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Drugs as Corrosion Inhibitors: A Review

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Abstract: ***The inhibiting effect of drugs towards the corrosion of different metals and alloys has been reviewed in this paper. Results of Weight loss method, Potentiodynamic polarization and Electrochemical impedance spectroscopy were investigated. Kinetic and thermodynamic parameters provide valuable information about the mechanism of corrosion inhibition. Different classes of drugs, having hetero-atoms or aromatic ring in their molecular structures were reported in this article.***

Keywords: Drugs, corrosion, adsorption isotherms, medium, alloys

1. Introduction

Corrosion is the deterioration of metal by chemical attack or reaction with its environment. It is a constant and continuous problem, often difficult to eliminate completely. Prevention would be more practical and achievable than complete elimination. Corrosion processes develop fast after disruption of the protective barrier and are accompanied by a number of reactions that change the composition and properties of both the metal surface and the local environment, for example, formation of oxides, and diffusion of metal cations into the coating matrix, local pH changes, and electrochemical potential. The use of inhibitors is one of the best options of protecting metals and alloys against corrosion. Several inhibitors in use are either synthesized from cheap raw material or chosen from compounds having hetero atoms in their aromatic or long-chain carbon system. However, most of these inhibitors are toxic to the environment containing heavy metals. This has prompted the search for green corrosion inhibitors [1]. A number of heterocyclic compounds containing N, O and S either in the aromatic or long chain carbon system have been reported to be effective inhibitors [2-5]. These inhibitors have extended π -electron systems and functional groups (such as -C=C-, -OR, -OH, $-NR_2$, $-NH_2$ and –SR). The functional groups provide electrons that facilitate the adsorption of the inhibitor on the metal surface [6-11]. Most of organic inhibitors are expensive, toxic and have negative effect on the environment this properties restrict its use to inhibit the metal corrosion. Thus it is important and necessary to develop low cost and environmentally safe corrosion inhibitors [12- 13]. In the recent years drugs has been used as corrosion inhibitors. According to Eddy and Odoemelam, the use of drugs for the inhibition of the corrosion of metals has some advantages over the use of some organic/inorganic inhibitors because of their eco-environmental nature [14]. Drugs are nontoxic, cheap, negligible negative effects on environment, so it suggested replacing the traditional toxic corrosion inhibitors [15]. Many authors generally agree that drugs are inhibitors that can compete favorably with green corrosion inhibitors and that most drugs can be synthesized from natural products. The choice of some drugs used as corrosion inhibitors is based on the following: (a) drug molecules contain oxygen, nitrogen and sulphur as active centers, (b) drugs are reportedly environmentally friendly and important in biological reactions and (c) drugs can be easily produced and purified [16-20]. Research efforts have been done recently on the use of antibacterial drugs as corrosion inhibitors for carbon steel and aluminum in acidic and alkaline media [21-23]. GokhanGece (2011) review from literatures the use of many types of drugs as corrosion inhibitors of various metals [24]. Some drugs (such as ampicillin, ampiclox, cloxacillin, tetracycline, methocarbamol, orphenadrine, penicillin G, azithromycin, etc) have been found to be good inhibitors for the corrosion of metals [25]. The inhibitive effect of four antibacterial drugs, namely Ampicillin, Cloxacillin, Flucloxacillin and Amoxicillin towards the corrosion of aluminum was investigated [26]. Cephalosporins are among the oldest and most frequently prescribed naturally occurring antimicrobial agents, among these cephalosporins, only for the present, cefatrexyl, cefazolin and cefalexin are used as corrosion inhibitors of iron in acidic media [28-29]. The use of expired drugs as corrosion inhibitors can be traced back to 2009"s by R. S. Abdel Hameed, where expired ranitidi ne was used as corrosion inhibitors for Al in HCl corrosive medium [60-61]. The inhibition action of these drugs was attributed to blocking the surface via formation of insoluble complexes on the metal surface. The corrosion inhibitions of various drugs were studied by weight loss technique, potentiodynamic polarization measurements,electrochemical frequency modulation (EFM), electrochemical impedance spectroscopy (EIS), and linear polarization resistance. Kinetic parameters (activation energy, pre-exponential factor) as well as thermodynamic parameters (enthalpy, entropy, free energy of adsorption) were also calculated for some drugs. Some quantum chemical parameters and the Mulliken charge densities for omeprazole were calculated by the semi-empirical AM1method to provide further insight into the mechanism of inhibition of the corrosion process. Quantum chemical approach was also used to calculate some electronic properties of the molecule in neutral and protonated form in order to find any correlation between the inhibition effect and molecular structure of fluconazole molecule. Quantum chemical studies showed that in adsorption process of fluconazole molecules, nitrogen and oxygen atoms, and benzene ring act as active centres. Thermometric and Gasometric measurements were carried out to find out the reaction number, inhibition efficiency, and degree of surface coverage. Theoretical calculations investigate by studying the relationship between molecular structure and inhibition efficiency by using semi-empirical molecular quantum calculations within the PM3 method as implemented in HyperChem package. Drugs are effectively

