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Corrosion Inhibition of Steel in HCL Media Using 2-Methoxymethyl-Benzlamine

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Abstract: *In this research was the study of corrosion inhibition of steel in hydrochloric acid using 2-methoxy methyl-benzyl amine concentrations ranging from 0.0001 -0.1 ppm and temperatures ranging from 313-333 K and using the methods of both weight loss and polarization. The results showed that the corrosion potential tends to mixed type between the anode and cathode, and this type of corrosion inhibitors is effective and good efficiency when increasing concentrations of inhibitor corrosion and less efficiency increase of temperature as well as the calculation of thermodynamic factors such as the energies of both the activation, enthalpy, entropy and free of adsorption and showed good results and also kind of adsorption is chemical to the surface of the metal.*
Keywords: *corrosion, 2-methoxy methyl-benzyl amine, HCl, polarization, weight loss, potential*

I. Introduction

Iron and steel are main metals that use in industry and obvious in the metallurgical industry is the growth of knowledge and technology. Owing to the employ of metallic composition in make contact with liquids, acids and salts media in latest industrial history demonstrates several failures [1]. Description as corrosion inhibitors for mild steel in acid medium so many of N- and S- including organic compounds so newly, scientists have been interested with the employ of confident organic compounds as corrosion inhibitors in metal-corroding systems [2].

Recently, that has concerned many of investigations over main industrial of problems corrosion of metals [3,4]. For get on inferior energy by forming a chemical composite in a more stable state when metals are basically unstable and have the natural propensity to react with their environments. The steel is considered very weak to attack in aggressive media, so exposed metals to industrial environments [5].

Some investigators [6] were studied effect Benzylamine-N-(p-methoxybenzylidene) on corrosion inhibition of Al-Mg alloy in 2.0 M HCl. Galvanostatic polarization, weight loss, electrochemical impedance spectroscopy and scanning electron microscopy were employed. The inhibition efficiency decreased with raise in temperature andincreased with enlargesinhibitor concentration. The adsorption is follow Langmuir adsorption isotherm. The inhibitor is of mixed type as the polarization measurement indicated.

Researchers [7] were examined the inhibition effect of newly synthesized Schiff bases N-benzylidene benzylamine (A) and benzene methan amine-α-methyl-N-(phenyl methylene) (B) on the corrosion behavior of Al-Pure in 1M HCl was studied using electrochemical impedance spectroscopy, galvanostatic polarization and adsorption studies. The results show the inhibitors act as mixed type inhibitors, and that (A) and (B) have excellent inhibiting whereeffects of inhibitor concentration, temperature and surface coverage are studied.The inhibitors are inhibitingof corrosion by blocking the reaction sitesand do not influence on the mechanism of the electrode processes.Due to the adsorption of inhibitor molecules on the metal surface, the high inhibition efficiency of (A) and (B).Because of the formation of a defensive film,the decrease of surface area obtainable for electrode reactions to happen.

II. Experimental Work

In this research, we used two different methods to calculate the weight loss corrosion rates by calculating weights for selected models and the other method is to calculate the polarization corrosion current density and the potential of corrosion of anode and cathodic polarization curves by using potentiostat with computerized.

We used steel with coupons with dimensions 5cm length x 3cm width x 0.3cm thickness, Steel specimen of composition, (wt.%): 0.14 % C, 0.27 % Mn, 0.13 % Si, 0.09 % S ,0.36 % P, 0.017 % Cu, and bal. Fe, in this study and the effect of corrosion inhibitor 2-Methoxymethyl-benzylamine with different concentrations ranging from 0.0001, 0.001, 0.01 and 0.1 ppm, the presence of hydrochloric acid 1N HCl at different temperatures 313, 323 and 333K

III. Results and Discussion

Fig.1,represents polarization curves between potential (mV) with current (A/cm^2) for various inhibitors concentrations at 313 K, we note cathodic and anodic curves thus corrosion potential and corrosion current density, where that potential corrosion and current density corrosion decrease with increasing inhibitor concentrations and corrosion potential E_{corr} reveals that inhibitor is a mixed kind between anodic and cathodic, subsequently efficiency increased as Table 1, thus with regard to temperatures 323 and 333 K in Figs.2&3 respectively.But at certain concentration and increasing temperatures,note increase corrosion current density and corrosion potential and efficiency decreased according to researchers [6,7,8].

