

Corrosion Inhibition Activity of Cefixime on Mild Steel Surface in Aqueous Sulphuric Acid

S. Tanwer, S. Kumar Shukla*

Department of Chemistry, Manav Rachna University, Faridabad-221004, Haryana India.

ARTICLE INFO

Article history:

Received: 28 Aug 2021

Final Revised: 21 Oct 2021

Accepted: 13 Oct 2021

Available online: 25 Dec 2021

Keywords:

Gravimetric analysis

Tafel polarization

EIS technique

Cephalosporin antibiotic

ABSTRACT

Interaction of pharmaceutically active drug Cefixime on mild steel surface in 0.5 M sulphuric acid solution was studied using gravimetric analysis techniques, Polarization techniques, i.e., Polarization resistance, Tafel polarization, and Electrochemical Impedance Spectroscopy (EIS) techniques. It shows more than 96 % corrosion inhibition efficiency at an ambient temperature of 308 °K on a mild steel surface with a 4.0×10^{-4} M inhibitor concentration. Gravimetric studies were also conducted at various temperatures and concentration ranges of the testing solution to justify their range of applicability at different practical conditions. And It is found very much suitable for its workings at the normal temperature and lower acid concentration ranges. Adsorption parameters and thermodynamic parameters were calculated from gravimetric analysis data. These parameters were obtained at different temperatures and concentration ranges and reveal that the inhibitor follows the physical adsorption mechanism. Langmuir's adsorption isotherm governs the adsorption of the cefixime molecule. Inhibition of cefixime on the surface of mild steel is supplemented by atomic force microscopy. The result reveals that the inhibited surface has less roughness than the uninhibited surface. Prog. Color Colorants Coat. 15 (2022), 243-255 © Institute for Color Science and Technology.

1. Introduction

The lower cost of mild steel leads to its applicability as structural metal among all the different types of steel and metals. It is also known as simple carbon steel. It applies to many applications due to its unique features [1]. It is considered a significant challenge due to low resistance towards corrosion in a neutral and acidic environment. Most severe corrosion takes place in the acidic environment of mineral acid [2]. Scientific and industrial communities have been very concerned about the inhibition of corrosion in mild steel [3]. Self-assembled materials are known as high corrosion materials for iron [4]. Various methods are available to mitigate corrosion in different environments [5-10].

When a piece of metal is immersed in the acidic solution to eradicate the unwanted scales is known as

acid pickling. Hydrochloric acid, sulphuric acid, and phosphoric acids are the most commonly used acids in this procedure. The acidic solution assaults the scale, and rust dissolves it in the aqueous acidic solution from the metal surface. The acidic solution then begins damaging the exposed surface of the metal when it dissolves the rust. Certain materials are incorporated into the aqueous acidic solution using for the pickling to retard the dissolution of metal [11]. The most frequently utilized acids in this operation comprise hydrochloric acid and sulphuric acid. Corrosion inhibitors are added to the cleaning solution to inhibit the metal breakdown and acid intake [11]. Inorganic corrosion inhibitors generally used in this practice have mainly phosphate, chromates, and other heavy metals, increasing environmental hazards. These compounds

*Corresponding author: * sudhish.shukla@gmail.com

are either banned or restricted for such uses by various environmental laws and guidelines, particularly in the global economy. The environmental concerns of these compounds are their toxicity and the risks inherent in their disposal [12]. Generally, organic compounds with heteroatoms, polymers are used as corrosion inhibitors. However, among all, very few are the inhibitors that are non-toxic and environmentally sustainable compounds. Along with the plant extracts, many pharmaceutically active compounds also show inhibition efficiency [13]. These compounds are less toxic and can be used after their expiry to avoid their disposal hazards in the environment [14, 15]. Mild steel corrosion avoidance is essential both conceptually and practically [16]. Acids are very commonly used in many industrial applications such as pickling, scraping, and scale & rust removal. In contrast, inhibitor materials are used to inhibit metal dissolution owing to their abrasiveness.

Organic corrosion inhibitors mainly have nitrogen, sulfur, and oxygen-like heteroatoms, which have lone pair of electron adsorb on the metal surface through interaction with vacant d-orbital to inhibit [17-22]. The efficacy of an organic inhibitor is dependent upon its ability to attach to a metal surface. Its stability generally influences the adsorption of inhibitor molecules in the acidic environment, donor capacity, electron density, structural area, and molar mass [23-26]. Many organic compounds exhibit effectiveness towards mild steel surface inhibition [17-22, 27, 28]. However, only a few non-toxic and ecologically favorable materials were identified as inhibitors towards mild steel corrosion. Some of the known eco-friendly, low toxic corrosion inhibitors of the acidic environment are succinic acid, tryptamine, ascorbic acid sulphate drugs, etc. Dithiobiurate compounds are highly effective corrosion inhibitors towards a mild steel surface in an acidic medium, with significantly lower toxicity [29-35].

