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# Inhibition by 4-Chloro-2-FluoroBenzylamine Hydrochloride for Corrosion for Mild Steel in HCl Media

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## ABSTRACT
In this paper were studied inhibition by 4-Chloro-2-fluorobenzylamine Hydrochloride for corrosion for mild steel in HCl media with inhibitor concentrations 100-300 ppm and temperatures 40-60 C, where show results that inhibitor above is from good type for mild steel and these above conditions, thus efficiency of inhibition increase with increasing inhibitor concentrations and decreasing temperatures. weight loss and hydrogen gas evolution methods were used in process , and the activation energy increase with increasing inhibitor concentration thus energy enthalpy and free energy of adsorption with increased ,adsorption be chemisorption with addition inhibitors. Existence atoms chlorine, fluorine and $H_2N$ in structure of inhibitor have clear indicator in formation film layer on metal surface and stopped from corrosion reaction in process.
**Keywords**:4-Chloro-2-fluorobenzylamine Hydrochloride;HCl; mild steel; weight loss;polarization

## INTRODUCTION
The corrosion of the problems that threaten the technology and the global economy so that the degree of progress.(1). Continuous coating of steel structures is the treatment of the fact that this steels exposed to corrosion and has a growing problems.(2)
The corrosion inhibitors when added to the solution and the metal work on the block and corrosion inhibition against acids and keep the metal and have a good efficiency. (3,4,5)
The mild steel with extensive use of the metals industries , so faces in most cases to corrosion as a result of exposure to aggressive environments such as acids , salts , etc., then it must reduce this phenomenon , using corrosion inhibitors to protect the metal.(6,7,8)
Investigators (9), were studied of Passivation films, formed by the anodization of copper in alkaline benzotriazole (BTA) solutions, have been examined. Adding of benzylamine to the anodizing solutions was found to lead to much faster passivation and larger corrosion resist in aqueous chloride. These passivation films appear to consist mainly of a $[Cu(II)BTA_2]n$ polymeric network.
Scientists (10) ,were investigated Corrosion inhibition of Al-Mg alloy in 2.0 M HCl in without and with of various concentration of Benzylamine-N-(p-methoxybenzylidene) . Weight loss , galvanostatic polarization, , scanning electron microscopy (SEM) and electrochemical impedance spectroscopy (EIS) were employed. The inhibition efficiency reduced with increase in temperature and increased with enlarges inhibitor concentration. The adsorption of Schiff base was found to follow Langmuir adsorption isotherm. To elaborate the mechanism of corrosion inhibition, thermodynamic factors$\Delta G_{ads}$,$Q_{ads}$ and energy of activation ($E_a$) were calculated. The inhibitor is of mixed type as the polarization measurement indicated .Electrochemical impedance and scanning electron microscopy were used to investigate the mechanism of corrosion inhibition and the surface characteristics of inhibited and uninhibited metal respectively.
Researcher (11) , was studied of corrosion inhibition of steel in hydrochloric acid using 2-methoxy methyl-benzyl amine reaching from 0.0001 -0.1 ppm concentrations , and temperatures ranging 313-333 K and by the techniques of both polarization and weight loss . The results exhibited that the corrosion potential inclines to mixed kind between the anode and cathode, and this kind of corrosion inhibitors is active and good efficiency when increasing concentrations of inhibitor corrosion and efficiency increase of temperature as well as the calculation of thermodynamic parameters such as the energies of both the activation, enthalpy, entropy and free of adsorption and exhibited good results and also type of adsorption is chemical onmetal surface .

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## EXPERMENTAL WORK

Mild Steel specimen of composition, (wt. %): 0.12% C, 0.31% Mn, 0.16% Si, 0.08% S, 0.40% P, 0.020% Cu, and bal. Fe. The metal sample were ready, removed grease and freshbefore described .By loss of weighttechnique, seven mild steel coupons of dimension 4.2cm x 2.2cmx0.21cm were used in the testswith 1M HCl with the five different concentrations 100,150,200,250 and 300 ppm of 4-Chloro-2-fluorobenzylamine Hydrochloride (Purity, 97 %) used as inhibitor, and temperatures 40 ,50 and 60 C.So test was using hydrogen gas evolution technique with 50 ml volume every experiment without and with inhibitors.

