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Anticorrosion Potential of Salazopyrin Drug for Copper in Nitric Acid Solution.

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ABSTRACT

(Z)-2-hydroxy-5-((4-(N-pyridin-2-ylsulfamoyl) phenyl) diazenyl) benzoic acid (Salazopyrin), was inspected as corrosion protective for copper in one molar nitric acid solutions utilized by (EIS), tafel polarization, (EFM) and mass reduction studies. Surface examination was tested using (SEM). The impact of temperature on corrosion manner with appending various dose on the range of temperature of 25-45 °C by mass reduction test. Curves of Polarization detect that the drug compound act as a mixed inhibitor. The capability of inhibition rises with improvement in the inspected drug compound dose and with rise the temperature of solution. The inhibitor adsorbed on surface of copper was following the isotherm Temkin. The data given from electrochemical and chemical techniques are in perfect agreement.

Keywords:

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INTRODUCTION

The Copper metal is a good manner so it's utilized on range of applications. It is utilized in alloys , tubes, wires production, electronics, and also sheets. The utilized corrosion protective of Cu in acid medium is mainly to less the corrosion of Cu at the time of acid descaling and cleaning. The probability of the corrosion prevention for Cu has obtained many studies until now reproducible possible inhibitors have been discussion [1-3].

The most important technique to prevent corrosion is inhibitors utilized. The impact of inhibitor is to block the site of Cu metal from the medium of corrosive and/or the electrode reactions change that cause metal liquefaction. Most of the acid capability, inhibitors are organic compounds that include most atoms N, S or O in their compound. Heterocyclic compounds are well known for their capabilities as protective corrosion and those containing nitrogen.

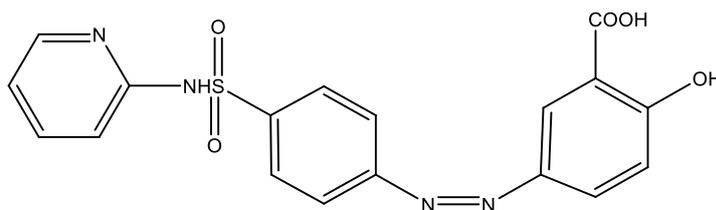
The inspected drug compound display interesting possibilities for corrosion protective and particular important due to including atoms with electronegative such as N, S, and O in their drug structure, miscibility high in water, safe utilize, and big molecular size such these drug compounds should be perfect corrosion protective.

The target of this work is to determine the inhibition impact of some drug inhibitors on the Cu corrosion in 1 molar Nitric acid utilized mass reduction and Tafel methods. The kind of adsorption and the mechanism of corrosion protective are also illustrated.

MATERIAL AND METHODS

Materials and Solutions

Experiments were done by utilized Cu coins (99.98%) which were mounted in Teflon. An epoxy was utilized to fill the area between Teflon and Cu electrode. The sheet of Pt was utilized as auxiliary electrode, (SCE) saturated calomel electrode as electrode reference was related to a conventional electrolytic cell of capacity 100 ml via a bridge with a Luggin capillary. The solution aggressive utilized was reading by softening of 70% HNO₃ with water bi-distilled. The storage solution was utilized in 1000 ppm of Salazopyrin was utilized to readying the wanted dose by dilution with bi-distilled water. The range of Salazopyrin dose utilized was 50-300ppm



(Z)-2-hydroxy-5-((4-(N-pyridin-2-ylsulfamoyl)phenyl)diazenyl)benzoic acid
Chemical Formula: C₁₈H₁₄N₄O₅S
Molecular Weight: 398.39

Preparation of pharmaceutical compound

Two tablets of Salazopyrin were grinding to make smooth powder. The powdered product (1000 g) were insoluble directly in water, after heating all the powder becomes soluble, by filtration the powder mixed with 1 liter of distilled water to prepare the stock

Mass reduction measurements

Seven parallel copper sheets of 1×1×0.2 cm were abraded with emery paper (grade 320–500–800–1200) and then washed with bi distilled water. First weight accurately then the coins were putted in a 100 ml beaker, which include 6 ml of dose of Nitric acid without and with appending of various Salazopyrin doses. All the Nitric acid solutions were open system to air condition. After 180 minutes, the coins of Cu were obtained,

washed, dried, and accurately weighed. The mean mass reduction of seven copper parallel coins could be given. (η %) and (θ), of Salazopyrin for the corrosion of copper were measure as equation [4].

$$\eta\% = \theta \times 100 = 100 \times (1 - W / W^{\circ}) \quad (1)$$

Where, W° =the data of the mean mass reduction without the drug inhibitor, W are the data of the mean mass reduction with inhibitor of drug.

Electrochemical testes

Potentiodynamic polarization

Electrochemical technique were done in three electrodes thermostatic cell conventional assembly utilized a Gamry Galvanostat/ZRA/Potentiostat (model PCI 300/4), a sheet of platinum is a counter and saturated calomel electrode (SCE) were utilized as reference electrodes, the Cu electrode was in the form of a cut square from Cu electrode of size (1 x1 cm) and was welded by one side to a copper wire utilized for connection electrical, the Cu electrode was abraded successively with different emery papers grades , rinsed with bi-distilled water and then degreased with $(\text{CH}_3)_2\text{CO}$, washed with bi-distilled water and dried finally. Electrochemical testes were done at 25°C. The diagrams for potentiostatic were occurred from -5 to 5 V at a scan with rate 0.5 mVs^{-1} after reached to the steady state (30 minutes) [5], utilized for the measure of current corrosion is done by extrapolation of cathodic and anodic Tafel lines of charge transfer corrosion controlled reactions to a point which yield $\log i_{\text{corr}}$. and the corresponding potential of corrosion (E_{corr}) for solution blank and for each inhibitor concentration. The current corrosion density (i_{corr}) was utilized to measure the efficiency of inhibition (% η) and (θ) as equation 2:

$$\% \eta = 100 \times \theta = 100 \times [1 - (i^{\circ}_{\text{corr}} / i_{\text{corr}})] \quad (2)$$

Where i_{corr} is the current of corrosion in drug solutions, and i°_{corr} is the current of corrosion in HNO_3 .

