The Inhibition of Mild Steel Corrosion in Acidic Solution by Amine Melamine Chloral Resin

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Abstract

The effect of amine melamine chloral resin on the corrosion of mild steel in acidic media (1N H_2SO_4) has been investigated using weight loss measurements. The thermodynamic functions were calculated from weight loss data and interpretation of the results are given .The results obtained showed that the resin could serve as an effective inhibitor for the corrosion of mild steel in sulphuric acid media . Inhibition was found to increase with an increasing of time but decreasing with increasing temperature.

Introduction

The effect of inhibitors adsorbed on metallic surface in acid solutions is to slow down the cathodic reaction as well as the anodic process of dissolution of the metal. Such effect is obtained by forming barrier film by means of the blockage of the reaction sites (Mora-Mendoza et al.,2002).

The molecules that contain both of nitrogen and sulfur atoms in their structures are of particular importance. Since these provide an excellent inhibition compared with those which contains only nitrogen or sulfur (Schmitt,1984). The corrosion inhibition of these compounds is attributed to their molecular structure. The planarity and the lone pairs of electron in the hetro atoms determine the adsorption capability of these molecules on the metallic surface (Quraishi& Sharma,2002).

The heterocyclic compounds containing nitrogen or sulfur atoms are good corrosion inhibitors in aggressive media (Bentiss et al.,2001; Elazhar et al.,2002; Bentiss et al.,2004).

Recently many workers have reoriented their attention to the development of new corrosion inhibitor based on organic compounds such as pyrazole (Touhami et al.,1999), triazole (Kertit et al,1997), tetrazole (Kertit et al,1998), imidazole (

Gomma et al.,1007) and oradiazole derivatives (Bentiss et al.,2003).
Thermodynamic parameters such as adsorption heat, adsorption entropy and adsorption free energy can be obtained from experimental data of the studies of the inhibition process at different temperatures. The kinetic data such as apparent activation energy and pre experimental factor at different inhibitor concentration are calculated and discussed **(Osman,1998;Zhaa&Mu** ,**1999**).

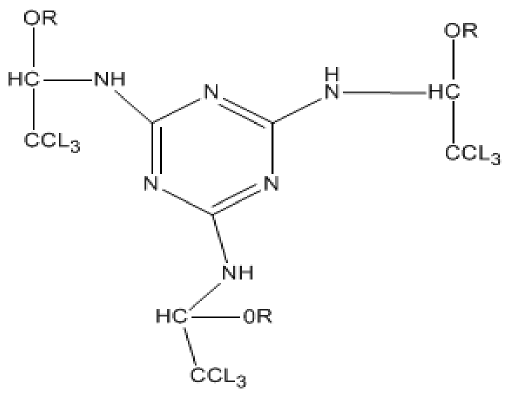
The aim of the present work is to investigate the amine melamine chloral resin on the corrosion behavior of mild steel in or 1N sulfuric acid medium employing the weight loss method. The thermodynamic parameters were calculated and discussed.

Experimental

1- Chemicals :

Melamine , chloral, diethanol amine and sulfuric acid were supplied by BDH company.

2-Amine melamine chloral resin was prepared according to the procedure explained in reference (Al-Luaibi,1995) to obtained the following structure



Where R ($-CH_2CH_2-NH-CH_2CH_2OH$)

3- Corrosion test:

Corrosion test was performed on a mild steel of the following percentage composition : 0.21% C ,0.38% Si , 0.09% P, 0.01% Al, 0.05% S, 0.05% Mn, and the reminder is iron.

For the gravimetric measurements a pre-treatment of the surface of specimens was carried out by grinding with emery paper of 600-1200 grit

Then rinse with double distilled water, ethanol and dried at room temperature before use.

The aggressive solutions 1N sulfuric acid were prepared in double distilled water.

Gravimetric experiments were carried out in double glass cell equipped with thermostat temperature . The solution volume was 100ml. The steel specimens had a rectangular form (2 cm length , 2cm width and 0.05 cm thickness). At the end of the test the specimens were thoroughly washed with ethanol and then weighted. Duplicate experiments were performed in each case and the mean value of the weight loss was reported.

Results and Discussion:

The effect of addition of amine melamine chloral resin on the corrosion of mild steel in 1 N sulfuric acid solution was studied by weight loss at various immersion period. Inhibition efficiency (% E) is calculated as follows:

$$\% E = \frac{W_{corr} - W_{corr(inh)}}{W_{corr}} \times 100$$

Where W_{corr} and $W_{corr(inh)}$ are the corrosion rates of mild steel in the absence and presence of the inhibitor respectively.

The effect of increasing time on the weight of mild steel in the inhibited and uninhibited acid solutions is shown in Fig.(1).

It is obvious that the weight loss varied linearly with immersion period in plain acid and inhibited acid which indicate the absence of insoluble product on the steel surface. The curve obtained in the presence of the inhibitor fall significantly below that of free acid. The relatively large divergence of the plots indicates the increase of % E with time as shown in Fig.(2).

To evaluate the adsorption of amine melamine chloral and thermodynamic parameters of corrosion process of mild steel in 1N sulfuric acid. The weight loss measurements were carried out in the range of temperature 303—333 °K in the absence and presence of inhibitor at various immersion periods Fig.(3) and Fig.(4). The data explain that the amine melamine chloral resin acts as a good corrosion inhibitor for the acid corrosion of mild steel. Since doubling the temperature leads to a slight decrease in the inhibition efficiency .

