbon steel in existence prepared inhibitor is less than the rate of corrosion in presence of inhibitors commercial as shown in the Table 5, and percentage of inhibition efficiency in case existence of inhibitor (III) 92.36% and was calculated by the equation 2 previously mentioned.

Table 5: Shows data of comparison between commercial disincentives and prepared inhibitor.

Type of inhibitor	Inhibition efficiency (%IE)	Corrosion rate (3hrs.)	Acceptable corrosion rate (3hrs.)	Corrosion inhibitor dosage%	Specifications acceptance
Saline water (Blank)	-----	67.03	----	-----	-----
HQI-85M	87.30	8.51		0.1	Acceptable
COIL GARD	89.21	7.23		0.2	Acceptable
	88.16	7.93		0.1	Acceptable
AI-600	87.36	8.47		0.2	Acceptable
	86.55	9.01	9.76	0.1	Acceptable
WFT-9368	86.79	8.85		0.2	Acceptable
	86.70	8.91		0.1	Acceptable
AS-101	88.19	7.91		0.2	Acceptable
	72.84	18.20		0.1	Not acceptable
Prepared inhibitor (III)	77.44	15.12		0.2	Not acceptable
	91.73	5.54	-----	0.1	Acceptable
	92.36	5.12		0.2	Acceptable

4. Conclusions

The main conclusions drawn from this study that the heterocyclic compound which containing on hetero atoms N, S and O it is excellent inhibitor, it have been inhibit corrosion processes which occurs on crude oil pipeline. The method of inhibitor preparation (III) does not need to long periods of time and acceptable ecologically and economically. Also infer that inhibition efficiency has been increased with increasing inhibitor concentration, and time increase do not affect on efficiency of inhibitor. The polarization results showed that inhibitor could be classified as anodic type for all concentrations which have been studied, except the concentration $10^{-2}M$ is cathodic type. Adsorption mechanism of inhibitor on the carbon steel surface are processes for chemical adsorption and physical adsorption and which occur tandem.

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