## RESULTS AND DISCUSSION

Figure 1, shows large deviation of weight loss with time without and with inhibitor, when adding inhibitors lead to weight loss or corrosion rate decrease of mild steel in HCl ,accord equation 1 in below, when a slow increase of the inhibitor concentration , decreased weight loss of mild steel in acid media at temp.40 C, as well as observe the same indicator in Figure 2 and 3 at temperature 50and 60 C, respectively. These results are according to researchers.(10)

The inhibition efficiencies(%$E$) were estimated from the equation below:

$$\% E = \frac{W_u - W_i}{W_u} \qquad 1$$

Where $w_u$ and$w_i$ are the weight loss data of metal coupons uninhibited and inhibited respectively.

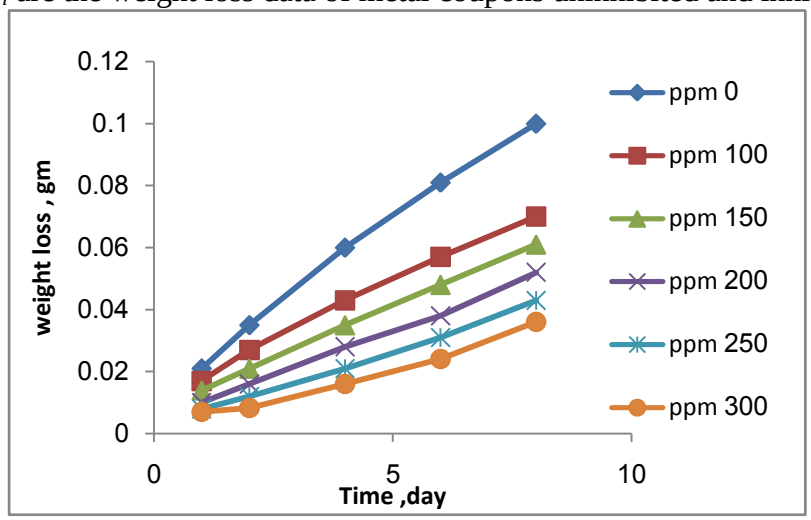


**Figure 1 :**Variation of weight loss with time for mild steel in 1M HCl acid solution containing different concentrations of 4-Chloro-2-fluorobenzylamine Hydrochloride at 40ºC

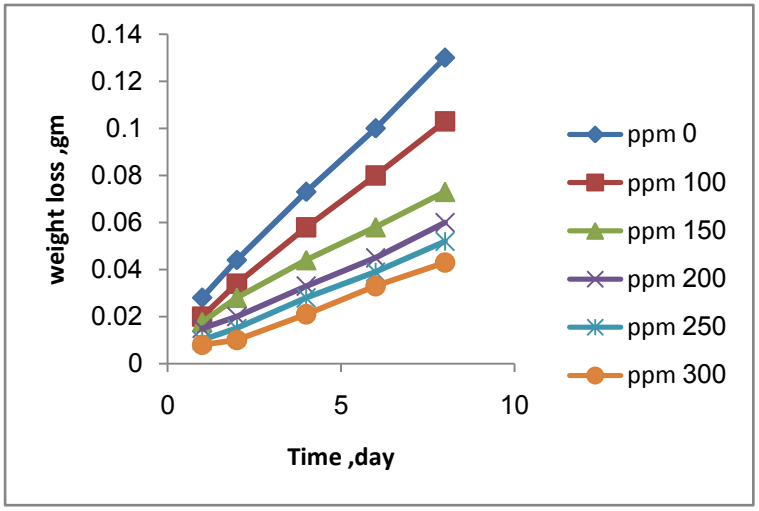


**Figure2::**Variation of weight loss with time for mild steel in 1M HCl acid solution containing different concentrations of 4-Chloro-2-fluorobenzylamine Hydrochloride at 50ºC