The apparent activation for the corrosion process is calculated from Arrhenius type plot according to the following equation :

$$W = K \exp^{-\Delta E}/^{RT}$$

Where :

E is the apparent activation corrosion energy

R is the universal gas constant.

K is the Arrhenius pre- expontial constant.

T is the absolute temperature.

Arrhenius plots for the corrosion rate of mild steel are given in Figs(5-11)

Values of ΔE for mild steel in 1 N H_2SO_4 with absence and presence of amine melamine chloral resin were determined from the slope of plotting L w versus 1/T .

An alternative formula of Arrhenius equation is :

$$W = {}^{RT/Nh\ \ \exp\ \Delta S/R}\ \ \exp\ {}^{-\Delta H/RT}$$

Where :

h: Plank's constant .

N: Avogadro number

ΔS: entropy

ΔH: the enthalpy.

Figs.(12-18) shows a plot of In W/T against 1/T a straight line were obtained with a slope of -ΔH/R and an intercept of (In R/nh +ΔS/R) from which the values of ΔH and ΔS are calculated . These values were listed in Table (1). The higher values of ΔE and ΔH in the presence of amine melamine chloral compared to that of pure acid indicate when the temperature increase resulted in the protection efficiency (Putilova et al.,1960). The negative value of ΔS implies that the complex represents an association rather than dissociation step which indicate a decrease in disordering for the forward reactions to the activated complex.

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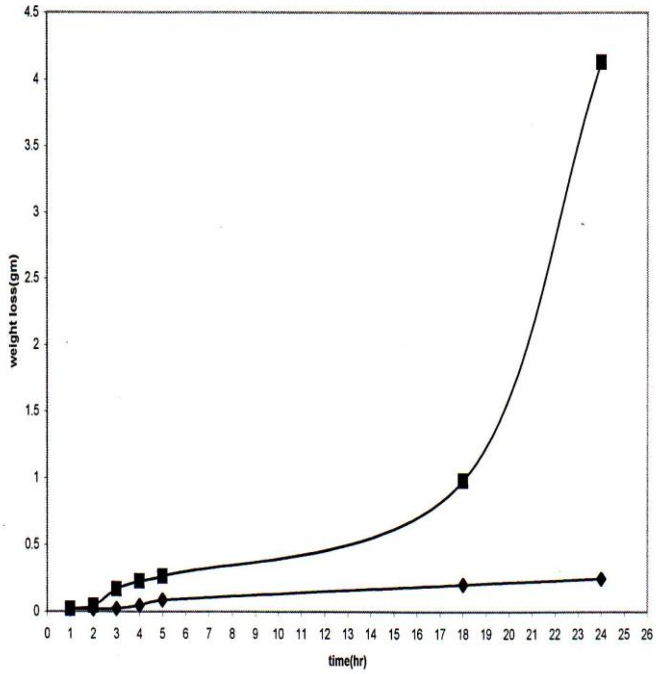
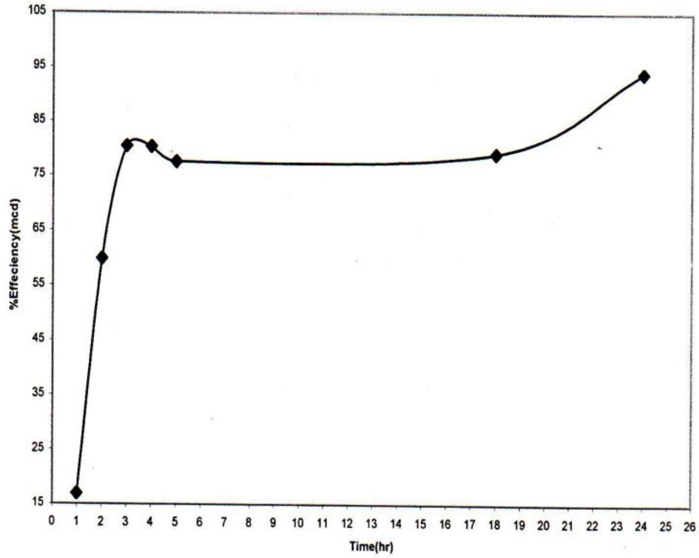
Table (1): Values of ΔE, ΔH and ΔS for mild steel in 1N H_2SO_4 in the absence and present of inhibitor at different time intervals.

Thermodynamic parameter With inhibitor			Thermodynamic parameter Without inhibitor			Time
ΔS	ΔH	ΔE	ΔS	ΔH	ΔE	
-68.70	74.61	77.30	-14.48	61.78	64.35	1hr
-68.83	69.64	62.30	-11.12	60.07	60.69	2hr
-58.82	64.33	66.97	-12.66	52.44	55.09	3hr
-66.12	46.20	48.84	-5.19	39.73	42.38	4hr
-120.98	55.45	58.11	-11.84	28.81	31.47	5hr
-118.9	43.47	46.14	-74.98	20.63	4.89	18hr
-9821	47.97	50.62	-33.87	4.94	19.11	24hr



Fig(1): Weight loss as a function of immersion time of mild steel; In 1 N H_2SO_4 ■ without inhibitor ♦ with inhibitor



Fig(2): Variation of %E with immersion time for mild steel in 1N H_2SO_4 containing inhibitor