The inhibition efficiency was evaluated agreeing to the follow rule [9]:

$$E = \frac{I_{un} - I_{in}}{I_{un}} \quad (1)$$

Where;

I_{un} , I_{in} are corrosion current density without and with inhibitor, mA/cm^2

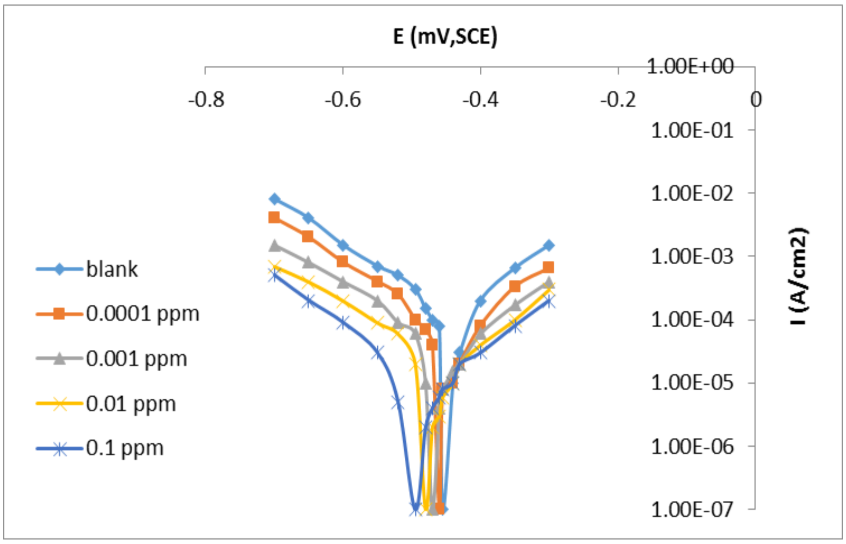

Fig.1: Polarization curves for steel at various concentrations of 2-Methoxymethyl-benzylamine in 1M HCl at 313 K

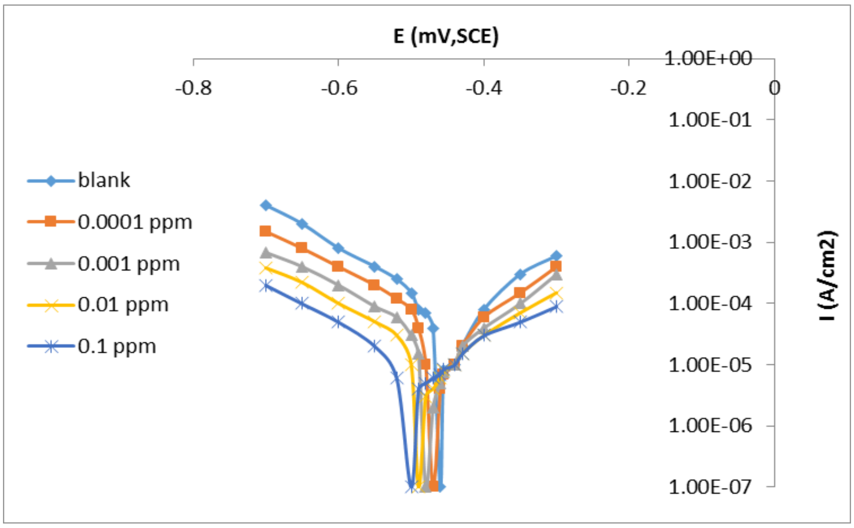

Fig.2: Polarization curves for steel at various concentrations of 2-Methoxymethyl-benzylamine in 1M HCl at 323 K