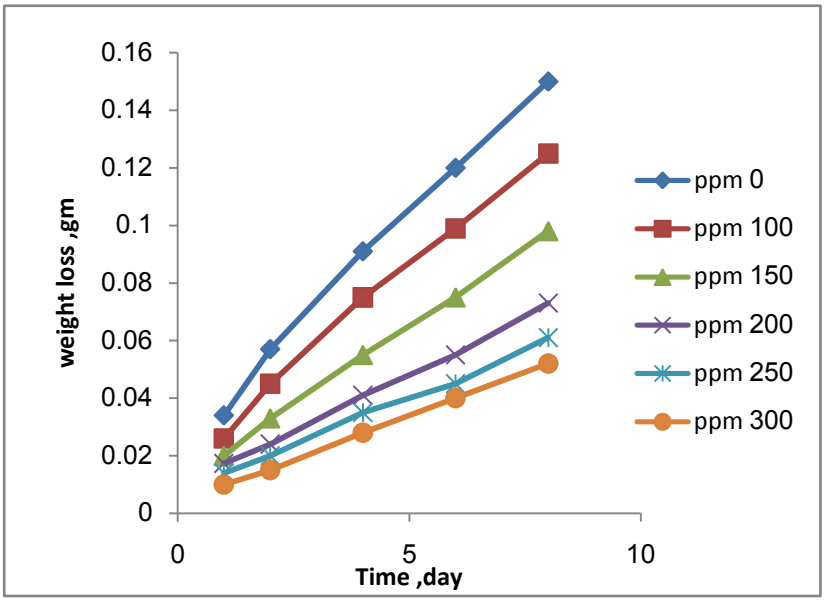


**Figure 3:** Variation of weight loss with time for mild steel in 1M HCl acid solution containing different concentrations of 4-Chloro-2-fluorobenzylamine Hydrochloride at 60ºC

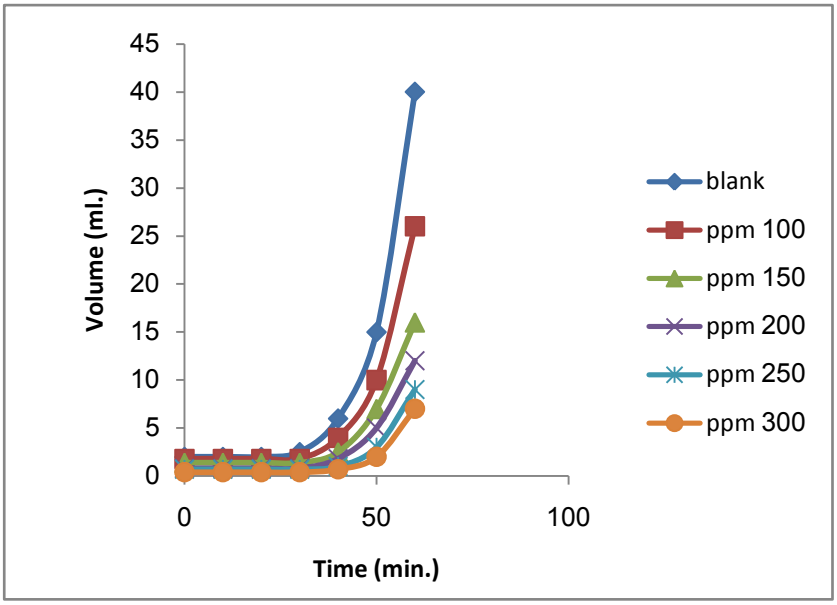


**Figure4:**Relationbetween volume of hydrogen gas evolved with time (minutes) for the inhibition of mild steel in 1M HCl acid solution containing different concentrations of 4-Chloro-2-fluorobenzylamine Hydrochlorideat 40ºC