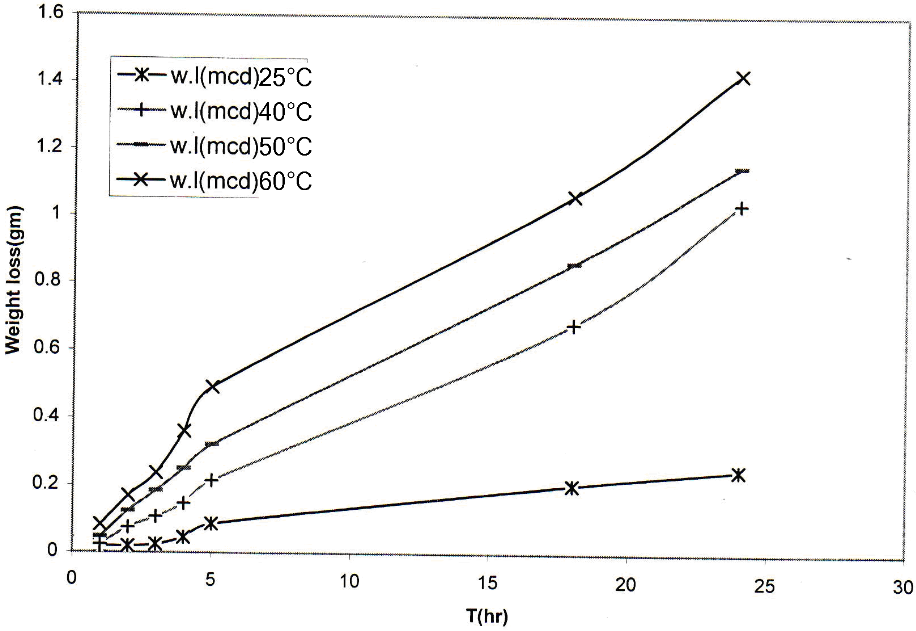


Fig.(3): Weight loss as a function of immersion time in the presence of inhibitor at different temperature.

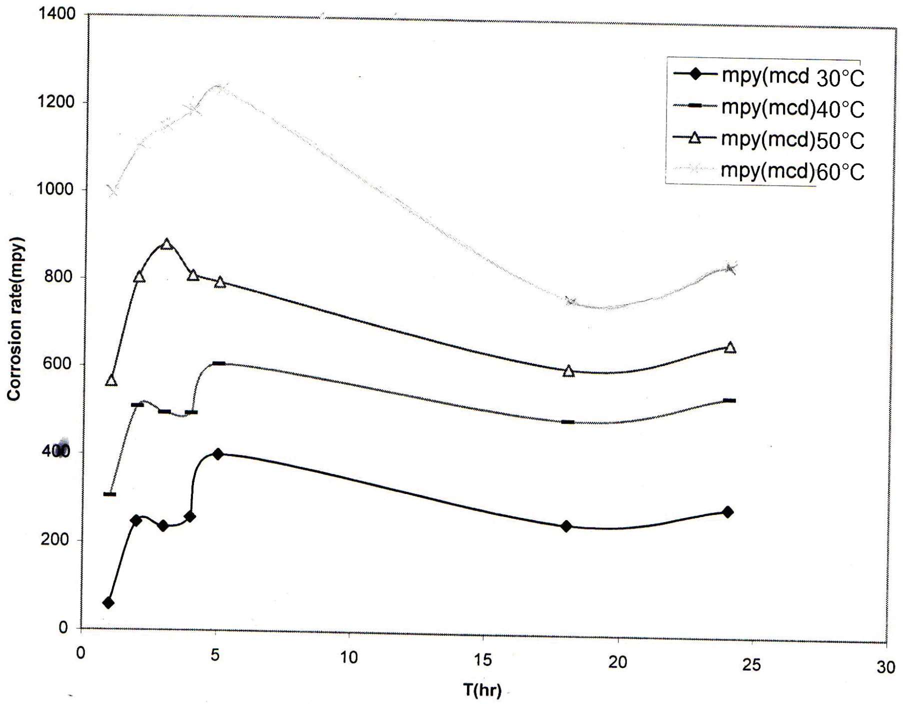


Fig.(4): Corrosion rate as a function of immersion time in the presence of inhibitor at different temperature