In the present study, cefixime is taken to evaluate its inhibition activity towards mild steel surface in the sulphuric acid medium. It is a third-generation cephalosporin antibiotic and is used after its expiry date is over. Cefixime has generally been used to treat a wide range of bacterial infections, including the respiratory system, ear, gonorrhoea, urinary tract, etc. Cefixime has chemical formula $C_{16}H_{15}N_5O_7S_2$ and molecular weight 453.4.

2. Experimental

2.1. Inhibitor

Cefixime is procured from the common medicine shop and kept until the expiry date is over. The stock solution of this compound is made with water. This stock solution was used for all the experimental processes by using the dilution method for various concentrations of inhibitors.

2.2. Corrosion measurements

Corrosion measurements were conducted on mild steel surfaces duly cleaned by emery paper of different grades followed by washing and degreasing with deionized water and acetone. A hot air blower is used until the surface is dehydrated. A desiccator keeps all the clean samples for experiments with 0.5 M sulphuric acid solution.

2.3. Gravimetric measurements

10 cm² areas sheet of mild steel were taken for gravimetric analysis in 100 mL test solution with the 0 to an optimum concentration of Cefixime inhibitor. Experimentation was performed at various temperatures, times, and acid concentrations. All the experiments were conducted in triplicate, and average values have been taken into consideration to calculate different parameters. Inhibition efficiency, corrosion rate, surface coverage, and measure of thermodynamic and adsorption parameters were calculated as mentioned in literature [36, 37].

2.4. Electrochemical studies

Potentiodynamic polarization parameters, i.e., polarization resistance and Tafel polarization and Electrochemical impedance spectroscopy (EIS), will be conducted three-electrode assembly with calomel electrode as a reference, platinum as a counter electrode, and metal sample for a test as a working electrode. The active electrode area will be 1 cm². Gamry instrument potentiostat / Galvanostat with Gamry framework system on ESA 400 for all the electrochemical studies and analysis will be done through Echem analyst version 5.50 software packages for data fitting. All the experiments were conducted with the parameters reported in the literature [38, 39].

3. Results and Discussions

3.1. Gravimetric analysis

All the data of weight loss evaluated by the gravimetric analysis were listed in Table 1 along with corrosion inhibition efficiency (η %), corrosion rates (C_r in mmpy), and surface coverage (Θ) at different temperature ranges. Data represented in Table 1 shows that % inhibition efficiency increases as the concentration of the inhibitor increase up to 4.0×10^{-4} M. Table 1 shows that with the variation of temperature from 298 to 338 K, the efficiency decreases. The maximum inhibitor efficiency was discovered to be 96.93 % at 298 K. Mostly at all the temperature ranges, the maximum efficiency was

exhibited at 4.0×10^{-4} M inhibitor concentration. Also, Figure 1 displays the inhibition efficiency with the increase in the concentration of the Cefixime molecules. Figure 2 represents the variation in corrosion rate with varying temperature and inhibitor concentration. It is found that the corrosion rate increases with an increase in the inhibitor concentration and temperature. A decrease in inhibition efficiency and increase in corrosion rate due to a temperature rise suggests that the process of adsorption of the inhibitor molecule on the metal surface is physical. The inhibitive action of the Cefixime molecule is due to its adsorption on the metallic surface with π -electrons and non-bonding electron pairs.

Table1: Gravimetric analysis data of inhibitive action of cefixime on mild steel surface different temperature ranges.

Temperature (K)	Inhibitor concentration (M)	Weight loss (mg cm^{-1})	Inhibition efficiency (η) (%)	Corrosion rate (C_r) (mm/y)	Surface coverage (Θ)
298	Blank	14	-	52.14	-
	0.5×10^{-4}	5.32	62.00	19.81	0.620
	1.0×10^{-4}	4.41	68.50	16.43	0.685
	1.5×10^{-4}	3.17	77.36	11.81	0.773
	2.0×10^{-4}	2.35	83.21	8.75	0.832
	2.5×10^{-4}	1.52	89.14	5.66	0.891
	3.0×10^{-4}	1.09	92.21	4.06	0.922
	3.5×10^{-4}	0.43	96.93	1.60	0.969
	4.0×10^{-4}	0.44	96.86	1.64	0.969
	4.5×10^{-4}	0.43	96.93	1.60	0.969
308	Blank	17.17	-	63.95	-
	0.5×10^{-4}	7.89	54.05	29.39	0.540
	1.0×10^{-4}	6.06	64.71	22.57	0.647
	1.5×10^{-4}	4.2	75.54	15.64	0.755
	2.0×10^{-4}	3.28	80.90	12.22	0.809
	2.5×10^{-4}	2.54	85.21	9.46	0.852
	3.0×10^{-4}	1.59	90.74	5.92	0.907
	3.5×10^{-4}	0.7	95.92	2.61	0.959
	4.0×10^{-4}	0.67	96.10	2.50	0.961
	4.5×10^{-4}	0.67	96.10	2.50	0.961

Table1: Continue.