Electrochemical impedance spectroscopy (EIS) technique

The equivalent electrical circuit model utilized for this system is shown below (Fig. 1) where R_{ct} = charge transfer resistance, R = resistor and R_s =resistance of solution, and C_{dl} represents the double layer capacitance. Gamry applications contain software EIS300 for EIS measurement; computer was utilized for summation of data. Echem Analysis 5.5 software was utilized for fitting plotting, and graphing data. The protection efficiency (% η) and (θ) of the surfactant have been obtaining from the resistance of charge transfer data utilized the following equation 3:

$$\% \eta_{\text{EIS}} = \theta \times 100 = 100 \times [(R_{\text{ct}} - R^*_{\text{ct}}) / R^*_{\text{ct}}] \quad (3)$$

Where R^*_{ct} are the charge transfer resistance in the HCl, and R_{ct} are the charge transfer resistances in surfactants. The interfacial double layer capacitance (C_{dl}) values were computed from the impedance value by the following equation 4:

$$C_{\text{dl}} = 1 / 2\pi R_{\text{ct}} f_{\text{max}} \quad (4)$$

Where f_{max} = maximum frequency (Hz).

Electrochemical frequency modulation (EFM) technique

Electrochemical frequency modulation, EFM, EFM can be utilized as a fast and nondestructive experimental for rate of corrosion technique without prior knowledge of Tafel constants. EFM performed by utilized 2 frequencies (2.0 to 5.0 Hz). The time in this work which given steady state of the specimens was found half-hour, the Intermodulation spectra include current responses form corrosion density (i_{corr}) and harmonical intermodulation peaks of current. The larger peaks were utilized to measure the current, the Tafel slopes (β_a and β_c) and the causality factors (CF2 & CF3) [6]. All the experiments were conducted at $25 \pm 1^\circ\text{C}$.

Surface examination

For Surface examination morphological result, surface coupons (1 cm x 1 cm x 0.2cm) of Cu were tested after and before incurrence of one molar nitric acid for twelve hours without and with Salazopyrin. Scanning electron microscope (JEOL JSM-5500) was utilized for this experimental

RESULT AND DISCUSSION

Mass reduction measurements

Mass reduction measurements were achieved for copper in 1 molar Nitric acid in the presence and absence of various Salazopyrin dose and are given in Figure (1). (η %) data measured are written in Tables 1& 2. From these tables, it is observed that the η % improvement with raising the dose of Salazopyrin and increase with raising the temperature range 25-45°C. (η %) and (θ) were measured by equation (1).

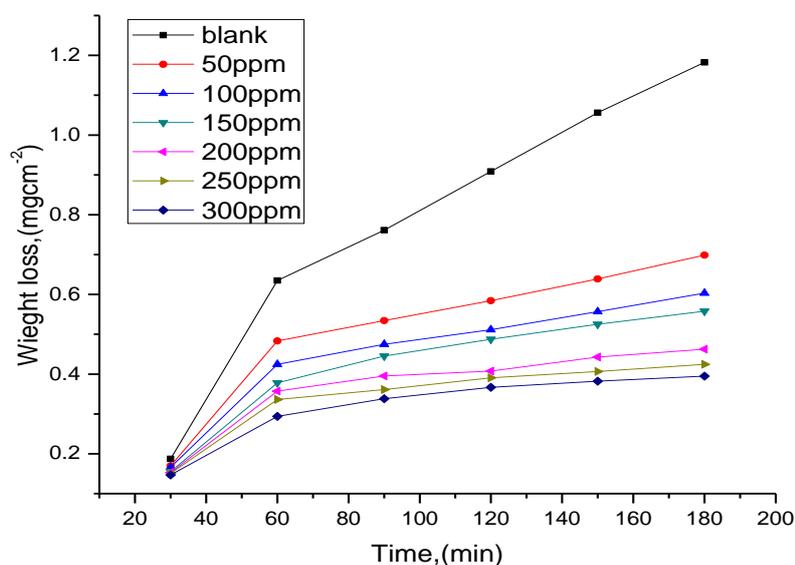


Figure1: time -mass reduction diagrams for the corrosion of Cu in 1 Molar Nitric acid in the presence and absence of different doses of Salazopyrin at 25°C

Table 1; Corrosion rate (C.R.) and (IE %) data given from mass reduction test for Cu in 1 molar Nitric acid solutions with and without different doses of Salazopyrin at 25°C

Conc ppm	Mass loss mg cm ⁻²	C.R., mg cm ⁻² min ⁻¹	θ	% η
1M HNO ₃	0.90868	0.008	---	---
50	0.5873	0.005	0.3537	35.37
100	0.5112	0.004	0.4374	43.74
150	0.4874	0.004	0.4636	46.36
200	0.4075	0.003	0.5515	55.15
250	0.3906	0.003	0.5701	57.01
300	0.3666	0.003	0.5966	59.66

Table 2: Value of mass reduction results for Cu in 1 molar Nitric acid solution in the presence and absence of various dose of Salazopyrin at 25–45°C

Conc., ppm	Temp., °C	C.R., mg cm ⁻² min ⁻¹	θ	%η
50	25	0.005	0.354	35.4
	30	0.005	0.410	41.0
	35	0.007	0.520	52.0
	40	0.011	0.553	55.3
	45	0.017	0.585	58.5
100	25	0.004	0.4374	43.7
	30	0.005	0.493	49.3
	35	0.006	0.580	58.0
	40	0.009	0.617	61.7
	45	0.015	0.645	64.5
150	25	0.004	0.464	46.4
	30	0.004	0.526	52.6
	35	0.005	0.618	61.8
	40	0.008	0.650	65.0
	45	0.013	0.677	67.7
200	25	0.003	0.552	55.2
	30	0.004	0.577	57.7
	35	0.005	0.639	63.9
	40	0.008	0.680	68.0
	45	0.012	0.713	71.3
250	25	0.003	0.570	57.0
	30	0.004	0.590	59.0
	35	0.005	0.662	66.2
	40	0.007	0.705	70.5
	45	0.011	0.741	74.1
300	25	0.003	0.597	59.7
	30	0.004	0.603	60.3
	35	0.004	0.677	67.7
	40	0.007	0.729	72.9
	45	0.010	0.767	76.7

The resulted of action inhibition of the Salazopyrin due to the adsorption of its extracts on surface of copper. The layer given by the adsorbed Salazopyrin, separation the one malar nitric acid from the surface

copper metal which limits the liquefaction of the final by corrosion sites blocking and hence lowering the rate of corrosion, with higher efficiency as their dose rise [7].