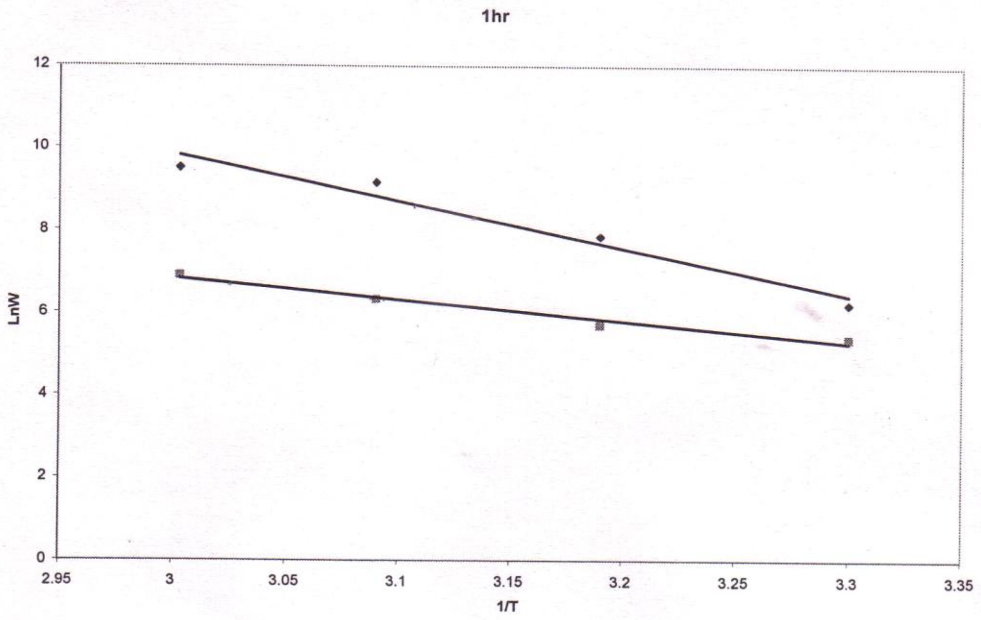


Fig.(5): Arrhenius plots of In w Vs 1/T at one hour

♦ without inhibitor ■ with inhibitor

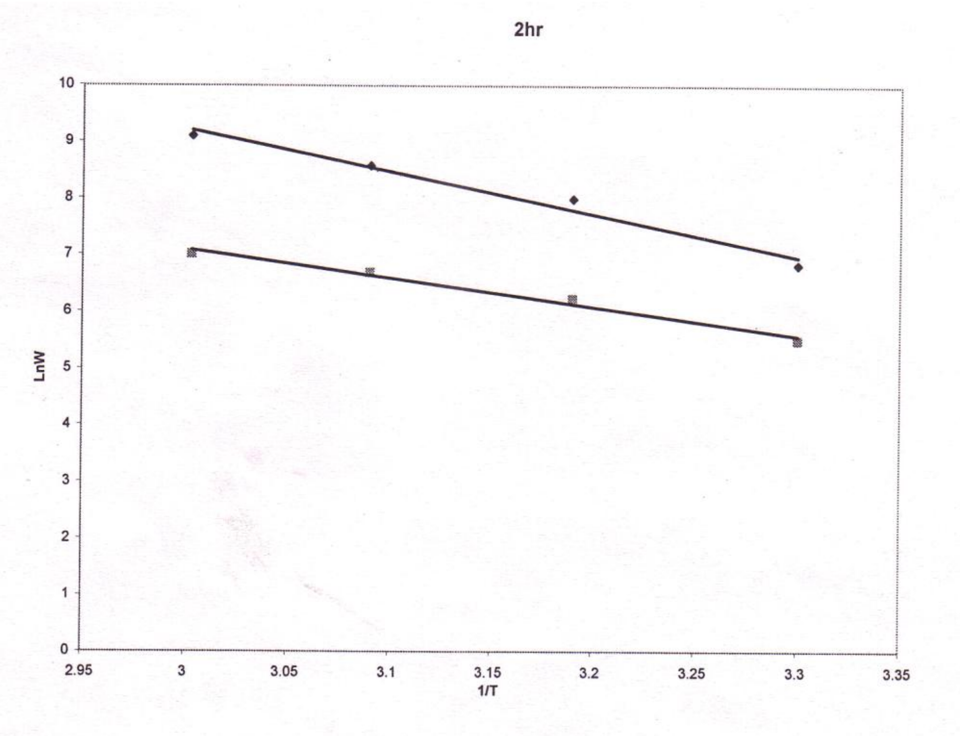


Fig.(6): Arrhenius plots of In w Vs 1/T at two hour

♦ without inhibitor ▄ with inhibitor

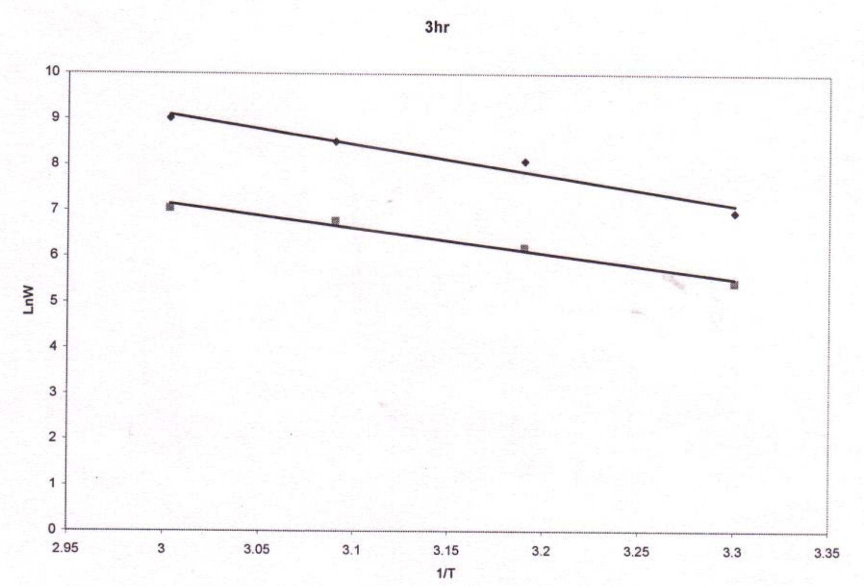


Fig.(7): Arrhenius plots of In w Vs 1/T at three hours

♦ without inhibitor ▄ with inhibitor