used as corrosion inhibitors for mild steel, copper, aluminum, iron and zinc in different acidic and alkaline media in various concentrations.

2. Literature Survey

N.O.Eddy et.al (2008) studied inhibition efficiency of Penicillin V Potassium in acidic medium. With the increase in the concentration of drug, rate of corrosion decreases of mild steel in H_2SO_4 .Adsorption characteristics of the inhibitor has also been studied and found to be spontaneous and consistent with the mechanism of physical adsorption. S.K.Shukla et al. (2009) reported corrosion inhibition of Streptomycin against mild steel in 1.0 M HCl. Result obtained from tafel polarization, electrochemical impedance spectroscopy revealed that inhibition occurs through adsorption of the drug on the metal surface without modifying the mechanism of corrosion process. In an another interesting work of I.Naqvi et al. (2011) Cefixime is the choice of drug used against mild steel in 1.0 M HCl solution. Kinetic as well as thermodynamic parameters were calculated. The adsorption of Cefixime takes place according to Langmuir‟s adsorption isotherms. R.S.Abdel Hameed (2011) has investigated corrosion inhibition activity of expired Rantidine in 1.0 M HCl using different techniques. Results obtained from polarization and electrochemical impedance spectroscopy is in good agreement with each other. In another publication of S.U.Ofoegbu et al. (2012) Chloroquine diphosphate is used against mild steel in 0.1M HCl solution using weight loss techniques. A.S.Fouda et al.(2013) reported that the Septazole acts as a mixed inhibitor in 0.1 M HCl at different concentration .The adsorption of Septazole on the surface of copper followed by Langmuir‟s adsorption isotherms at all concentration and temperature were studied .In another publication of same author (2014) Streptoquin and Septazole were studied as corrosion inhibitors in 0.1 M HCl solution. These drugs act as a mixed type inhibitor suppressing the corrosion reaction by forming a protective adsorption film on copper surface. Abdulrasoul salih mahdi in 2014 studied on the inhibition effect of Amoxicillin on corrosion concrete reinforced steel samples immersed in alkaline solution consisting of 2% KOH and 3% NaCl which is a simulation to the chloride contaminated concrete pore solution using potentiodynamic polarization technique. Inhibition efficiency of various antibiotics drugs in 0.1N, 0.01N & 0.001N (HCl H_2SO_4 HNO_3) acidic medium has been reported by Suraj.B.Ade et al. (2014). Weight loss technique has been employed for the study corrosion of mild steel in various acidic medium. The work of I.A.Akpan et al.2014 was focused on the antihypertensive drug Amlodipine which significantly increases the resistance of mild steel against corrosion in 0.1 M solution. The adsorption mode of the drug was found to be monolayer chemisorption obeyed Langmuir‟s adsorption isotherms. In another publication of same author (2015) Amidoquine is the choice of drug. Similar results were obtained as mentioned as above. Expired Phenytoin sodium drug is a mixed type of corrosion inhibitor. Thermodynamic parameters revealed that drug decreases corrosion rate (Hussain I.Al-Shafey 2014). Tenormin was investigated as corrosion inhibitor for stainless steel in 2.0 M HCl solution. Potentiodynamic polarization & electrochemical impedance spectroscopy were used to study corrosion efficiency (A.S.Fouda et al 2015). S.karthikeyan et al. (2015) reported corrosion inhibition activity of Vancomycin in 1.0 M H_2SO_4 medium. Polarization studies revealed that inhibitor acted as cathodic inhibitor and follows Langmuir‟s adsorption isotherms.