Polarization measurements

Figure 2 given the curves of potentiodynamic polarization for copper in one molar Nitric acid solutions in the presence and absence of different doses of Salazopyrin at room temperature. The presence of Salazopyrin shifts both anodic and cathodic branches to the lower values of i_{corr} and thus causes a remarkable decrease in the corrosion rate, the parameters derived from the polarization curves in Figure 2 are given in Table 3, in one molar Nitric acid solution, the presence of Salazopyrin causes a remarkable decrease in the corrosion rate i.e., shifts anodic and cathodic curves to lower current densities, both cathodic and anodic reactions of copper electrode are retarded by Salazopyrin in 1 molar Nitric acid solution and the Tafel slopes of β_a and β_c at 25°C change obviously upon addition of Salazopyrin, which say that the presence of Salazopyrin change the mechanism of cathodic and the metal dissolution process" [8-10]. In the attendance of Salazopyrin, E_{corr} change to lower -ve data but this shift is very little (about 60 mV), which lead to that Salazopyrin can be classified as type mixed inhibitor. Since $\beta_c > \beta_a$, Salazopyrin is classified as mixed type inhibitor but the anode is less polarized than the cathode when an outcome current was found.

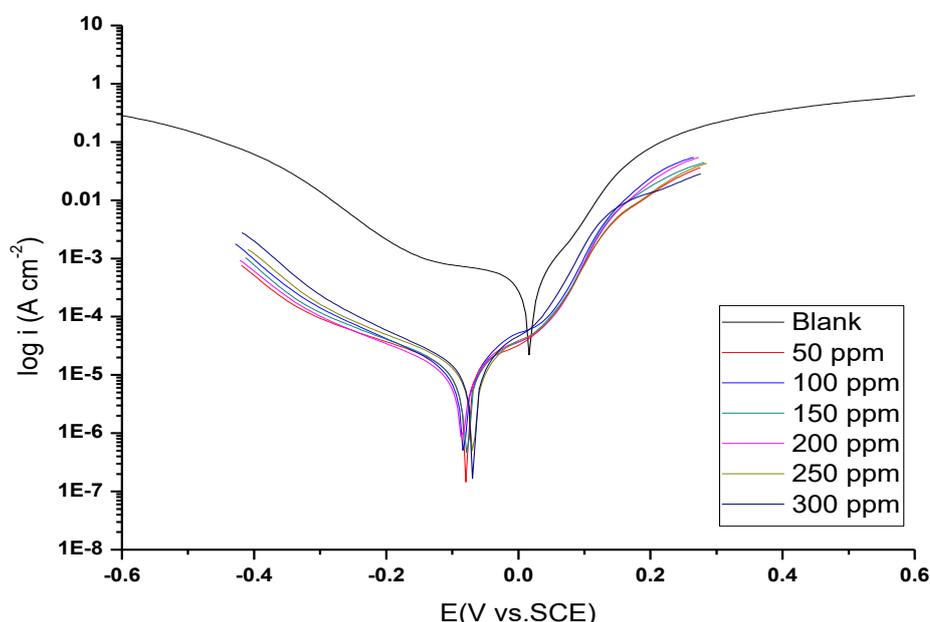


Figure 2: diagram of tafel for the copper corrosion in one molar Nitric acid with and without different dose of Salazopyrin at room temperature.

Table 3; Effect of doses of Salazopyrin on the parameters of electrochemical measured utilized by potentiodynamic polarization method for the corrosion of Cu in 1 molar Nitric acid at 25°C ,

Conc., ppm	i_{corr} , $\mu\text{A cm}^{-2}$	$-E_{corr}$, mV vs. SCE	β_a , mVdec ⁻¹	β_c , mVdec ⁻¹	CR, mm y ⁻¹	θ	% η
1 M HNO ₃	506.0	20.6	82	451	249.60	---	---
50	28.0	80.0	280	479	14.34	0.945	94.5
100	26.3	80.9	253	469	13.50	0.948	94.8
150	18.0	79.0	187	289	9.20	0.964	96.4
200	16.0	80.7	147	252	8.20	0.968	96.8
250	15.90	68.0	127	253	8.10	0.970	96.9
300	13.7	68.8	118	197	7.02	0.973	97.3

(EIS) tests

Electrochemical impedance spectroscopy given a new technique for characterizes the coverage film on the metal electrode which is lead to charge resistance transfer (R_{ct}). The interface capacitance can also be utilized to calculate the film quality [11-15]. Form observed result given that the organic substance wrap on the surface of metal rely not only on the metal nature and the organic substance structure, but also on the conditions of experimental such as concentration of adsorbent and immersion time [16]. Figure 3 and Figure 4 given a similar kind of Nyquist and Bode draws for copper with different doses of the Salazopyrin. The presence of half semi-circle single lead to the charge transfer single process due to liquefaction of Cu metal surface which is unimpressed with Salazopyrin inhibitor. All the impedance spectra were measured at the consentient open-circuit potentials. The Nyquist Salazopyrin diagrams from different half semicircles are draw as expected from the EIS theory which due to disappear of frequency. Inspections of the resulted reveal that each impedance diagrams content of a higher capacitive loop with one time capacitive constant in the Bode – phase plots Figure 4. The diameter of the capacitive loop improves with rise dose and lead to the inhibition percent of the process corrosion.