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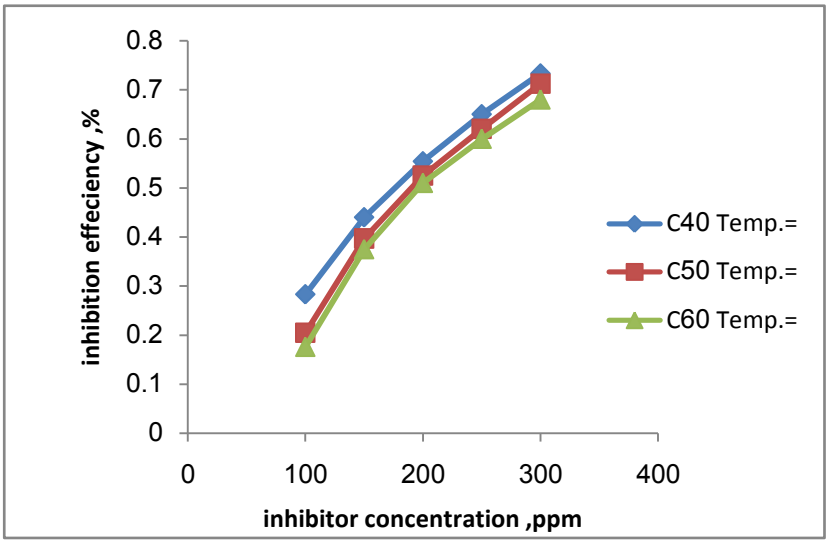


**Figure5:** Variation of inhibition efficiency with inhibitor concentration for mild steel in 1M HCl acid solution containing different concentrations of 4-Chloro-2-fluorobenzylamine Hydrochloride

Fig.4 shows relation between volume of $H_2$ evolved with time, we note decreasing of volume $H_2$ evolved with increasing concentrations of inhibitor.(11)

**Table1:**Effect inhibitor concentration on percentage inhibition efficiency at different temperature.

| **Inhibitor conc.ppm** | **percentage inhibition efficiency %** | | |
|---|---|---|---|
| | 40 C | 50 C | 60 C |
| 100 | 28.3 | 20.5 | 17.6 |
| 150 | 44.0 | 39.7 | 37.5 |
| 200 | 55.4 | 52.5 | 51.0 |
| 250 | 65.0 | 62.0 | 60.0 |
| 300 | 73.3 | 71.2 | 68.0 |

Table 1 and Fig.5 showesinfluenceinhibitor concentration on effeciency with temperatures variouswhere we note with increase concentration of inhibitor cause increasing effeciency.(10,11)
Figure 6, represents Arrhenius plot, Log C.R vs. 1/T uninhibited and inhibited and corrosion rate (C.R) is calculated by**:**

$$(C.R) = \frac{87.6 * w}{D * a * t} \qquad 2$$

Where, *C.R* is corrosion rate (mmpy) , *w* is loss of weight (mg) , *D* is density of alloy (g/cm$^3$) , *a* is exposed area (cm$^2$), *t* is exposure time (hr).(12)

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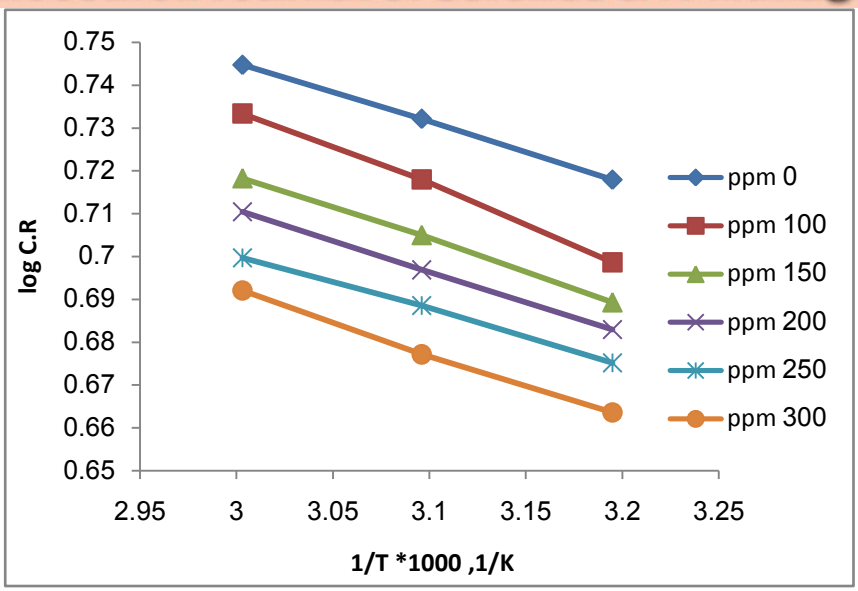