Temperature (K)	Inhibitor concentration (M)	Weight loss (in mg cm^{-1})	Inhibition efficiency (η) (%)	Corrosion rate (C_p) (mm/y)	Surface coverage (θ)
318	Blank	26.05	-	97.01	-
	0.5×10^{-4}	11.82	54.63	44.02	0.546
	1.0×10^{-4}	10.36	60.23	38.59	0.602
	1.5×10^{-4}	8.83	66.10	32.89	0.661
	2.0×10^{-4}	6.90	73.51	25.70	0.735
	2.5×10^{-4}	4.84	81.42	18.03	0.814
	3.0×10^{-4}	3.30	87.33	12.29	0.873
	3.5×10^{-4}	2.29	91.21	8.53	0.912
	4.0×10^{-4}	2.21	91.52	8.23	0.915
	4.5×10^{-4}	2.21	91.52	8.23	0.915
328	Blank	33.74	-	125.66	-
	0.5×10^{-4}	17.85	47.10	66.48	0.471
	1.0×10^{-4}	15.41	54.33	57.39	0.543
	1.5×10^{-4}	12.97	61.56	48.31	0.616
	2.0×10^{-4}	10.96	67.52	40.82	0.675
	2.5×10^{-4}	9.31	72.41	34.68	0.724
	3.0×10^{-4}	7.04	79.13	26.22	0.791
	3.5×10^{-4}	4.92	85.42	18.32	0.854
	4.0×10^{-4}	4.42	86.90	16.46	0.869
	4.5×10^{-4}	4.41	86.93	16.43	0.869
338	Blank	43.06	-	160.38	-
	0.5×10^{-4}	26.95	37.41	100.38	0.374
	1.0×10^{-4}	24.59	42.89	91.59	0.429
	1.5×10^{-4}	22.16	48.54	82.53	0.485
	2.0×10^{-4}	18.33	57.43	68.27	0.574
	2.5×10^{-4}	15.35	64.35	57.17	0.644
	3.0×10^{-4}	13.60	68.42	50.65	0.684
	3.5×10^{-4}	12.09	71.92	45.03	0.719
	4.0×10^{-4}	12.01	72.11	44.73	0.721
	4.5×10^{-4}	12.02	72.09	44.77	0.721

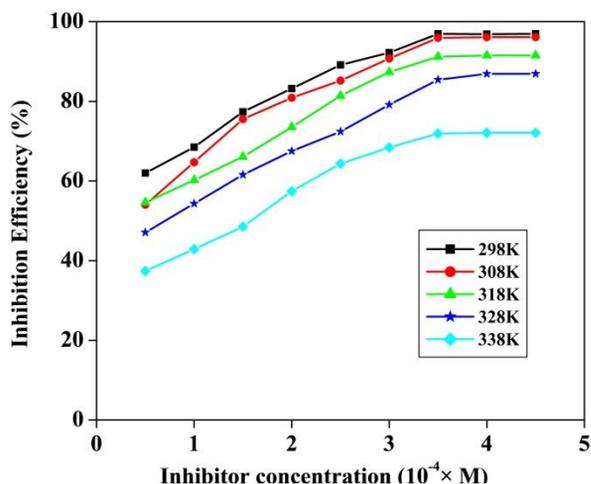


Figure 1: Inhibition concentration vs. Inhibition efficiency graph at the varying temperature of the corrosive media and variable concentration of the cefixime.

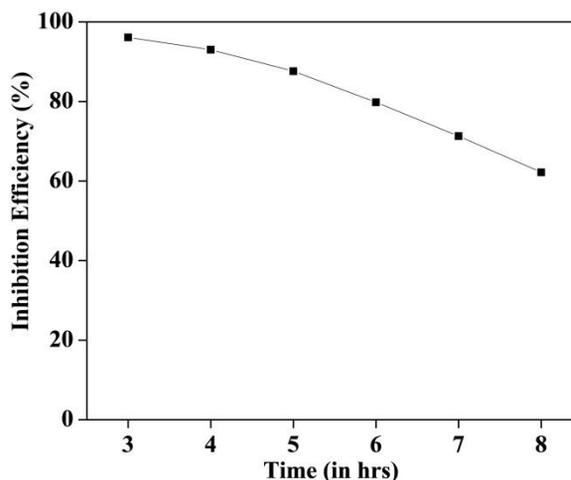


Figure 3: Inhibition efficiency graph at different time intervals at an optimum inhibitor concentration.

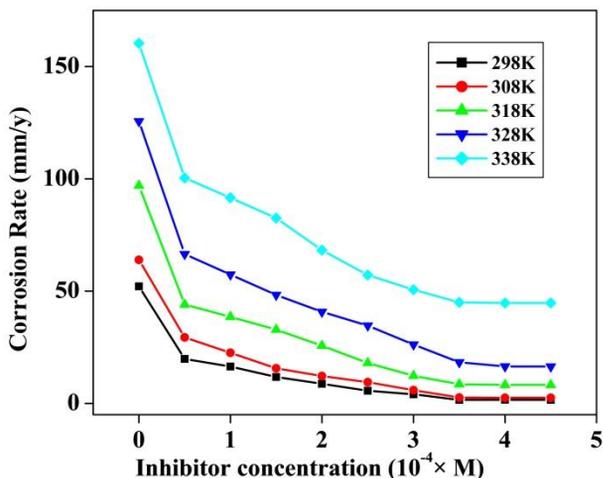


Figure 2: Inhibition concentration vs. corrosion rate graph at the varying temperature of the corrosive media and variable concentration of the Cefixime.