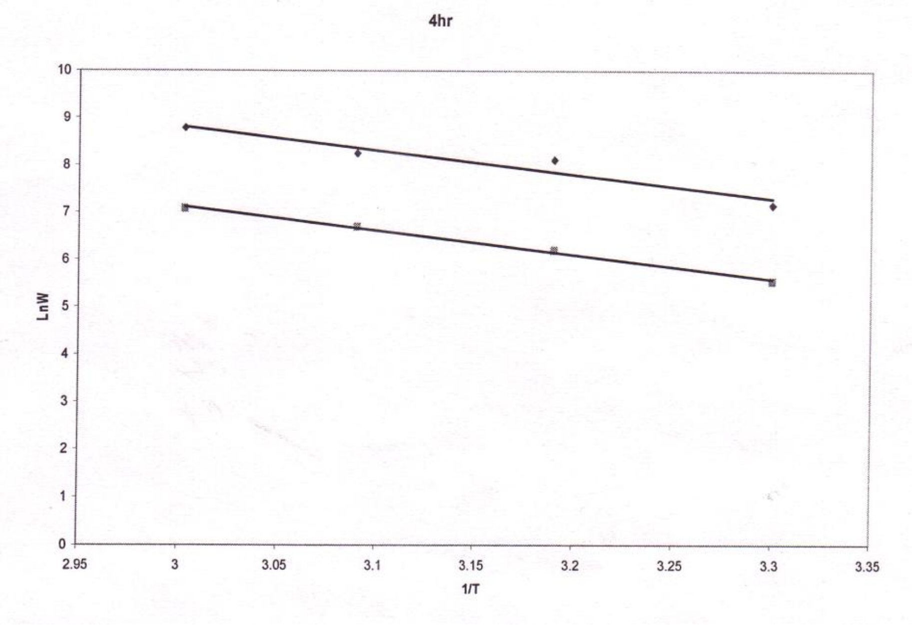


Fig.(8): Arrhenius plots of In w Vs 1/T at four hours
♦ without inhibitor ■ with inhibitor

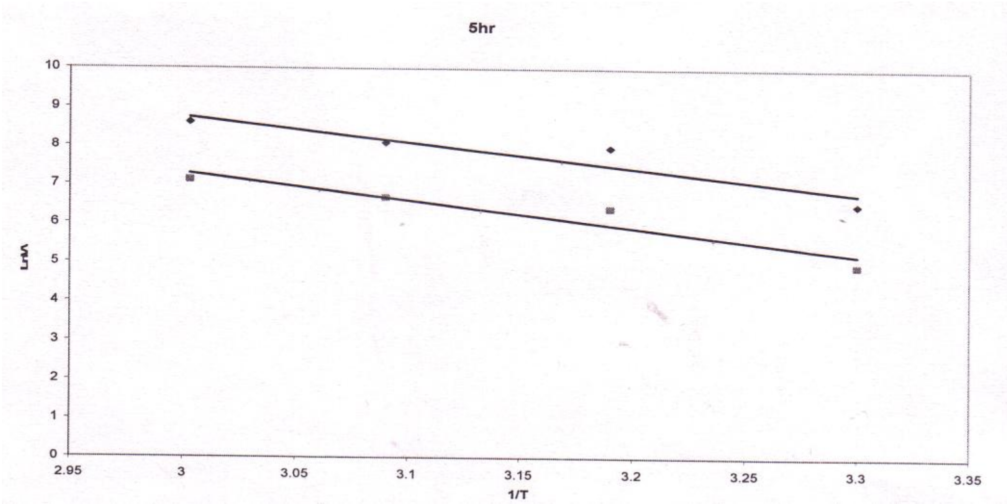


Fig.(9): Arrhenius plots of In w Vs 1/T at five hours
♦ without inhibitor ■ with inhibitor

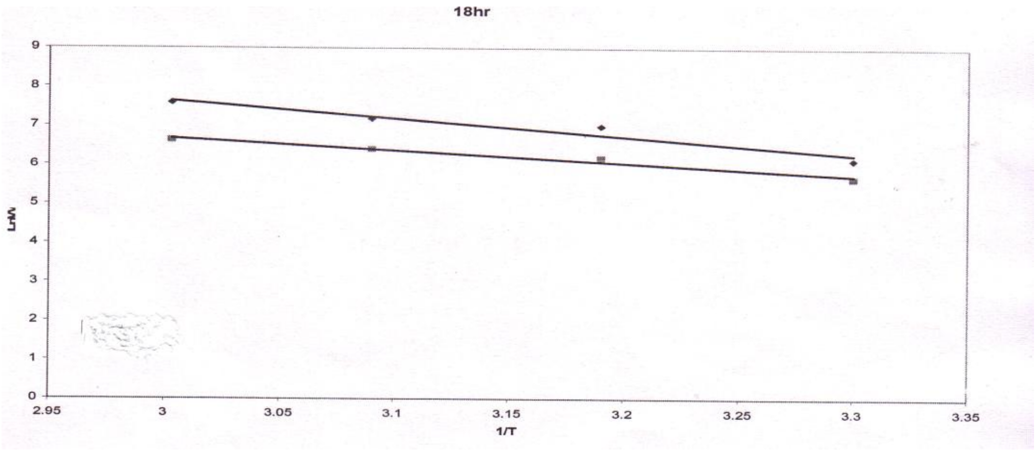


Fig.(10): Arrhenius plots of In w Vs 1/T at 18 hours
♦ without inhibitor ■ with inhibitor