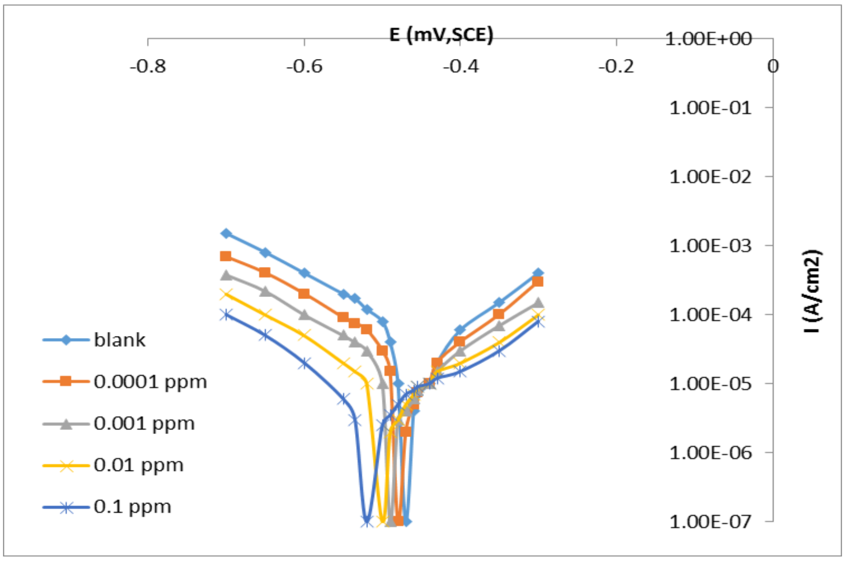

Fig.3: Polarization curves for steel at various concentrations of 2-Methoxymethyl-benzylamine in 1M HCl at 333 K

Table 1: Effect concentration of inhibitor on corrosion current density, corrosion potential and efficiency with various temperatures by using polarization method

Conc. of inhibitor ppm	E_{corr}, mV			Corrosion current density, µA/cm^2			Inhibition efficiency %		
	40˚C	50˚C	60˚C	40˚C	50˚C	60˚C	40˚C	50˚C	60˚C
0	-480	-470	-455	50	70	84	--	--	--
10^{-4}	-486	-480	-470	31	49	60	38.00	30.00	28.57
10^{-3}	-491	-584	-482	19	30	38	62.00	57.14	54.76
10^{-2}	-502	-496	-491	7	10	12	86.00	85.71	85.71
10^{-1}	-520	-500	-495	3	5	7	94.00	92.85	91.66

Table 2 shows that whenever increased corrosion inhibitor concentration decreased the corrosion rate increased inhibition efficiency at a temperature of 40 C, and so the same case in the 50 and 60 C, but the temperature increase efficiency decreases depending on the decrease corrosion rates and all this is in the way the loss of weight as in Fig.4 and 5.

Table2: Effect concentration of inhibitor on corrosion current rate and efficiency with various temperatures by using weight loss method.

Conc. of inhibitor ppm	Corrosion rate (mmpy)			Inhibition efficiency %		
	40˚C	50˚C	60˚C	40˚C	50˚C	60˚C
Blank	1.33	1.56	1.78	0	0	0
10^{-4}	0.79	1.07	1.27	40.60	31.47	28.48
10^{-3}	0.47	0.70	0.73	60.44	55.22	58.77
10^{-2}	0.21	0.31	0.37	83.73	80.08	78.95
10^{-1}	0.10	0.14	0.20	92.84	90.77	88.67

Table 3, and Figs. 6&7,Was calculated kinetic factors such as the energies of both the activation, enthalpy , entropy and free of adsorption, and note that an increase of corrosion inhibitor increases the activation energy and the energy of enthalpy especially in high concentrations a sign that the activation energy of the corrosion inhibitor is an excellent high-impact effectively protect the metal,The energy entropy decreased significantly sign that random in the system has decreased and is considered a measure of random and non-uniformity . And the free energy of adsorption increased and grown a good indication of the adsorption of the metal surface by corrosion inhibitor. Thus we note that action of inhibitor is chemical adsorption on the metal surface as a result it contains atoms of nitrogen and oxygen which have an effective role in adsorption process [10,11].

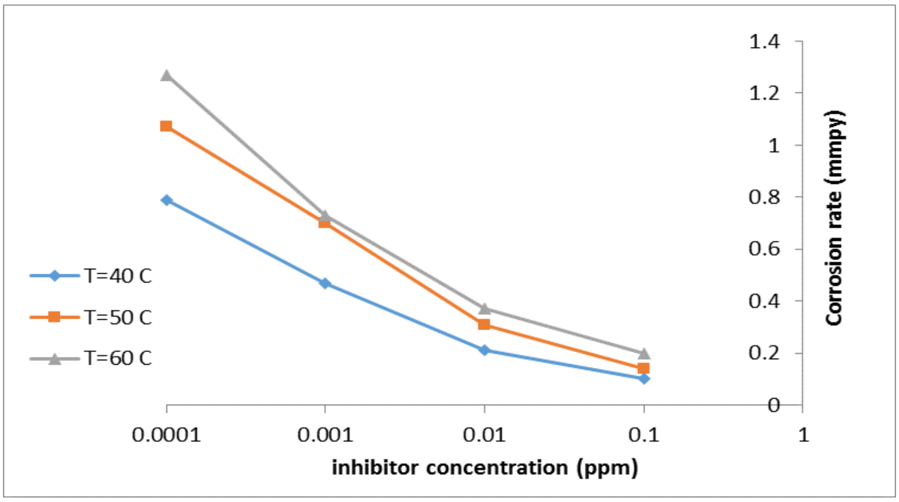

Fig.4: Effect inhibitor concentration on corrosion rate with various temperatures