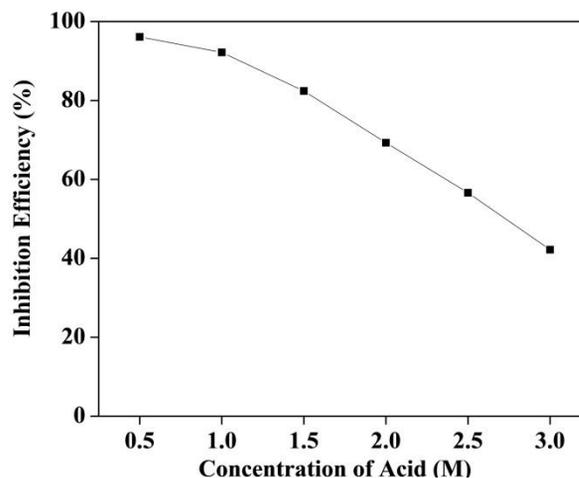


Figure 4: Inhibition efficiency graph at different acid concentration ranges at an optimum inhibitor concentration.

3.2. Effect of immersion time

The effect of immersion time on corrosion inhibition property of mild steel in the presence of inhibitor has been studied. The calculated inhibition efficiency against the time graph has been reported in Figure 3. It is evident from Figure 4 that with the increase in contact time of corrosive environment, inhibition efficiency decreases. This event may be due to the desorption of the inhibitor film formed with the longer exposure in an acidic environment. Such results find when the physical adsorption of the inhibitor predominates on the mild steel surface [21, 22].

3.3. Effect of acid concentration

Weight loss studies were also conducted at various acid concentrations (0.5-3.0 M) at an optimum concentration of the inhibitor, and the results of inhibition efficiency are reported in Figure 4. It is evident from Figure 4 that the sharp decrease in the inhibition efficiency with the increase in acid concentration, due to the dissolution of the inhibitor film in highly acidic media [21, 22].

3.4. The effect of temperature on the adsorption isotherm

Understanding how organo-electrochemical reactions

work via adsorption isotherms is critical. It was evaluated using several isotherms via C_{inh} versus C_{inh}/θ graph [40, 41]. For the experimental data given in this trial, the Langmuir adsorption isotherm was deemed appropriate owing to the most linear depiction of the regression coefficient (R^2). A mild steel plate, as previously stated, has been begun for testing in 0.5 M H_2SO_4 solution with different inhibitor concentrations in conjunction with the steel surface at different temperatures ranging from 298 to 338 K, as shown in Figure 5. Linear regression coefficient and slope are depicted in Figure 5. The R^2 value in Table 2 varies from 0.99822 to 0.99283, which is very close to the unity suggests that the adsorption isotherm followed is the Langmuir adsorption isotherm. Adsorption coefficient was calculated through the intercept of the curve represented in Figure 5, and with the help of Kads value, Gibb's free energy was calculated and reported in Table 3. The Gibb's free energy value at different temperature ranges is between 31.01 and 37.44 $KJ mol^{-1}$, which is within the scope of 20 - 40 KJ

mol^{-1} . It suggests that the adsorption of inhibitor on the metal surface have physical adsorption [42].

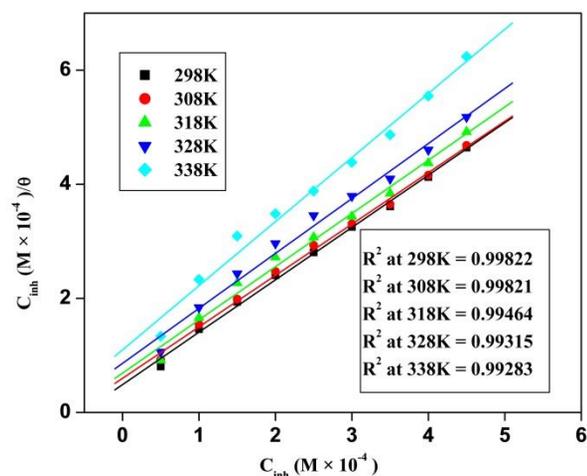


Figure 5: Langmuir's adsorption isotherm at different concentrations of cefixime in 0.5 M Sulphuric acid solution.

Table 2: Adsorption parameter of cefixime on mild steel at different temperature ranges.

Temperature ($^{\circ}K$)	Kads (Mol^{-1})	Slope	R^2	$-\Delta G_{ads}$ ($KJ mol^{-1}$)
298	4.9×10^3	0.91	0.99822	31.01
308	5.9×10^3	0.90	0.99821	32.52
318	6.9×10^3	0.93	0.99464	33.99
328	8.6×10^3	0.96	0.99315	35.66
338	1.1×10^4	1.12	0.99283	37.44

Table 3: Thermodynamic data for different concentration ranges of cefixime on mild steel corrosion in sulphuric acid.