Table 1: List of drugs used as corrosion inhibitors in different media

S.No	Metal/alloy	Medium	Inhibitor (drug)	Class of drug	Author/Year
1.	Mild steel	1M,1.5M,2M,2.5M H_2SO_4acid solution	PenicillinV potassium	Antibiotic drug[34]	N.O. Eddy et al.2008
2.	Mild steel	1M HCl acid solution	Streptomycin	Antibiotic drug[59]	S.K.Shukla et al. 2009
3.	Aluminium	0.1M HCl acid solution	Fluconazole &Clotrimazole	Antifungal drug[62]	I.B.Obot et al.2009
4.	Mild steel	1M HCl acid solution	Cefixime	Antibiotic drug	Imran Naqv et al. 2011
5.	Carbon steel	1 mol L^{-1} HCl acid solution	Sulfathiazole	Antibacterial drug[66]	A. Samide et al.2011
6.	Aluminum 6063	2M sodium hydroxide solution	Omeprazole	Anti-inflammatory drug[35]	Haider A. Abood 2011
7.	Mild steel	1M HCl acid solution	Cefacetrile	Antibiotic drug	Ashish Kumar Singh et al.2011
8.	Mild steel	1M HCl acid solution	Rantidine	Histamine-2 blocker agent[60]	R.S.Abdel Hameed et al. 2011
9.	Mild steel	1 M HCl solution	Tinidazole	Antiprotozoal & Antibacterial agent[63]	I.Reza et al 2011
10.	Mild steel	0.1M HCl acid solution	Chloroquine diphosphate	Anti-malarial	S. U. Ofoegbu et al. 2012
11.	Carbon steel	0.5M H_2SO_4 acid solution	Cefazolin & Cefotaxime	Antibacterial drug[57]	A.A.Nazeer et al. 2012
12.	Carbon steel	0.1mol L^{-1} H_2SO_4 acid solution & 0.25 mol L^{-1} acetic acid+ 0.25 mol L^{-1} sodium acetate buffer solution	Paracetamol & Carbamazepine	Analgesic-Antipyretic &anticonvulsant drug[61] respectively	N.Vaszilcsin et al.2012
13.	Copper	0.1M HCl acid solutions	Septazole	Antibacterial drug	A. S. Fouda et al 2013
14.	Mild steel	1M HCl acid solution	Diclofenac sodium	Anti-inflammatory& Analgesic	K.R. Ansari et al.2013
15.	Carbon steel	1M H_2SO_4acid solution	Lornoxicam& Tenoxicam	NSAID	A. S. Fouda et al 2013
16.	Mild steel	1M HCl acid solution	Trazodone	Anti-depressant drug	S.Mani megalai et al.2013
17.	Mid steel	1M HCl acid solution	Meclizine	Antihistamine drug[65]	J.Ishwara Bhat et al. 2013
18	Copper	0.1M HCl acid solution solutions	Streptoquin and Septazole	Antibiotic drug	A. S. Fouda et al.2014
19.	Mild steel	0.1M HCl acid solutions	Amlodipine	Anti-hypertensive drug	I. A. Akpan et al.2014
20.	Steel	Alkaline solution consisting of 2%KOH& 2%NaCl which is a simulation to chloride concrete pore	Amoxicillin	Anti-bacterial drug	Abdulrasoul Salih Mahdi 2014