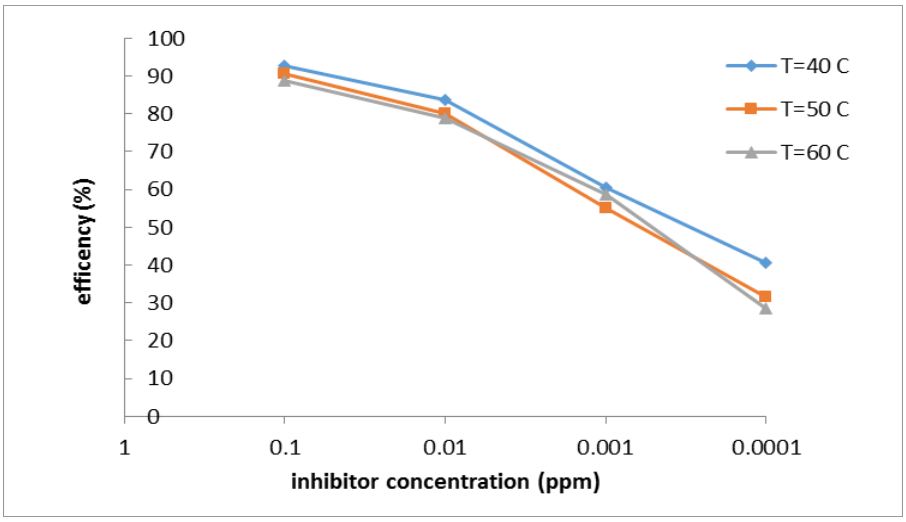

Fig. 5: Effect inhibitor concentration on efficiency with various temperatures

Arrhenius equation is calculated by: [12]

$$k = Ae^{-Ea/RT} \qquad (2)$$

Where, k is the rate of a reaction , T is absolute temperature , A is the pre-exponential factor , E_a is the activation energy, and R is the universal gas constant = (8.314 J mole^{-1} K)

Kinetic parameters may be evaluated from the effect of temperature, such as enthalpy and entropy from an alternative formulation of Arrhenius equation is: [13]

$$k = \frac{RT}{Nh} e^{(\frac{\Delta S}{R})} . e^{(-\frac{\Delta H}{RT})} \qquad (3)$$

Where, h the Plank's constant = (6.626*10^{-34} J sec moL^{-1}), N is the Avogadro's number = (6.022*10^{23} molecule. moL^{-1}), ΔS and ΔH the entropy and enthalpy energies, respectively.

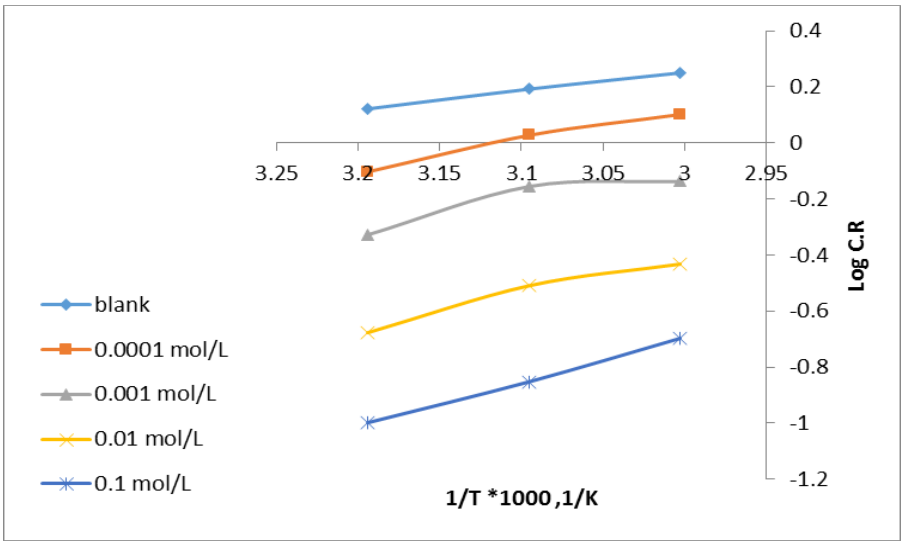

Fig.6: Relation between Log C.R with 1/T at conc. inhibitors different

Fig.6, represents Arrhenius plot Log C.R vs. 1/T without and with inhibitor, where corrosion rate (C.R) is calculated by:

$$(C.R) = \frac{87.6 * w}{D * a * t} \tag{4}$$

Where, C.R is corrosion rate (mmpy), w is weight loss (mg), D is alloy density (g/cm³), a is exposed area (cm²), t is exposure time (hr). [14]

$$\Delta G = \Delta H - T\Delta S \tag{5}$$

Where, ΔG is free energy for adsorption.

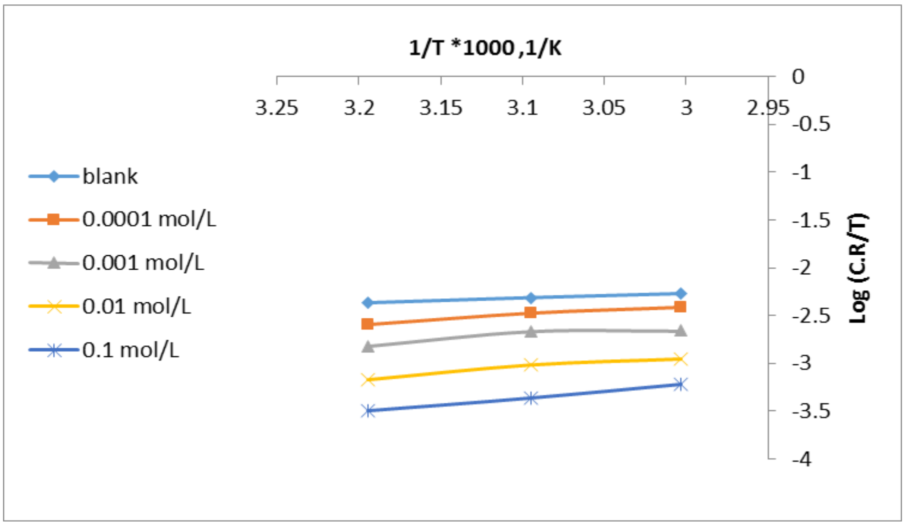

Fig.7: Relation between Log (C.R/T) with 1/T at conc. inhibitors different

Table 3: Effect of inhibitor concentration on thermodynamic kinetic parameters activation, enthalpy, entropy and free energies

Conc, of inhibitor ppm	E_a(kJ/mol)	ΔH (kJ/mol)	ΔS (kJ/mol.k)	ΔG_{ads} (kJ/mol) at 298 K
Blank	53.68	42.69	-0.1014	72.90
10^{-4}	86.64	75.65	-0.1036	106.52
10^{-3}	80.73	69.31	-0.1047	100.51
10^{-2}	103.97	92.56	-0.1064	124.26
10^{-1}	127.64	115.81	-0.1081	148.02

Table 3 illustrate effect of inhibitor concentration on activation, enthalpy, entropy and free energies ,where that To increase the concentration of the inhibitor increases energy both activation, enthalpy , free of adsorption , and decreasing entropy energy , this refers to the formation of a layer of film on the metal surface activated and growing adsorption , while the adsorption be a regular , non- random molecules of nitrogen and oxygen in the compositional structure of the inhibitor corrosion which have effective and clear effect of the adsorption. Adsorption here and be the kind of chemisorption, where the activation energy is higher than 80 kJ /mol. [11,15]

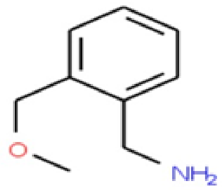

Fig.8: Structure of inhibitor 2-Methoxymethyl-benzylamine

IV. Conclusions

- The results showed that the corrosion potential tends to mixed type between the anode and cathode**.**
- Corrosioninhibitor is effective and good efficiency when increasing concentrations of inhibitor corrosion and less efficiency increase of temperature in both methods weight loss and polarization.
- Calculation of thermodynamic factors such as the energies of activation, enthalpy, entropy and free of adsorption and showed good results.
- Kind of adsorption is chemical to the surface of the metal.

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