The Inhibition Effect of Peach Juice on Corrosion of Low Carbon Steel in Hydrochloric Acid at Different Temperatures

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Abstract

The corrosion inhibition of low carbon steel in1N HCl solution in the presence of peach juice at temperature (30,40,50,and 60)°C at concentration (5, 10, 20, 30, 40and 50 cm3/L)were studied using weight loss and polarization techniques. Results show that the inhibition efficiency was increased with the increase of inhibitor concentration and increased with the increase of temperature up to 50ºC ,above 50ºC (i.e. at 60 ºC) the values of efficiency decreases. Activation parameters of the corrosion process such as activation energies, Ea, activation enthalpies, ΔH, and activation entropies, ΔS, were calculated. The adsorption of inhibitor follows Langmuir isotherm. Maximum inhibition efficiency obtained was a bout 91% at 50ºC in the 50 cm3/L inhibitor concentration. The polarization curves show that peach Juice is a mixed inhibitor.

Keywords: low carbon steel, corrosion inhibition, peach juice, electrochemical method

Introduction

Corrosion inhibitors are widely used in industry to reduce the corrosion rate of metals and alloys in contact with aggressive environments. Most of the corrosion inhibitors are synthetic chemicals, expensive, and very hazardous to environments. Therefore, it is desirable to source for environmentally safe inhibitors [1-2]. There are some reports on the inhibition effects of non-toxic compounds on the corrosion of metals. We have recently reported the inhibition effect of amino acids on the steel [1] and aluminum [3] corrosion in acidic media. The inhibition effects of some non-toxic organic compounds have been also reported for steel corrosion [4, 5] but they are expensive.

Metals and alloy are exposed to the action of acids in industry [6]. Processes in which acids play a vary important part are acid pickling, industrial acid cleaning, cleaning of oil refinery equipment, oil well acidizing and acid descaling[6,7]. The exposure can be most sever but in many cases.

The aim of this study was to investigate the inhibition effect of peach Juice as a cheap, raw and non-toxic corrosion inhibitor on steel corrosion in hydrochloric acid. The electrochemical measurements were used to evaluate the inhibition efficiencies. In addition, the effect of temperature on inhibition behavior of the inhibitor was also studied.

Experimental Work

Materials and samples
Peach juice
Fully ripened peaches were purchased from a local market (Baghdad-Iraq) the fruits were washed in tap water and then mechanically compressed to obtain corresponding juice. The juice was then filtered to obtain a homogenous solution. In this process 300 ml peach juice from 1kg fresh was obtained. The extracted juice was kept frozen (< 00C) in glass bottles until farther experiment, the concentrations of inhibitor were chosen as5, 10, 20, 30,40and50 cm3/L Properties of peach juice:

pH = 3.72 , Density = 1.078 g/ml

Low carbon steel

The material of electrodes used was low carbon steel, of chemical composition (wt %)

C	Si	Mn	Cr	Cu	Ti	V
0.15	0.164	0.58	0.009	0.0468	0.0089	0.0076
Ni	Al	Co	Fe	Mo	Pb	
0.00352	0.0514	0.0091	98.9	0.005	0.05	

Experimental Procedure
Weight loss Measurement

The experiments were carried out using rectangular steel coupons, each of an area about 10.8 cm2, after polishing and cleaning, accurately weighed to the 4 decimal of gram before it used.

Specimen was completely immersed in (250 ml) solution of corroding contained in (500 ml) beakers. They were exposed period of 2 hr, according to the test, at desired temperature and inhibitor concentration.

After each test, the specimen was washed with running tap water, scrubbed with a brash to remove corrosion products, then washed with tap water followed by distilled water and dried by clean tissue immersed in acctone for 1 minute, dried, immersed in benzene for 1 minute dried and left in a desiccators over silica gel for 1hr. before weighting then accurately to the 4th decimal and then reweighed.

The weight loss was then determined and the rate of corrosion was expressed in (g/m2.hr).

Electrochemical Measurements
Half-cell measurements

The change in potential of the working electrode as carbon steel was recorded as a function of time against saturated calomel electrode (SCE) which bridged by a luggin Haber probe.

The "half cell" potential was carried directly on the display of voltmeter.

Potentiostatic polarization measurements

The data were obtained in three electrode mode. Graphite and saturated calomel electrodes were used as counter and reference electrodes respectively, the specimens used as working electrode.

Corrosion cell parts were joined to each other, and then connected to a power supply, resistors, ammeter, and voltmeter, starting with cathodic polarization until reaching the corrosion potential then continuing with anodic polarization

Results and Discussion

Weight loss technique

Corrosion rate (CR) calculations from weight loss data was performed according to the following equation:

$$CR = \frac{weight loss (g)}{Area (m^2) * Time (hr)} \quad (1)$$

The surface coverage (θ) and inhibition efficiency, I% were calculated from the weight loss measurements using the following equations, respectively

$$\theta = 1 - \frac{(CR)_{inh}}{(CR)_{free}} \quad (2)$$

$$I\% = \left[1 - \frac{(CR)_{inh}}{(CR)_{free}} \right] \times 100 \quad (3)$$

Where $(CR)_{free}$, $(CR)_{inh}$, are the corrosion rate (g/m^2.hr) in the absence and HCl in absence and presence of peach juice as inhibitor of different concentrations at different temperatures.