Concentration of inhibitor (M)	E_a ($KJ mol^{-1}$)	λ ($mg cm^{-2}$)	ΔH ($KJ mol^{-1}$)	ΔS ($J mol^{-1} K^{-1}$)
Blank	24.29	9.14×10^5	21.68	-142.25
0.5×10^{-4}	33.67	1.54×10^7	31.05	-116.09
1.0×10^{-4}	36.21	3.43×10^7	33.59	-109.45
1.5×10^{-4}	41.61	2.12×10^8	38.99	-94.31
2.0×10^{-4}	44.10	4.32×10^8	41.48	-88.38
2.5×10^{-4}	49.13	2.21×10^9	46.52	-74.81
3.0×10^{-4}	54.00	1.02×10^{10}	51.39	-62.11
3.5×10^{-4}	71.45	4.51×10^{12}	68.83	-11.42
4.0×10^{-4}	70.32	2.85×10^{12}	67.71	-15.24
4.5×10^{-4}	70.75	3.33×10^{12}	68.14	-13.95

3.5. Activation and thermodynamic parameters

Understanding the inhibitive process of corrosion requires an understanding of the temperature of the solution. Temperature samples were tested at 298 to 338 °K for different doses of cefixime, and inhibition effectiveness and corrosion rate were computed and presented in Table 1. Corrosion rate at varied solution temperatures and inhibitor concentrations are linked with the Arrhenius equation to express the connection of mild steel corrosion rate with acidic media temperature (Eq. 1) [43-46].

$$\log(C_r) = \frac{-E_a}{2.303 RT} + \log \lambda \quad (1)$$

where,

E_a = apparent activation energy,

R = molar gas constant

λ = pre exponential factor.

Figure 6 displays a graph of corrosion rate vs. $1/T$, with the regression coefficient being incredibly near to one. The slope of the curve may be used to calculate activation energy (E_a). The curve's slope is equal to $(-E_a/2.303 R)$. The intercept of the curve is similar to the $\log \lambda$, which helps to calculate the pre-exponential factor (λ). Table 3 shows the calculated values for these two. The activation energy of the inhibitor is higher than that of the uninhibited sample. It increases when the inhibitor concentration increases, implying that the inhibitor adsorption on the mild steel surface is physical. The dramatic rise in activation energy indicates that the inhibitor is less effective as temperature increases towards the mild steel surface in a 0.5 M sulphuric acid medium. According to the Arrhenius equation, the corrosion rate is also influenced by λ raising the value, which lowers the corrosion rate [47].

For the activated complex in transition state equation 2, which is also known as the alternative Arrhenius equation, is used for the calculation of enthalpy of activation (H) and entropy of activation (S) (Eq. 2) [48, 49].

$$C_r = \frac{RT}{Nh} \exp\left(\frac{\Delta S}{R}\right) \exp\left(-\frac{\Delta H}{RT}\right) \quad (2)$$

where,

h = Planck's constant,

N = Avogadro's number,

ΔS = entropy of activation

ΔH = enthalpy of activation.

A straight-line graph of $\log(C_r/T)$ vs. $1/T$ is represented in Figure 7. Enthalpy of activation (ΔH) and entropy of activation (ΔS) is computed from the slope and intercept of the curves and represented in Table 3. According to Table 3, the enthalpy value increases with increasing inhibitor concentration during the inhibition process. It is evident from values listed in table 3 that the enthalpy of the activation is a positive value at all the concentration range of inhibitor indicates that the process of inhibition on mild steel surface is endothermic, and increasing the inhibitor concentration makes metal dissolving harder [50].

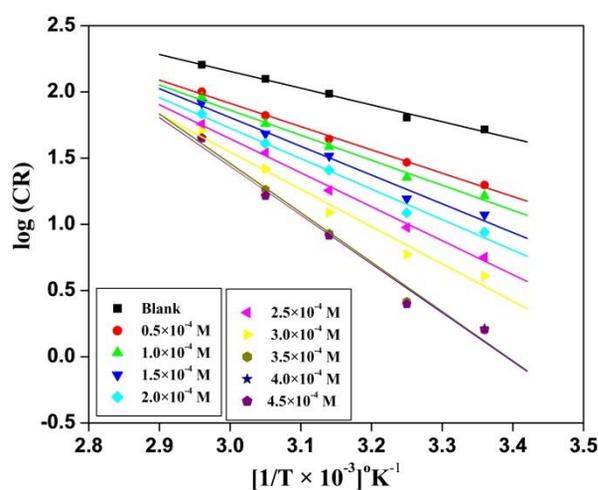


Figure 6: Transition state graph of cefixime at different temperature range for mild steel in 0.5 M H_2SO_4 .