**Figure 6:** Relation between log(C.R) and 1/T for different inhibitors conc.

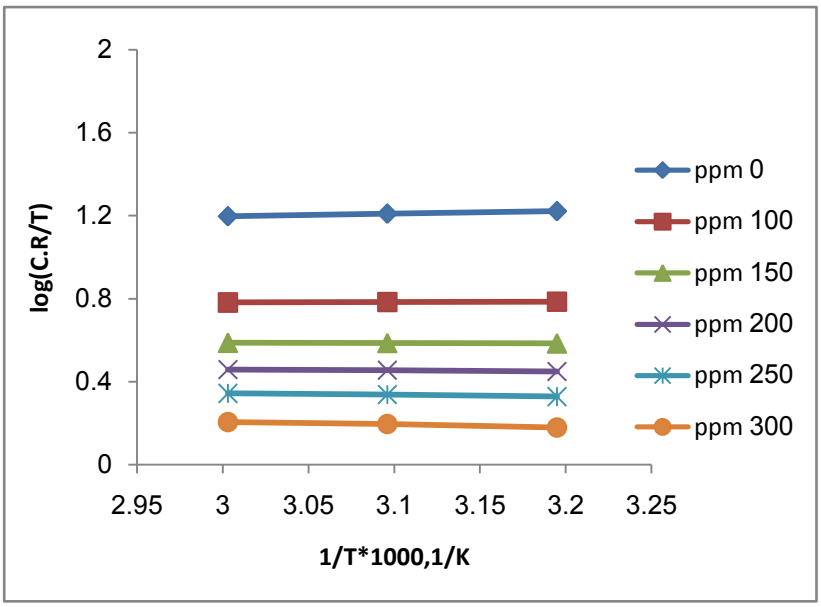


**Figure7:**Relation between log(C.R/T) and 1/T in 1M HCl for different inhibitors conc.

**Table2:**Thermodynamic adsorption parametersEa , ΔH , ΔS and $\Delta G_{ads}$ for mild steel in 1M HCl acid solution without and with concentrations of4-Chloro-2-fluorobenzylamine Hydrochloride.

| Conc, of inhibitor ppm | $E_a$(kJ/mol) | ΔH (kJ/mol) | ΔS (kJ/mol.k) | $\Delta G_{ads}$ (kJ/mol)at 298 K |
|---|---|---|---|---|
| Blank | 75.65 | 0.00100 | -0.0754 | 22.470 |
| 100 | 229.46 | 0.00015 | -0.0760 | 22.648 |
| 150 | 234.45 | 0.00014 | -0.0767 | 22.856 |
| 200 | 274.36 | 0.00037 | -0.0771 | 22.976 |
| 250 | 307.61 | 0.00066 | -0.0773 | 23.036 |
| 300 | 274.36 | 0.00110 | -0.0776 | 23.125 |

The activation energy $E_a$, the enthalpy energy ΔH, the entropy energy ΔS and free energy ΔG for mild steel in 1M HCl acid solution without and with inhibitor 4-Chloro-2-fluorobenzylamine Hydrochloride and from Arrhenius equation were calculated ,equations 3 ,4 and 5.(13)

$$R_{corr} = Ae^{-Ea/RT} \quad 3$$

$$R_{corr} = \frac{RT}{Nh} e^{\left(\frac{\Delta S}{R}\right)} . e^{\left(-\frac{\Delta H}{RT}\right)} \quad 4$$

$$\Delta G = \Delta H - T\Delta S \quad 5$$

where, $R_{corr}$ is the rate of corrosion by weight loss, A is the frequency factor, *N* is Avogadro's number,*h* is Planck's constant and R is the universal gas constant.