		solution			
21.	Mild steel	(0.1N,0.01N,0.001N) HCl, HNO_3, H_2SO_4	Dicloxacillin Cefuroxime Cefadroxil Cefixime Amoxicillin	Antibiotic drug	Suraj B. Ade et al. 2014
22.	Mild steel	(0.1N,0.01N,0.001N) HCl, HNO_3, H_2SO_4	Isoconazole Itraconazole Clotrimazole Fluconazole Ketoconazole	Anti-fungal drug	Suraj B. Ade et al. 2014
23.	Mild steel	0.5M H_2SO_4acid solution	Aspirin	Analgesic[42]	R. Kushwah et al.2014
24.	Carbon steel	1N H_2SO_4acid solution	Cefixime	Antibiotic drug	A. S. Fouda et al.2014
25.	Mild steel	0.1M HCl acid solution	Cephalexin	Antibiotic drug	I. A. Akpan et al.2014
26.	Mild steel	0.1M HCl acid solutions	Sulphadoxine& Pyrimethamine	Anti-malarial drug	I. A. Akpan et al.2014
27.	Carbon Steel	1M HCl acid solution	Phenytoin Sodium	Anti-convulsant drug[67]	Hussin I. Al-Shafey et al 2014
28.	Mild steel	1M H_2SO_4acid solution	Vancomycin	Antibacterial drug	S. Karthikeyan et al. 2015
29.	304 Stainless steel	2M HCl acid solution	Tenormin	Cardio-vascular drug	A. S. Fouda et al 2015
30.	Steel	1M HCl acid solution	Fluconazole	Anti-fungal drug	P. Malekmohammadi Nouri et al. 2015
31.	Zinc	2M HCl acid solution	Guaifenesin	Expectorant	Hadeel Adil 2015
32.	Mild steel	0.1M HCl acid solution	Amodiaquine	Anti-malarial &Anti-inflammatory drug	I. A. Akpan et al 2015
33.	Mild steel	1M HCl & 1M H_2SO_4 acid solution	Ambroxol	Expectorant[58]	P.Geethamani et al 2015
34.	Carbon steel	1 M HCl acid solution	Acetazolamide	Diuretic[64]	A.S.Fouda et al. 2015

3. Proposed Methodology

Different methods have been used to determine the inhibition efficiency of different drugs by Weight loss technique [36-44,25,22-23] [30-32] Potentiodynamic polarization measurements [47-48] [25,23] [39,22] [36,32,30,15] Electrochemical frequency modulation [EFM] [47-48] [25,32], Electrochemical impedance spectroscopy [EIS] [47-48] [25,23] [39,22] [36,32,30], linear polarization resistance [45-46] [41,39,22,33].

3.1 Weight Loss Measurements

Weight of metal wire pieces before and after dipping in corrosion solution, loss in weight, % loss weight was calculated by usual method. The % inhibition efficiency was calculated by using following formula.

$$I.E = \frac{Wu - Wi}{Wu} \times 100$$

Where, I.E = Inhibition efficiency
Wi = Loss is weight in inhibitor solution,
Wu = Weight loss in control solution

Table 2: For the various pharmaceutical drugs the values of corrosion potential (E_{corr}), corrosion current densities (I_{corr}), anodic Tafel slope (β_a), cathodic Tafel slope (β_c),inhibition efficiency (IE%), charge transfer resistance(R_{ct}) and double layer capacitance (C_{dl}) were calculated-