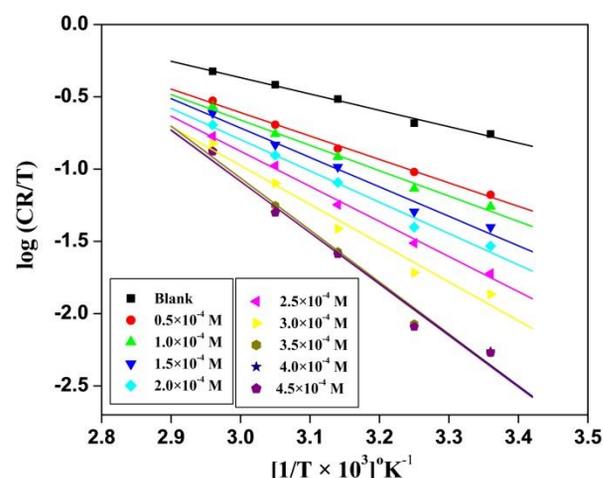


Figure 7: Arrhenius plot: $\log(CR/T)$ versus $1/T$ different concentrations of the cefixime in 0.5 M sulphuric acid solution.

The energy barrier for the reaction contributes towards greater protection efficiency. The entropy of activation (ΔS) increases when inhibitor concentration rises compared to the free acid solution. In the presence of cefixime inhibitor, the entropy of activation increased compared to an acid solution without the inhibitor molecule. This variance is related to the ordering and disordering of phenomena of inhibitor molecule phenomena on the mild steel surface. In the presence of the inhibitor molecule, the activation entropy is higher, leading to the increase in disorders of the activated complex during the transition state. As a result, the inhibition efficiency will improve.

3.6. Linear polarization

Data on linear polarisation are calculated and reported in Table 4. Polarization resistance rises as inhibitor concentration increases, resulting in increased inhibition effectiveness of the inhibitor employed in the study. The maximum inhibition efficiency was about 94.3 %, consistent with the inhibition efficiency observed in weight loss trials.

3.7. Tafel polarization

Polarization measurements have been conducted and reported in Figure 8. Figure 8 illustrates the impact of cefixime concentrations on the anodic and cathodic polarization of mild steel in 0.5 M H_2SO_4 . Electrochemical characteristics of plots, including the density of corrosion current (I_{corr}), the potential for corrosion (E_{corr}), anodic slopes (b_a and b_c), resistance to polarisation (R_p), and inhibitor performance (IE %) displayed in Table 4 [51]. The addition of cefixime to the 0.5 M H_2SO_4 solutions inhibits both anodic metal dissolution and cathode hydrogen development, as

shown in Table 4. As per Table 4, when the quantity of cefixime was raised, the inhibition efficiency increased. Without significantly improving the potential for corrosion, the inhibitor resulted in a reduced I_{corr} corrosion current density, suggesting a mixed form inhibitor [52]. Without an inhibitor, the ability of mild steel became involved and changed to 455 mV (SCE) as a more negative value owing to the breakdown of an air-molded oxide coating, as shown in Figure 8. The potential moved to the positive side when an inhibitor was added to the solution. It is evident from the results that the due to increasing in Cefixime corrosion current decreases. The decrease in corrosion current is due to inhibition in the reaction of metal with acid due to the formation of protective oxide-and-cefixime films. This leads to forming a barrier between the metal and acid solution, which protects the metal with the increase in inhibitor concentration.

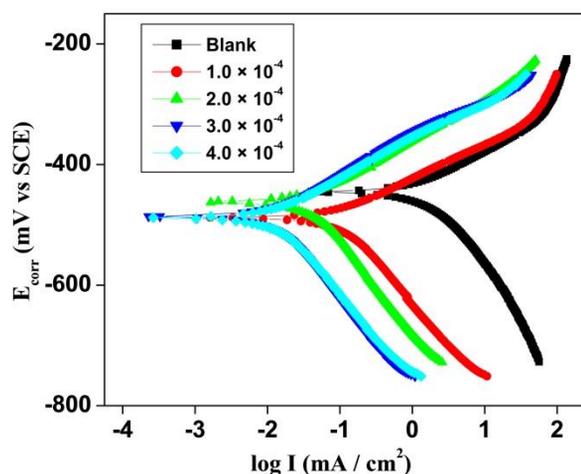


Figure 8: Tafel polarization curve of mild steel corrosion in absence and presence of different concentrations of cefixime at mild steel surface in 0.5 M sulphuric acid medium.

Table 4: Tafel and linear polarization data of mild steel corrosion in sulphuric acid with various concentrations of the cefixime.

Inhibitor Conc. (in M)	Tafel Polarization					Linear Polarization	
	$-E_{corr}$ (mV vs SCE)	b_a (mV dec ⁻¹)	b_c (mV dec ⁻¹)	I_{corr} ($\mu A cm^{-2}$)	IE (%)	R_p (Ωcm_2)	IE (%)
Blank	455	69	143	1275	-	55.3	-
1.0×10^{-4}	454	73	149	421	66.9	175.5	68.49
2.0×10^{-4}	461	71	153	244	80.8	278.9	80.17
3.0×10^{-4}	459	74	141	145	88.6	474.4	88.3
4.0×10^{-4}	462	76	145	75	94.1	978.5	94.3

3.8. Electrochemical impedance spectroscopy techniques

Corrosion inhibition activity has also been examined by electrochemical impedance spectroscopy with cefixime and without it in sulphuric acid medium. Then, the analyzed data is compared, and the Nyquist plot of the impedance spectra is reported in Figure 9. It is evident from the examination of Figure 7 that the obtained spectra have depressed semicircles resembling a depressed capacitive ring. These characteristics, which can be worsened by surface ruggedness, dislocations at the active site, or adsorption by the inhibitor molecules depicted in Figure 9, result in a single high-frequency semicircle that can be transmitted via the loading phase of corrosion and surface heterogeneity. An equivalent circuit was used at a constant phase angle to illustrate the impedance data of the iron/acid contact concept [53]. The relevant circuit parameters (R_s , R_p , Y_o , and n) for electrochemical impedance have been determined and given in Table 5.