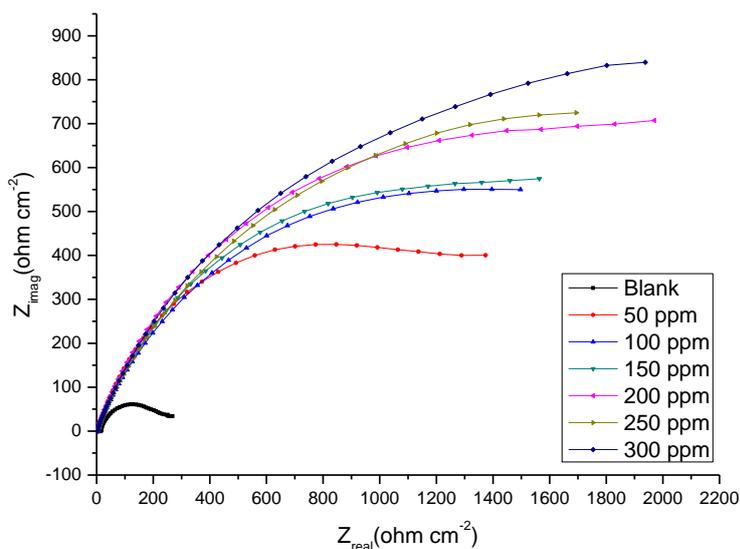


Figure 3. Nyquist plots showing effect of increments concentration of Salazopyrin on corrosion of copper in 1 molar Nitric acid

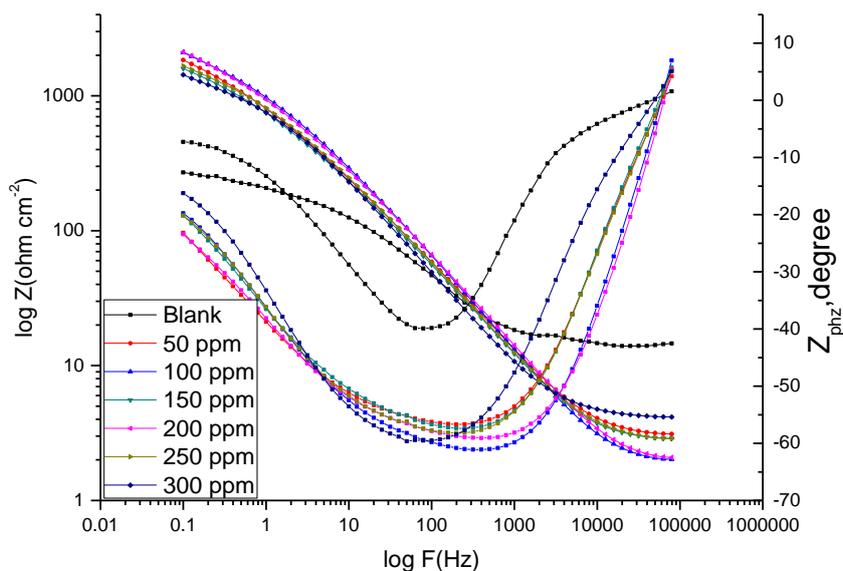


Fig. 4. Bode plot for corrosion of copper in 1 molar Nitric acid without and with various dose of Salazopyrin at 25°C

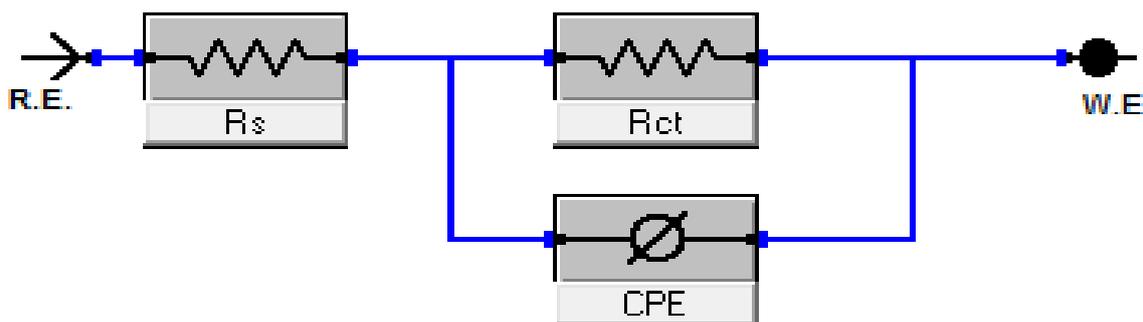


Figure 5. Equivalent circuit model utilized to fit the spectra of impedance

The equivalent electrical circuit model shown in Figure 5 was utilized to measure the obtained impedance data. The model contains of the resistance charge-transfer of the corrosion interfacial reaction (R_p) or (R_{ct}), the resistance solution (R_s) and the double layer capacitance (C_{dl}). Excellent fit with this model was obtained with our experimental result [17].

EIS data in Table 5 show that the R_{ct} data rise and the C_{dl} data lower with raise the inhibitor concentration. This is due to the gradual water molecules replacement by the adsorption of the molecules inhibitor on the surface of metal, lowering the extent of dissolution reaction. The high R_{ct} data, are generally, associated with slower corroding system [18, 19]. The lower in the C_{dl} can result from the low of the local dielectric constant and/or from the rise of electrical double layer thickness [20-23]. η % is measured from the charge-transfer resistance data as shown in equation 3 [24]. The η obtained from EIS resulted are close to those deduced from polarization technique.