Drug	Inhibitor Conc.	$-E_{corr}$ [mV vs SCE]	I_{corr} [A cm^{-2}]	β_a [mV dec^{-1}]	β_c [mV dec^{-1}]	IE [%]	R_{ct} [Ω cm^2]	C_{dl} [F cm^{-2}]	IE [%]
Septazole	blank	94	284.10µ	351	670	---	172.7	2640 µ	---
	900 ppm	212	43.18 µ	233	501	84.8	980.7	1542 µ	82.4
Streptoquin and Septazole	blank	144	284.10µ	351	670	--	---	---	--
	900 ppm	212	47.93 µ	233	501	83.1	---	---	---
	900ppm	197	24.66 µ	225	566	91.3	---	---	---
Tenormin	blank	372	598m	64	135	---	62.4	$22.99x10^{-5}$ µ	---
	300ppm	375	149m	39	110	75.1	1147.0	$12.97x10^{-5}$µ	94.6
Lornoxicam	blank	458	99.1x 10^{-4} m	348	479	---	4.99	$20.19x10^{-2}$	---
	50ppm	482	$2.61x10^{-4}$ m	275	188	97.3	171.9	$.59x10^{-2}$	97.1
Tenoxicam	50ppm	456	$6.67x10^{-4}$ m	306	236	93.3	23.40	$4.33x10^{-2}$	78.7
Cefacetrile	blank	469	730 µ	73	127	---	17.3	1006 µ	---
	100ppm	460	49.7 µ	65	193	93.7	371.2	73 µ	95.3
Cefixime	blank	487	896.1 µ	180	221	---	---	---	---
	600ppm	460	118.2 µ	134	177	86.8	---	---	---
Diclofenac sodium	blank	444	892µ	61	-81	-	13.56	137.95 µ	---
	100mg/L	505	25.5µ	69.1	-138.2	97.1	321.6	15.3 µ	98.0
Cefixime	blank	472	1370 µ	93.5	101.2	---	16.8	646 µ	---
	$8.8Mx10^{-4}$	495	114 µ	96.3	108.1	91.6	208.5	96 µ	91.8
Vancomycin	blank	390.18	545.14µ	82.5	132.0	---	---	---	---
	$75Mx10^{-4}$	314.42	16.35 µ	51.6	82.0	97	---	---	---

3.2 Electrochemical studies

Polarization experiments were carried out in a conventional three electrode cell-counter electrode, reference electrode & working electrode. By changing the electrode potential around the open circuit potential, potentiodynamic potential polarization curves were conducted. From tafel plot corrosion parameters such as $E_{corr,}$ I_{corr}, β_a and β_c were recorded.

3.3 Electrochemical frequency modulation

Impedance measurements were carried out in frequency range from 100 kHz to 0.1Hz with amplitude of 5 mV peak to peak using Ac signals at open circuit potential. The experimental impedance was analyzed and interpreted based on the equivalent circuit. The main parameters deduced from the analysis of Nyquist diagram are the charge transfer resistance R_{ct} (diameter of high-frequency loop) and the double layer capacity C_{dl}.

The charge transfer resistance (R_{ct}) values were calculated (table 2) from the difference in the Nyquist plots at low and high frequencies. Therefore, the inhibition efficiency, (IE %) and the degree of surface coverage (θ) can be calculated from the charge- transfer resistance according to Eq. (1) [52]

$$IE\% = \theta \times 100 = [R_{ct} - R_{ct}^{\circ}]/R_{ct} \times 100 \quad (1)$$

Where,

R_{ct}° = The charge-transfer resistances for uninhibited solution.

R_{ct} = The charge-transfer resistances for inhibited solution.

The double layer capacitance values (C_{dl}) was calculated using equation (2) [57]

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

Where,

f_{max} = The frequency at the maximum in the Nyquist plot.

R_{ct} = the values of charge transfer resistance.