The adsorption action of the inhibitor is comparable to the impedance distribution on the metal surface. Polarization resistance R_p is caused by the adsorption of pharmacological inhibitor molecules, and it rises with the quantity of adsorbed molecules. Furthermore, the deposited inhibitor layer decreases capacitance at the metal-solution interface by lowering the dielectric constant between metal and electrolyte and increasing metal thickness [54–56].

3.9. Surface study: AFM study

The atomic force microscopy method was used to determine the surface morphology of untreated mild steel surface and mild steel. The surfaces were exposed in 0.5 M H_2SO_4 in the absence of cefixime and presence of 4.0×10^{-4} M concentration of cefixime, as

illustrated in Figure 10 a-c. The surface roughness of untreated, uncontrolled, and inhibited mild steel surfaces is 51, 590, and 142 nm, respectively. The reduction in surface roughness demonstrates the efficacy of the cefixime.

3.10. Mechanism of inhibition:

Generally, corrosion occurs by the acidic media by the interaction of the acid with the iron molecule on the surface, and the electron-rich part of the acid reacts with electropositive metal and salt, which dissolves in the medium. When the inhibitor molecule comes into the close interaction of the metal surface, it adsorbed on the surface of the metal from its lone pair of electron and π electron cloud of the unsaturated part of the inhibitor. It avoids the contact of the acidic molecule from the metal surface by making a uniform film onto the surface. The schematic representation is shown in Figure 11 [10, 18-21].

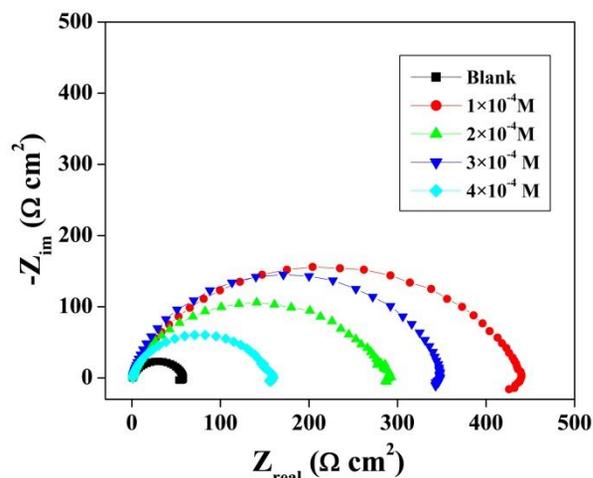


Figure 9: Nyquist plot of the EIS curve of mild steel corrosion with different concentrations of cefixime in 0.5 M sulphuric acid medium.

Table 5: Electrochemical impedance parameters at different concentrations of cefixime in 0.5 M H_2SO_4 .

Inhibitor concentration (ppm)	R_s ($\Omega \text{ cm}^2$)	R_p ($\Omega \text{ cm}^2$)	Y_o ($\mu\text{F cm}^{-2}$)	n	C_{dl} ($\mu\text{F cm}^{-2}$)	IE (%)
Blank	1.13	53.3	1181.5	0.858	55	-
1.0×10^{-4}	1.09	165.5	201.8	0.834	47	67.8
2.0×10^{-4}	1.11	294.4	109.5	0.821	39	81.9
3.0×10^{-4}	1.08	352.2	84.4	0.815	35	84.9
4.0×10^{-4}	1.01	445.9	73.5	0.811	32	88.0