Table 4. Resulted from electrochemical impedance measurements for corrosion of copper in 1molar Nitric acid solutions at various dose of Salazopyrin at 25°C

Conc., ppm	R_{ct} , Ω cm ²	C_{dl} , μ F cm ⁻²	θ	η %
1molar HNO ₃	273.60	179	---	---
50	1397.00	164	0.804	80.4
100	1674.00	143	0.837	83.7
150	1741.00	136	0.843	84.3
200	2033.00	129	0.865	86.5
250	2071.00	110	0.868	86.8
300	2238.00	107	0.878	87.8

(EFM) test

EFM is a nondestructive and linear corrosion test method that can directly calculated the current value of corrosion with only a small polarizing signal and without earlier Tafel slopes knowledge [25], these EFM technique advantages given it as ideal technique for corrosion monitoring online. Intermodulation spectra given from EFM calculation are obtain in Figure 6 are copper examples on solution of acid devoid of and containing 250 ppm dose of Salazopyrin at 25°C. Each spectrum is a current response as a function of frequency. The two large peaks are the response to the 2 Hz and 5Hz excitation frequencies. These peaks are utilized by the EFM 140 software package to measure the current corrosion and Tafel constants. The calculated corrosion kinetic parameters at different dose of the investigated Salazopyrin in one malar nitric acid at 25° C (i_{corr} , β_a , β_c , CF-2, CF-3 and % IE) are obtained in Table 5 which contain corrosion current densities lower and the inhibition efficiencies rise by increment the dose of the Salazopyrin, very close causality factors in Table 5 to theoretical value, which according to EFM theory [26] should guarantee the validity of Tafel slopes and corrosion current densities, indicating that the measured data are of good quality. The standard values for CF-2 and CF-3 are 2.0 and 3.0, respectively [26].

The inhibition efficiencies η_{EFM} % improvements by raise the concentration of Salazopyrin and measured from equation 5 as follow:

$$IE \%_{EFM} = (1 - i_{corr} / i_{corr}^{\circ}) \times 100 \quad (5)$$

Where, i_{corr}° and i_{corr} = corrosion current densities with and without Salazopyrin, respectively

The obtained data showed are in good agreement of kinetic parameters corrosion obtained from the EIS and Tafel extrapolation methods.

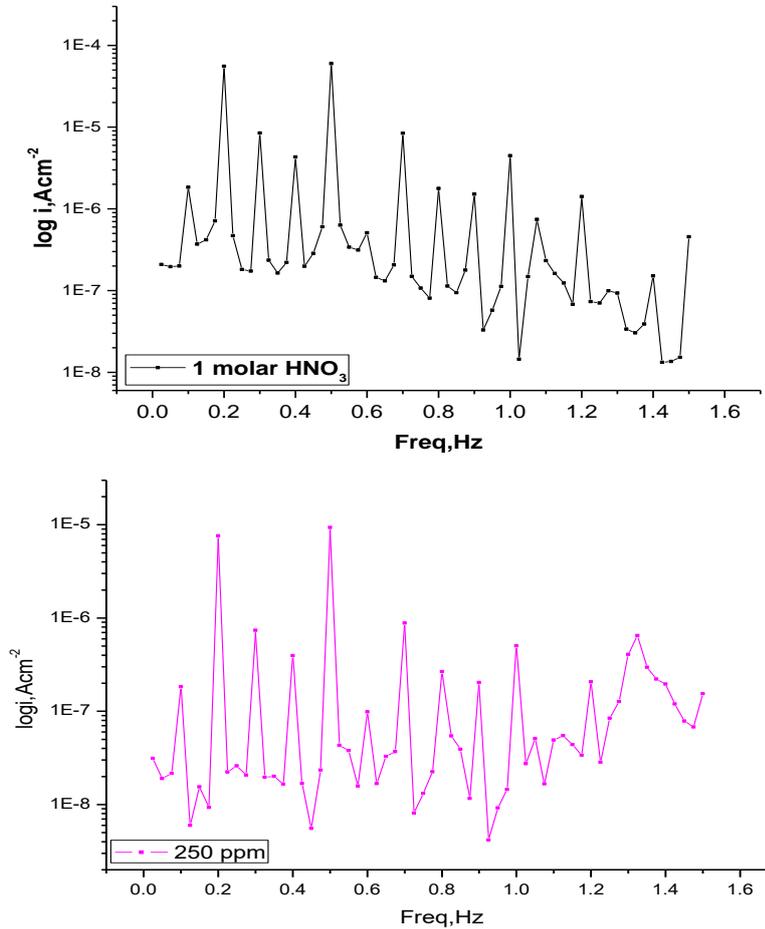


Figure 6: EFM plots for the Cu corrosion in one molar Nitric acid with 250 ppm and without doses of Salazopyrin at 25°C

Table 5: parameters given by EFM method for Cu in 1 molar nitric acid solutions include inconsistent doses of Salazopyrin at 25°C

Conc., ppm	$i_{corr}, \mu Acm^{-2}$	β_a mV dec ⁻¹	β_c mVdec ⁻¹	C.R. mpy	CF-2	CF-3	θ	$\eta\%$
1 molar HNO ₃	71.55	59.250	126.8	35.31	1.90	3.30	---	---
50	14.72	62.140	147.6	7.50	1.80	3.00	0.794	79.4
100	14.67	59.800	135.7	7.50	1.80	2.80	0.795	79.5
150	13.8	57.500	106.8	7.07	1.80	2.70	0.807	80.7
200	10.99	52.700	100.5	5.60	1.80	2.60	0.846	84.6
250	10.13	63.300	100.8	5.20	1.80	2.60	0.858	85.8
300	9.9	56.040	101.6	5.07	1.70	3.90	0.862	86.2

Temperature effect

The mode and interaction degree between a Salazopyrin inhibitor and a Cu surface have been broadly obtain with the adsorption isotherms applied. The Salazopyrin molecule adsorbed due to the energy interaction between Salazopyrin inhibitor and a metallic copper surface is biggest than that between water molecules and surface of copper [28]. To obtain the adsorption isotherms, (θ) given from mass reduction test was reading as a function of Salazopyrin inhibitor dose. The data of θ were then drawing to fit the most probability model of adsorption [29]. Attempts were made to fit value of experimental to inconsistent kind of isotherms contain Langmuir, Frumkin, Freundlich and Temkin isotherms. By far the data were best fitted by isotherm Temkin in Figure 7