C_{dl} = double layer capacitance obtained from the Nyquist plots and the calculated inhibition efficiency values

4. Results and Discussion

4.1 Weight Loss Measurements

Corrosion rate and inhibition efficiency of reported drugs (table1) in different concentration and in different media were studied. Result obtained through weight loss technique reveals that that corrosion rate values decrease as the concentration of inhibitor increases. Consequently, percent inhibition efficiency values increase with the increase in the concentration. This behavior could be attributed to the strong interaction of compound with the metal surface that results in the adsorption of inhibitor molecules [27].

4.2 Electrochemical Studies

It is clear from the potentiodynamic results reported in (table2) that the presence of drug, in different media, decreases the corrosion rate. The decrease in I_{corr} value is due to the adsorption of the inhibitor molecules. The values of β_a and β_c changed slightly with increasing inhibitor concentration indicated the influence of these compounds on the kinetics of metal dissolution and of hydrogen evolution. Due to the presence of some active sites, such as aromatic rings, hetero-atoms in the studied compound for making adsorption, they may act as adsorption inhibitors. According to Ferreira and others [51], if the displacement in corrosion potential is more than 85mV with respect to corrosion potential of the blank solution, the inhibitor can be seen as a cathodic or anodic type.

4.3 Electrochemical Frequency Modulation

It is apparent from (table 2) that the value of R_{ct} increased with increasing concentration of inhibitors. The increase in R_{ct} values is attributed to the formation of an insulating protective film at the metal or solution interface so that the (IEEIS %) inhibition efficiency increased. On the contrary, the value of C_{dl} decreased upon the addition of the inhibitor, suggesting, a decrease in the local dielectric constant and/or an increase in the thickness of the electrical double layer, indicating the inhibitor molecules function by the formation of the protective layer at the metal surface [56].

4.4 Thermodynamic Parameters

The values of thermodynamic parameters can provide valuable information about the mechanism of corrosion inhibition. Some thermodynamic adsorption parameters were (ΔG_{ads}, ΔH_{ads}, ΔS_{ads}) calculated from the estimated value of K_{ads} using adsorption isotherms at different temperatures.

The Langmuir"s isotherm for the adsorbed layers is given by the equation.

$$C_{inh}/\theta = 1/K_{ads} + C_{inh} \quad (3)$$

Where K_{ads} is the equilibrium constant of the adsorption/desorption process. Adsorption equilibrium constant [K_{ads}] and free energy of adsorption [ΔG_{ads}] were calculated using the equation

$$K_{ads} = 1/C_{inh} \times \theta/1-\theta \quad (4)$$

$$\Delta G^{\circ}_{ads} = -2.303RT \log [55.5K_{ads}] \quad (5)$$

It is well known that K_{ads} represents the strength between adsorbate and adsorbent. Large values of K_{ads} mean better inhibition efficiency of the inhibitors, i.e. strong electrical interaction between the double-layer existing at the phase boundary and the adsorbing inhibitor molecules. Small values of K_{ads}, however, reveal that such interactions between adsorbing inhibitor molecules and the metal surface are weaker, indicating that the inhibitor molecules are easily removable by the solvent molecules from the metal surface [54]. The negative values of ΔG°_{ads} ensure the spontaneity of the adsorption process and stability of the adsorbed layer on the steel surface. Generally, values of ΔG°_{ads} around -20 kJ mol^{-1} or lower are consistent with the electrostatic interaction between the charged molecules and charge metal, such as physisorption. When it is around -40 kJ mol^{-1} higher values it involve charge sharing or charge transfer from organic molecules to the metal surface to form a coordinate type of bond that is chemisorption [49-50]. Attempts were made to fit θ values to the Freundlich, Temkin, Langmuir, and Flory-Huggins isotherms, and the correlation coefficient (R^2) values were used to determine the best fit isotherm [39]

4.5. Kinetics Parameter

Temperature has a great effect on the rate of metal electro-chemical corrosion as it is the accelerating factor in most of chemical reactions. It increases the energy of the reacted species, as a result, chemical reaction get much faster. The dependence of corrosion rate (k) on the temperature can be expressed by Arrhenius equation

$$k = A\exp\left(-\frac{Ea}{RT}\right) \quad (6)$$

Where, Ea is the apparent activation energy, A is the pre-exponential factor and k is the corrosion rate.