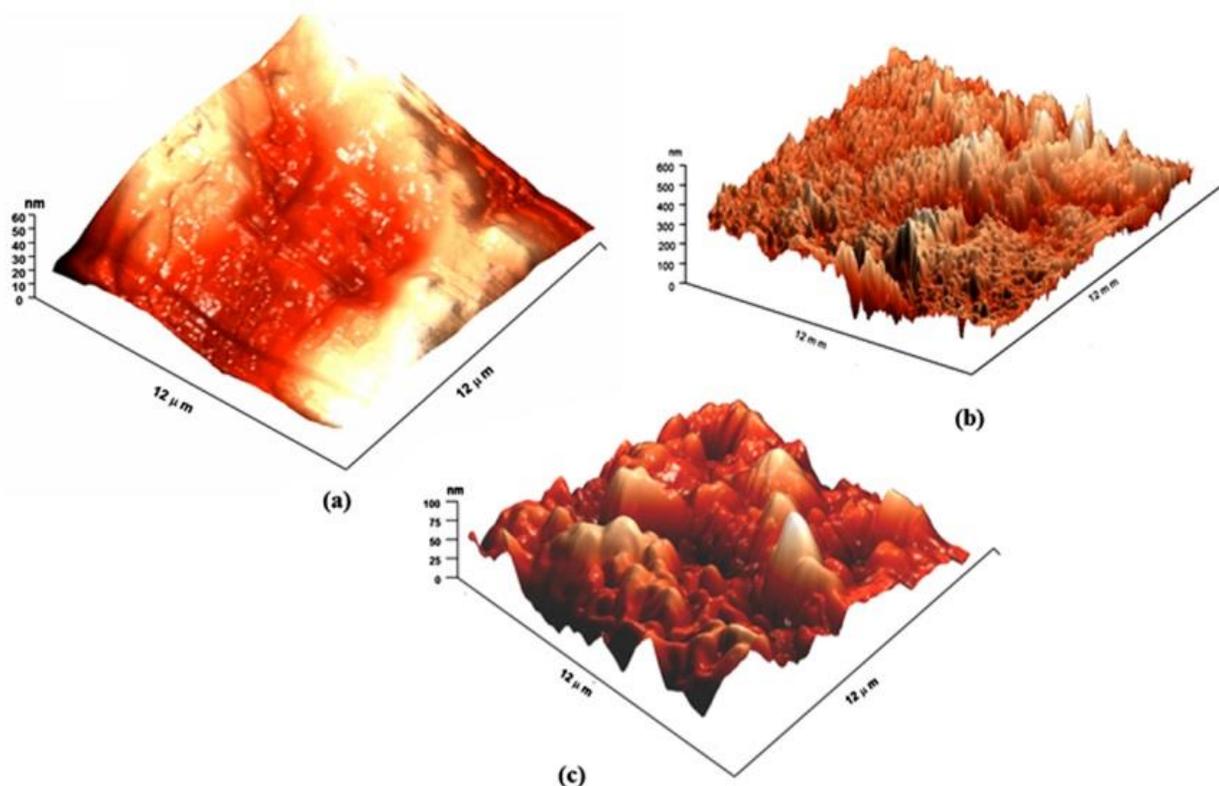


Figure 10: AFM representation of (a) unexposed polished mild steel surface, (b) mild steel surface exposed in 0.5 M sulphuric acid, and (c) surface exposed in 0.5 M sulphuric acid with 4.0×10^{-4} M concentration of Cefixime inhibitor.

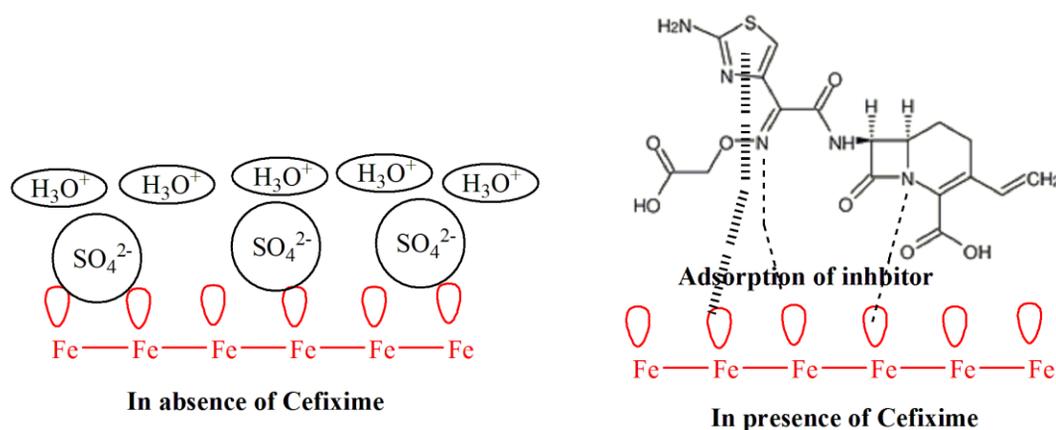


Figure 11: Schematic representation of adsorption of the inhibitor molecule.

4. Conclusion

Cefixime is a pharmaceutically active compound, and its expired form also exhibits more than 96 % of inhibition efficiency at 4.0×10^{-4} M concentration towards mild steel surface in 0.5 M sulphuric acid. With the increase in solution temperature, the inhibitor's effectiveness decreases, indicating a suitable inhibitor at lower temperatures. Cefixime lowers the inhibition efficiency with the rise in the acid concentration and on longer time exposure, which can deduce that cefixime is a suitable

corrosion inhibitor for lower temperature concentrations in a mild corrosive environment and shorter exposure duration. Electrochemical investigations revealed that it is adsorption of the inhibitor from the monolayer on the metal surface and shows mixed-type inhibition reaction, i.e., inhibition of both cathodic and anodic reaction. Adsorption of Cefixime on the surface of mild steel obeys Langmuir adsorption isotherm. Thermodynamic and adsorption parameters indicated that the interaction of inhibitor on mild steel surface is adsorbed physically.

5. References

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How to cite this article:

S. Tanwer, S. Kumar Shukla, Corrosion Inhibition Activity of Cefixime on Mild Steel Surface in Aqueous Sulphuric Acid. *Prog. Color Colorants Coat.*, 15 (2022), 243-255.