Chemisorption and physisorption are kinds of adsorption processes where that if energy of activation$E_a$is above 80KJ/mol then the process is chemisorption ,or below 40 KJ/mol is physisorption(11,14) , and this note in table 2 and chemisorption of processbecause of presence of cationic surfactants and activation energy $E_a$ increasing by increasing concentration inhibitor and formation adsorption film on metal surface ,thus free adsorbed energy increase with inhibitor concentration due existence atoms chlorine ,fluorine, and $H_2N$ in structure of inhibitor as Fig.8 and that active part in adsorption process where action on creation layer from inhibitor on surface stopped from corrosion process.(9,10,11)

fluorobenzylamine

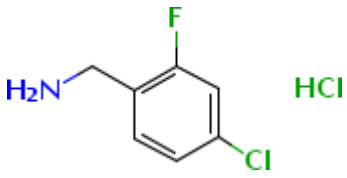


**Figure8:**structure of inhibitor 4-Chloro-2-Hydrochloride

## CONCLUSIONS

- Inhibition efficiencies increase with increasing inhibitor concentrations and with decreasing temperatures.
- Both activation, enthalpy, entropy and free adsorbed energies increasing with increase concentration of inhibitors.
- Good kind of inhibitor 4-Chloro-2-fluorobenzylamine Hydrochloride in process.
- Presence atoms chlorine, fluorine and $H_2N$ in structure of inhibitor have clear pointer in formation film layer on metal surface and stopped from corrosion reaction in process.

## REFERENCES

[ 1]. Abiola O K and Oforka N C, J CorrSci Eng., 2002, **3**(21), 117-124.

[ 2]. Ita B I and Edem C A, Global J Pure Appl Sci., 2000, **6**(2), 239 -242
[ 3 ] . Emregul K C and Hayvali M 2004 Mater. Chem. Phys. **83** 209
[ 4] . Khaled K F, Babic-Samardzija K and Hacker-man N 2004 J. Appl. Electrochem. **34** 697

[5].Quraishi M and Sharma H 2005 J. Appl. Electrochem. **35** 33

[6]. P. S. Desai and S. M. Kapopara, "Inhibiting effect of anisidines on corrosion of aluminumin hydrochloric acid," Indian Journal of Chemical Technology, vol. 16, no. 6, pp. 486–491, 2009.

[ 7 ] . A. S. Fouda, G. Y. Elewady, andM. N. El-Haddad, "Corrosion inhibition of carbon steel in acidic solution using some azodyes,"Canadian Journal on Scientific and Industrial Research,vol. 2, no. 1, pp. 1–18, 2011.

[ 8]. M. Ramananda Singh, K. Bhrara, and G. Singh, "The inhibitory effect of diethanolamine on corrosion of mild steel in 0.5M sulphuric acid medium," PortugaliaeElectrochimicaActa, vol. 26, pp. 479–492, 2008.

[9]. M. Fleischmann, I.R. HillG. Mengoli, M.M. Musiani "The synergetic effect of benzylamine on the corrosion inhibition of copper by benzotriazole**",**ElectrochimicaActa **,**Volume 28, Issue 10, October 1983, Pages 1325–1333

[10]. A S Patel, V A Panchal and N K Shah," Electrochemical impedance study on the corrosion of Al-Pure in hydrochloric acid solution using Schiff bases", Bull. Mater. Sci., Vol. 35, No. 2, April 2012, pp. 283–290

[11].R.A. AL-Uqaily," Corrosion Inhibition of Steel in HCL Media Using 2- Methoxymethyl-Benzlamine", IOSR Journal of Applied Chemistry (IOSR- JAC), Volume 8, Issue 4 Ver. II (Apr. 2015), PP 50-55.

[12].Muhamath, B.M. Ali, Kulanthai, Kannan, " Inhibition effect of PartheniumHystophrous L. extracts on the corrosion of mild steel in sulphuric acid ", *J.Appl.Sci. Environ.Management* 13 (2009) 27-36.

[13]. Arab, S.T., Emran, K.M.,."Thermodynamic study on Corrosion Inhibition of Fe78B13Si9 Metallic Glass Alloy in Na2SO4 Solution at Different Temperatures"*International Journal of Applied Chemistry*, No.1, Vol. 3 , pp.69-84, 2007.

[14] - James AO, Oforka NC, Olusegun K. Abiola.,"Inhibition of acid corrosion of mild steel by pyridoxal and pyridoxolhydrochlorides",*International of ElectrochemicalScience*. ;(2):278-284, 2007.