Enthalpy and entropy of activation (ΔH*, ΔS*) of the corrosion process were calculated from the transition state theory as given from eq. 7

$$k = \frac{RT}{Nh}\exp\left(\frac{\Delta S^*}{R}\right)\exp\left(-\frac{\Delta H^*}{RT}\right) \quad (7)$$

Where, h is Plank"s constant, N is Avogadro"s number, ΔS^* is the entropy of activation and ΔH^* is the enthalpy of activation.

The entropy of activation (ΔS*) in the absence and presence of inhibitor has large and negative values, this indicates that the activated complex in the rate determining step represents an association rather than dissociation, meaning that, a decrease in disordering takes place on going from reactants to the activated complex[55].

Table 3: for the various pharmaceutical drugs thermodynamic and kinetic parameters were calculated-

Drug	Inhibitor Conc.	Temperature (Kelvin)	K_{ads} M^{-1}	$-\Delta G^{o}_{ads}$ KJ	E_a KJmol^{-1}	ΔH^* KJ mol^{-1}	$-\Delta S^*$J mol^{-1} K^{-1}
Septazole	blank				9.40	5.17	194.9
	900 ppm	298-328	$(1.44 - 0.35)x10^{-4}$	36.4 - 24.4	40.8	11.95	173.40
Streptoquin and Septazole	blank	---	---	---	9.40	-19.1	226.3
	900 ppm	298-328	$(.72-.25)\ x10^{-4}$	30.7 - 21.9	25.7	-26.6	200.4
	900ppm	298-328	$(1.44-.35)x\ 10^{-4}$	36.4 - 24.4	40.8	-30.6	184.7
Tenormin	blank	---	---	---	53.5	22.4	58.1
	300ppm	303-318	$(270 - 175)x10^{-4}$	24.2 - 24.3	78.3	34.0	5.9
Lornoxicam	blank	---	---	---	48.6	46.5	110.2
	50ppm	303-333	$(594.3 - 149.6)x10^{-3}$	+8.806 - +5.859	91.3	89.9	5.9
Tenoxicam	50ppm	303-333	$(254.7 - 78.3)x10^{-3}$	+6.671 - +4.067	67.1	64.2	61.8
Cefacetrile	blank	---	---	---	42.72	39.55	86.75
	100ppm	---	---	39.5	35.60	32.50	121.62
Diclofenac sodium	blank	---	---	---	27.9	25.4	147
	100mg/L	308-338	$(118.84 – 2.54)\ x\ 10^{3}$	41.53 – 40.22	46.4	85.5	+65.49
Cefixime	blank	---	---	---	36.80	36.76	92.67
	$8.8Mx10^{-4}$	---	---	---	74.15	71.67	+3.64
Vancomycin	blank	---	---	---	---	---	--
	$75Mx10^{-4}$	313-333	(955 - 1364)	28.27 - 31.16	---	---	---

5. Conclusions

Corrosion inhibition study on the different class of drugs has been review in different media. Effectiveness of corrosion inhibition depends on their chemical composition, molecular structure and their affinities for metal surface. The most effective corrosion inhibitors are those compounds containing hetero atom like nitrogen, oxygen, and phosphorous as well as aromatic rings. Result obtained from the electrochemical techniques show that all the reported drugs acting as good corrosion inhibitors. The adsorption of drug on different metals follow Langmuir"s adsorption isotherm. From the weight loss technique it is evident that with the increase in the concentration of inhibitor value of corrosion rate decreases. Positive sign of enthalpy of activation reflects the endothermic nature of the reaction while negative sign indicates the exothermic nature of reaction.

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