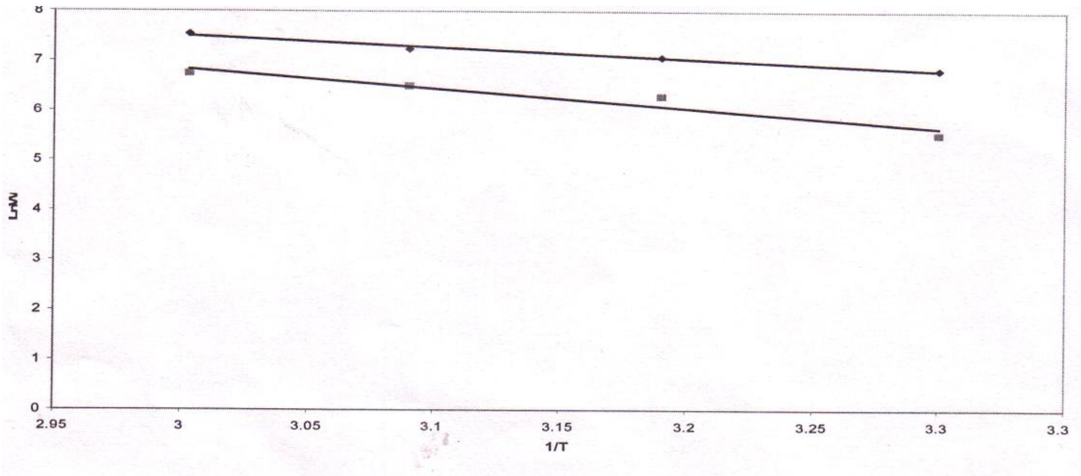


Fig.(11): Arrhenius plots of In w Vs 1/T at 24 hour
♦ without inhibitor ■ with inhibitor