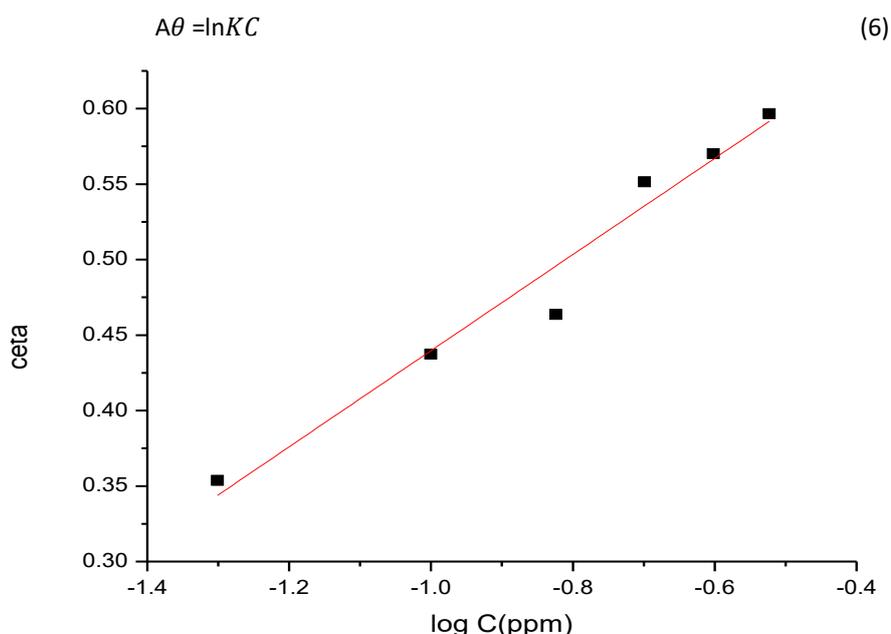


Figure 7: Temkin isotherm curve for Cu in one molar Nitric acid with inconsistent doses of Salazopyrin at 25°C

Kinetic-thermodynamic corrosion parameters

Mass reduction method was achieved at various temperatures (25°C–45°C) in the presence of various doses of Salazopyrin. Given the corrosion rate increases with the temperature raise for Salazopyrin (Table 2). The rate of Cu corrosion without Salazopyrin rises from 25 to 45°C whereas; with Salazopyrin the corrosion rate limits decrease. (η %) was given improvement with temperature. The corrosion parameter without and with drug in the temperature range 25–45°C has been illustrated in Table 2. The apparent activation energy (E_a^*) for liquefaction of copper in one molar nitric acid was measured from the slope of draw by utilized Arrhenius equation:

$$C.R = A \exp (-E_a^* / RT) \tag{7}$$

Where T = the absolute temperature, A = the Arrhenius constant, k = the rate of corrosion and R = the universal gas constant. By drawing log k against 1/T the data of (E_a^*) has been estimated ($E_a^* = (\text{slope}) 2.303 \times R$) (Figure 8). "Activation energy for the reaction of Cu in 1molar Nitric acid increases in the presence of Salazopyrin (Table 6), this increasing in E_a^* indicates the formation of energy barrier, the extent of the rate increment in the inhibited solution is higher than that in the free acid solution, (η %) of Salazopyrin increase directly with raising temperature, this result agree with the fact which state the adsorption of drug components on the copper surface may be chemical in nature, as the temperature raised the number of adsorbed molecules also increase leading to an increase in the (η %) and the obtained results suggest that Salazopyrin inhibits the corrosion reaction by increasing its activation energy". This could be illustrated by adsorption on the Cu surface given a barrier for mass and charge transfer. Moreover, the relatively decrease of data for activation energy with Salazopyrin lead to a chemical adsorption process. The data of (ΔS^\ddagger) and (ΔH^\ddagger) can be measured by equation 8, as follow:

$$k = (RT/Nh) \exp (\Delta S^*/R) \exp (\Delta H^*/RT) \tag{8}$$

where, h = Planck’s constant, ΔH^* = the enthalpy of activation, k = rate of corrosion, N = Avogadro number and ΔS^* = the entropy of activation. “A plot of $\log (k/T)$ against $1/T$ (Figure 9) should give a straight line, with a slope of $(\Delta H^*/2.303R)$ and an intercept of $[\log (R/Nh)+\Delta S^*/2.303R]$, from which the values of ΔS^* and ΔH^* can be estimated (Table 6) the negative value of ΔS^* for the inhibitor indicates that activated complex in the rate determining step(RDS) represents an association rather than a dissociation step, meaning that a decrease in disorder occur during the course of transition from reactant to the activated complex, the negative sign of ΔH^* indicates that the adsorption of inhibitor molecules is an exothermic process”. Generally, exothermic process lead to either chemisorption, physisorption or a both of combination.

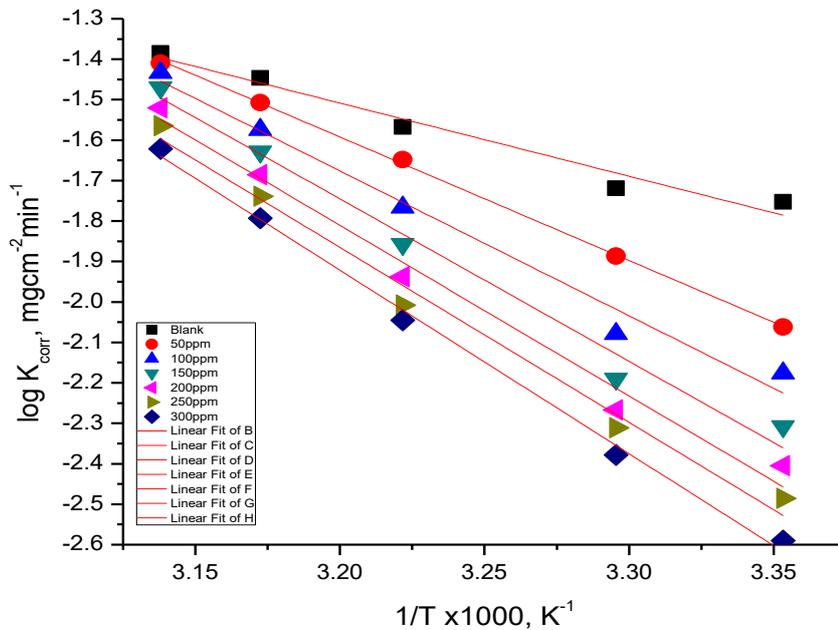


Figure 8: $\log k$ (corrosion rate) vs. $1/T$ curves for Cu in 1 molar Nitric acid in the presence and absence of inconsistent doses of Salazopyrin.