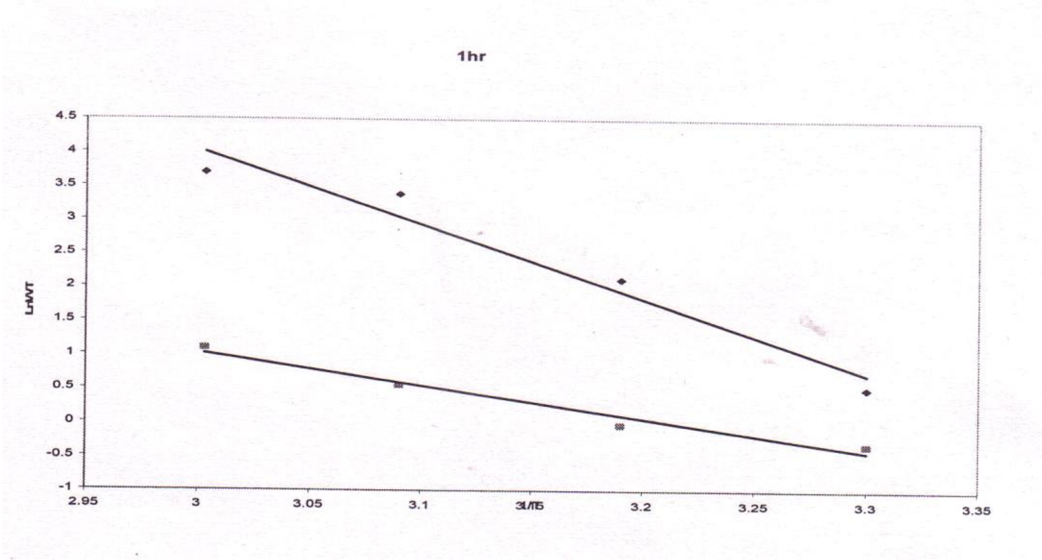


Fig.(12) Arrhenius plots of In w/$_T$ Vs 1/$_T$ at one hour

♦ without inhibitor ■ with inhibitor

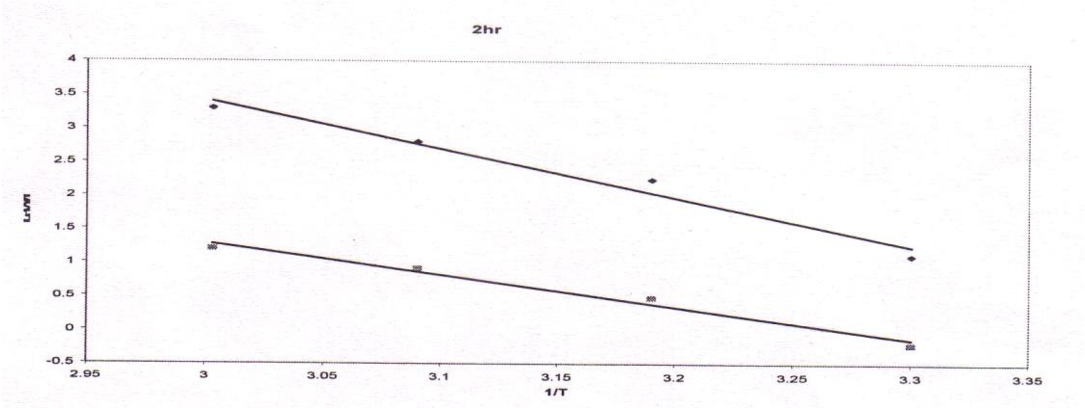


Fig.(13) Arrhenius plots of In w/$_T$ Vs 1/$_T$ at two hours

♦ without inhibitor ■ with inhibitor

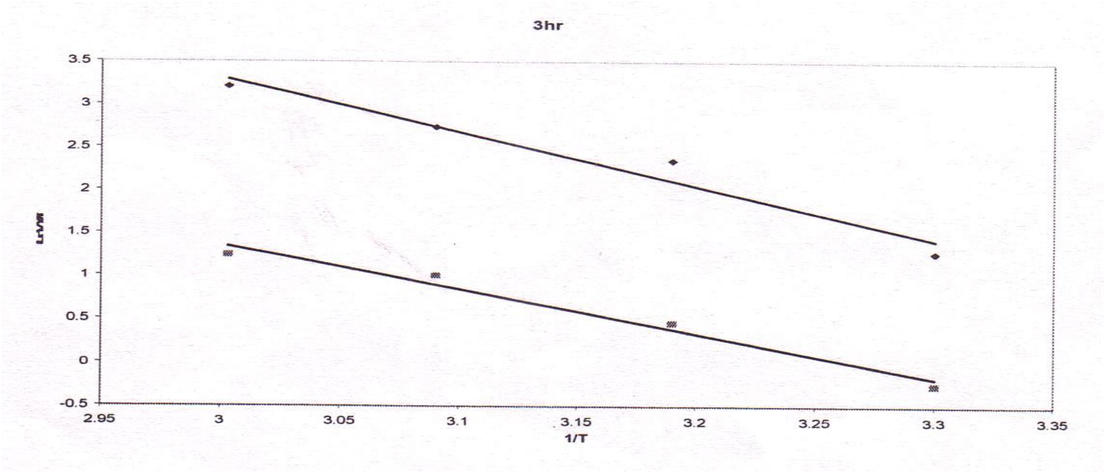


Fig.(14) Arrhenius plots of In w/$_T$ Vs 1/$_T$ at three hours

♦ without inhibitor ■ with inhibitor

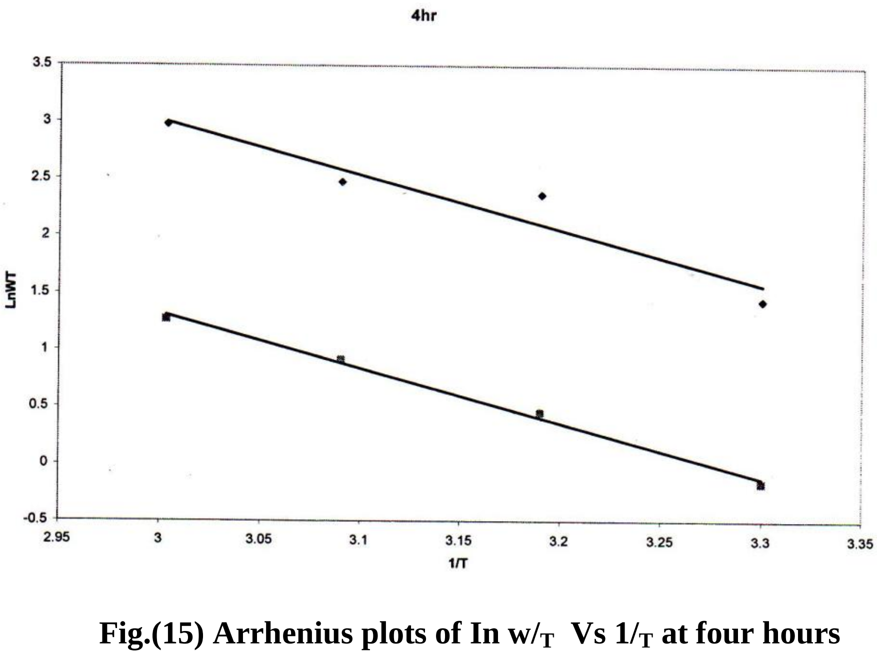


Fig.(15) Arrhenius plots of In w/$_T$ Vs 1/$_T$ at four hours

♦ without inhibitor ■ with inhibitor

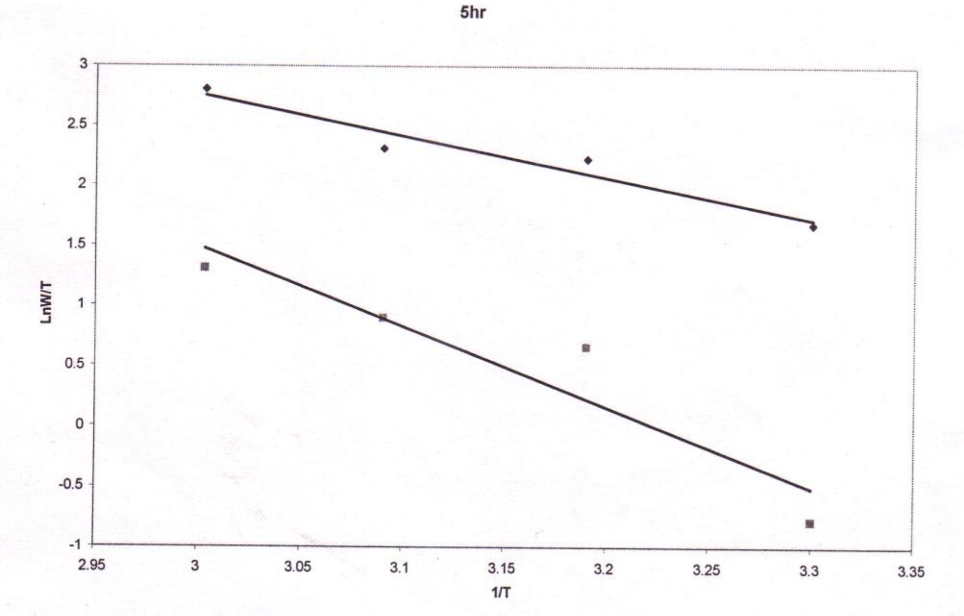


Fig.(16) Arrhenius plots of In w/$_T$ Vs 1/$_T$ at five hours

♦ without inhibitor ■ with inhibitor

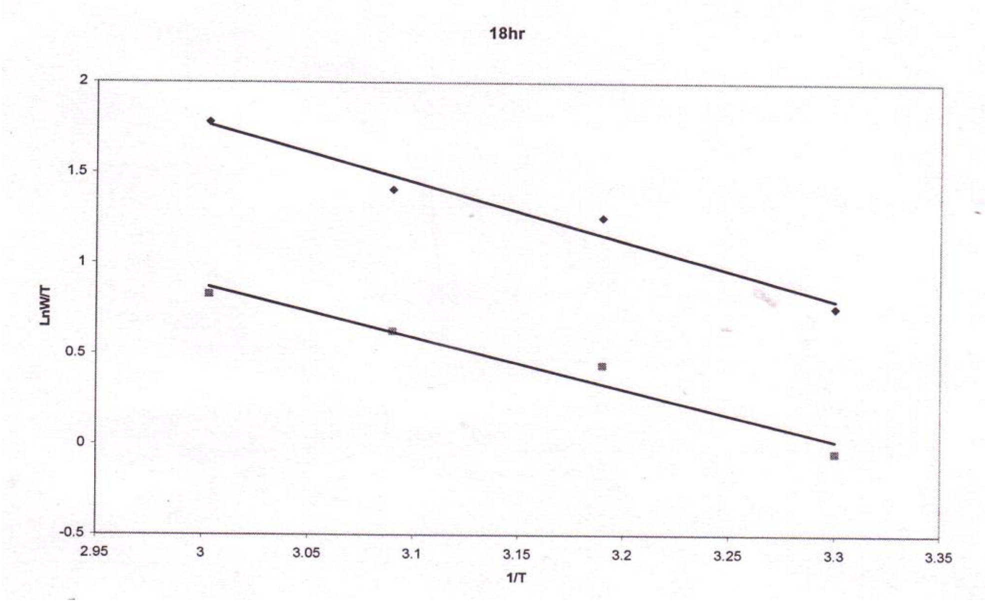