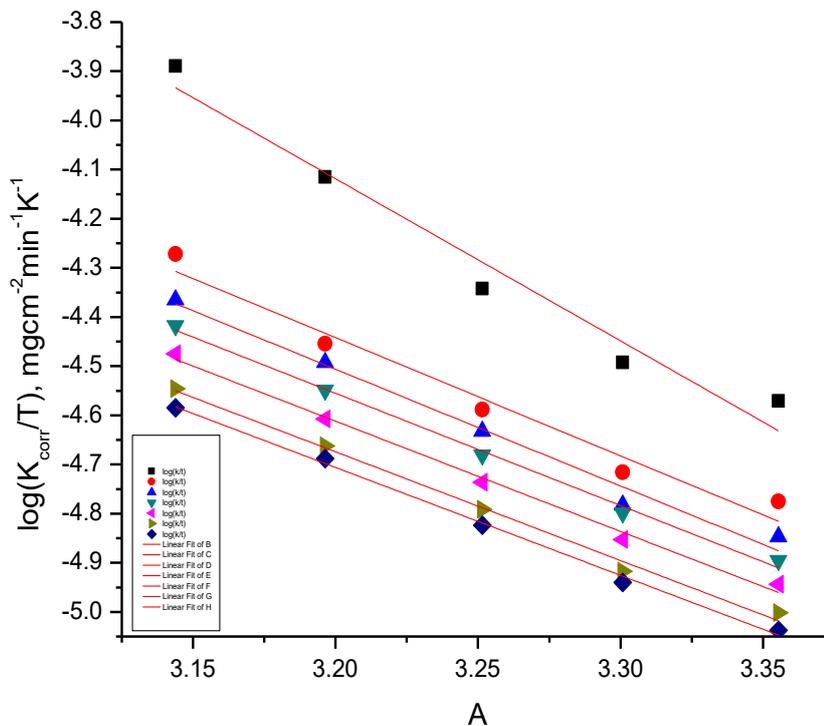


Figure 9: $1/T$ vs. $\log k/T$ plots for Cu in one Molar Nitric acid in the presence and absence of inconsistent doses of Salazopyrin.

Table 6; Activation parameters for dissolution of Cu with and without inconsistent dose of Salazopyrin in one molar Nitric acid in the range of 25-45°C

Conc. ppm	E_a^* kJ mol ⁻¹	ΔH^* kJ mol ⁻¹	$-\Delta S^*$ J mol ⁻¹ K ⁻¹
1 molar HNO ₃	34.63	27.42	74.36
50	58.46	19.97	135.42
100	68.58	19.75	138.28
150	76.91	19.00	144.74
200	80.75	18.65	148.43
250	82.79	18.39	151.53
300	86.88	18.25	153.21

Adsorption Isotherm

Thermodynamic adsorption parameters such as ΔS°_{ads} and ΔH°_{ads} can be estimated from combine form of the equation of Vant't Hoff

$$\ln K_{ads} = (\Delta S^\circ_{ads} / R) + (-\Delta H^\circ_{ads} / RT) + \ln (1 / 55.5) \tag{9}$$

Figure 9, given results of ΔH°_{ads} and ΔS°_{ads} utilized the equation (9) [30] are arranged in Table 7.

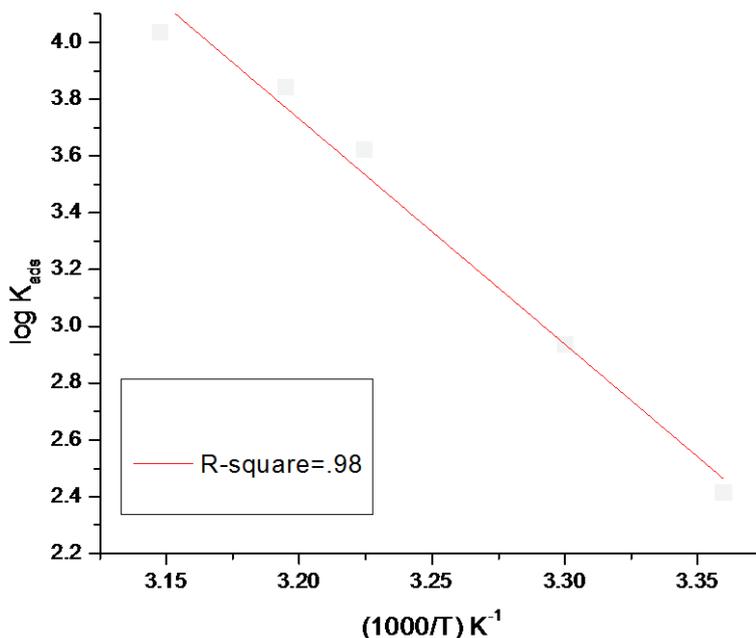


Fig. 10: Log K_{ads} vs. (1/T) curves for the corrosion of Cu in one molar Nitric acid in the presence and absence of various doses of Salazopyrin at various temperatures

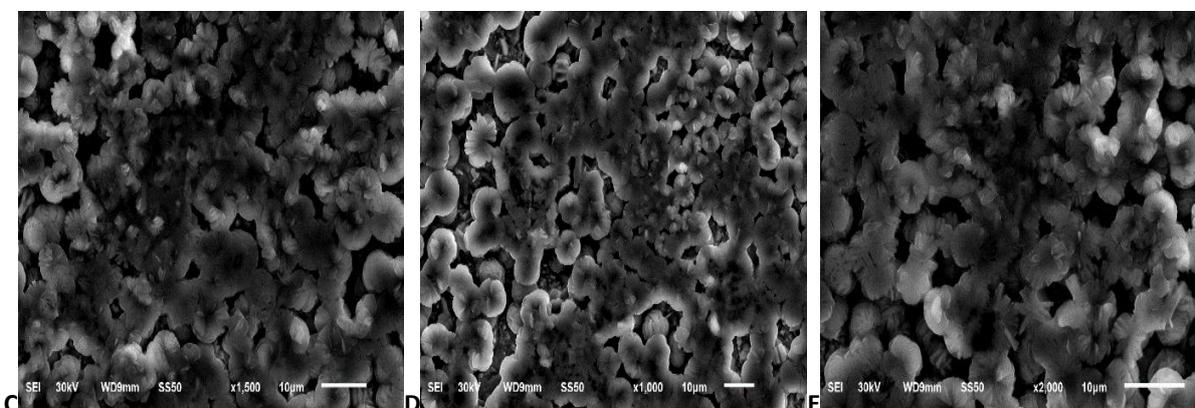
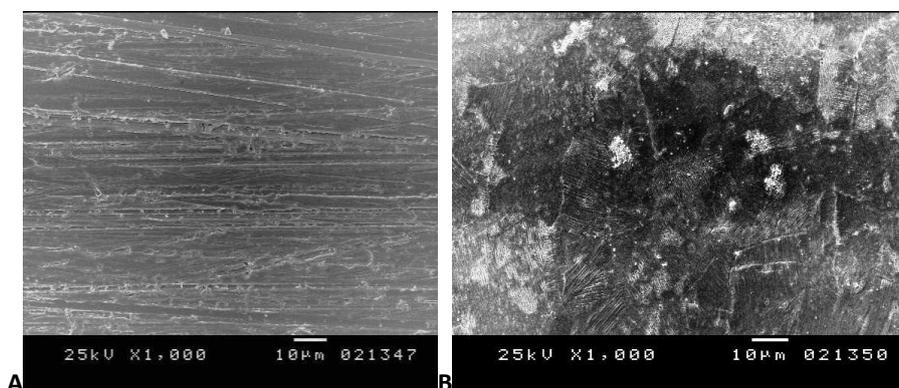
“Positive sign of ΔH°_{ads} referred to the adsorption of Salazopyrin on Cu surface is an endothermic process. ΔH°_{ads} is about 0.14 kJ mol⁻¹ which is more than the common physical adsorption heat (40 kJ mol⁻¹), but less than the common chemical adsorption heat (100 kJ mol⁻¹) [31], probably meaning that both physical and chemical adsorption occur (i.e. complex adsorption), the positive ΔS°_{ads} values are accompanied with endothermic adsorption process, this is agrees with the expected, when the adsorption is an endothermic process, it must be accompanied by an increase in the entropy change and vice versa” [32].

Table 7. Thermodynamic parameters for the adsorption of Salazopyrin on Cu in one molar Nitric acid at various temperatures

Temp., K	$K_{ads} \times 10^{-4} M^{-1}$	$\Delta S^{\circ}_{ads} J mol^{-1} K^{-1}$	$\Delta H^{\circ}_{ads} kJ mol^{-1}$	$-\Delta G^{\circ}_{ads} kJ mol^{-1}$
298	0.02	79.46	0.14	23.54
303	0.09	90.05		27.14
308	0.78	108.34		33.23
313	0.69	107.37		33.47
318	0.72	107.67		34.11

SEM/EDX examination

To verify if the used drug compounds are adsorbed on surface of Cu, experiments of SEM and EDX were performed. The SEM micrographs for Cu surface alone and after one day putting in one molar nitric acid with and without the appending of 300 ppm of the Salazopyrin is shown in Figures (11a, b). As expected, Figure 11a shows metallic Cu surface is clear smooth, while in without the used drug compound, the copper surface is damaged by Nitric acid corrosion (Figure 11b). In contrast, with of the Salazopyrin (Figure (11c-g)), the metallic surface seems to be almost not affected by corrosion. The corresponding EDX data are presented in Table 8. It is obvious from the EDX spectra of Cu in the presence of Salazopyrin, the appearance of C, O, N peaks which suggest the Salazopyrin adsorption on the Cu surface and corroborate the thin inhibitor film formed and given in SEM micrograph.



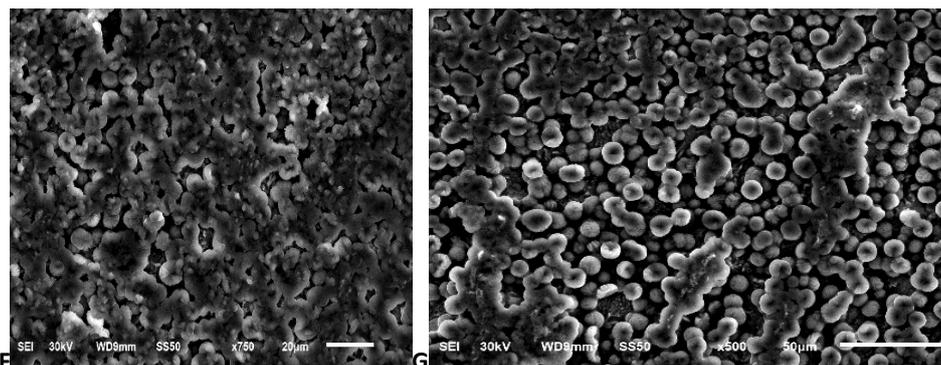


Figure 11: SEM figure of copper surface (a) before putting in 1 molar Nitric acid, (b) after 24 h of immersion in 1 molar Nitric acid, (C-G) after one day of putting in 1 molar Nitric acid +300 ppm of Salazopyrin at 25°C in different magnification power.

Table 8: Surface composition (weight %) of copper after immersion in 1 M Nitric acid with 300 ppm Of Salazopyrin at 25°C

element	Weight%	Atomic%
C	4.32	8.38
N	7.27	12.10
O	42.94	62.60
Al	0.45	0.39
Cu	45.03	16.53

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