Fig.(17) Arrhenius plots of In w/$_T$ Vs 1/$_T$ at 18 hours

♦ without inhibitor ■ with inhibitor

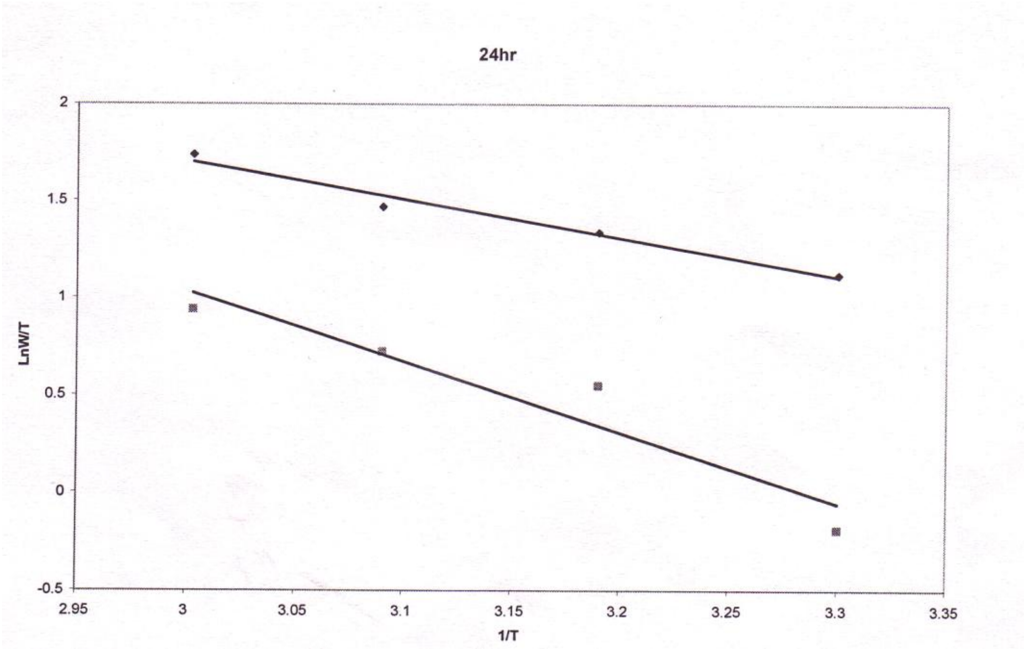


Fig.(18) Arrhenius plots of In w/$_T$ Vs 1/$_T$ at 24 hours
♦ without inhibitor ■ with inhibitor

تنشيط تأكل الفولاذ المعتدل في محلول حامضي بوساطة راتنـج الامين –الميلامين الكلورال

عبدالأمير حسين تعوبي

قسم الكيمياء- كلية العلوم-جامعة البصرة- البصرة- العراق

الملخــص:

تم بحث تاثير راتنج الامين- الميلامين الكلورال على تأكل الفولاذ المعتدل في وسط حامضي 1 نورمالي حامض الكبريتيك باستخدام قياسات الفقدان بالوزن . حسبت الدوال الثرموديناميكية من قراءات الفقدان بالوزن وأعطيت ترجمة للنتائج . بينت النتائج أمكانية استخدام راتنج الامين كمثبط مؤثر على تاكل الفولاذ المعتدل في وسط حامض الكبريتيك . وقد وجد ان كفاءة التثبيط تزداد مع زيادة الوقت لكن تقل مع ازدياد مدى درجات الحرارة