Table 1, effect of temperature on the corrosion rate (g/m^{2}hr) of carbon steel in 1N HCl acid in absence and presence of peach juice as corrosion inhibiton

Inhibitor conc. cm^3/l		Temperature (°C)			
		30	40	50	60
Nile	C.R	5.14	9.53	38.36	61
	θ	-	-	-	-
	I%	-	-	-	-
5	C.R	2.13	3.472	11.37	23.04
	θ	0.585	0.636	0.7	0.621
	I%	58.5	63.6	70	62.1
10	C.R	2.08	2.73	10.43	17.07
	θ	0.594	0.7135	0.728	0.72
	I%	59.4	71.35	72.8	72
20	C.R	2.05	2.223	9.722	16.47
	θ	0.6	0.766	0.75	0.73
	I%	60	76.6	75	73
30	C.R	1.22	2.08	6.8	14.14
	θ	0.763	0.7814	0.8227	0.76
	I%	76.3	78.14	82.27	76
40	C.R	1.203	1.57	5.21	12.59
	θ	0.766	0.835	0.86	0.81
	I%	76.6	83.5	86	81
50	C.R	1.147	1.3342	4.573	10.98
	θ	0.776	0.869	0.88	0.82
	I%	77.6	86.9	88	82

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The corrosion rates of low carbon steel corrosion in absence of inhibitor in 1N

HCl acid increased from (5.14 to 61) $g/m^2.h$ as the temperature increased from 30 to 60 ^oC .Figure 1,shows the variation of corrosion rate with temperature. The corrosion rate in 1N HCl increases sharply with increasing temperature.

Addition of peach juice as inhibitor reduce corrosion rate generally. Table 1, shows the variation in corrosion rate with the inhibitor concentration at various temperature levels. It is clear that the corrosion rate decreases with increasing the concentration of inhibitor at any used temperature, the effect of Temperature on corrosion rate for different concentrations of inhibitor is expressed in Figure 1, .This Figure shows that the corrosion rate increases with increasing temperature at all studied inhibitor concentration.
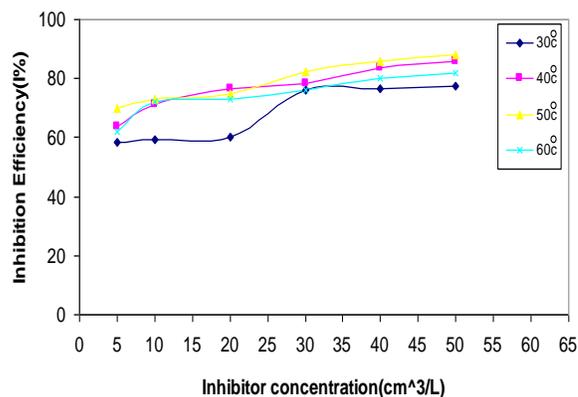

Fig. 2 Variation of Inhibition Efficiency with Inhibitor Concentration at Different Temperature.

Fig. 1 Effect of Temperature on Corrosion Rate of Low Carbon Steel in 1N HCl at Different Concentrations of inhibitor.
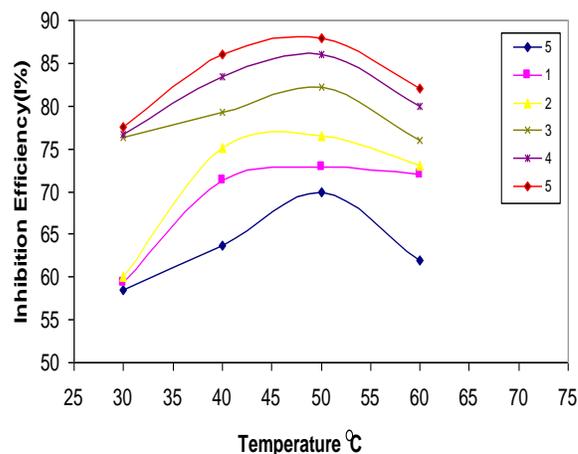
Fig.3 Effect of Temperature on Inhibition Efficiency at Different Inhibitor Concentration.

Values of inhibition efficiency increase with increasing inhibitor concentration. Figure 2, shows the variation of inhibition efficiency with inhibitor concentration. It varies as follows; from 58.5 to 62 % at 5 cm^3/L inhibitor concentration,from 59.4 to 72% at 10 cm^3/L,from 60 to 73 % at 20 cm^3/L,from 76.3 to 76% at 30 cm^3/L ,from 76.6 to 81% at 40 cm^3/L and from 77.6 to 82% at 50 cm^3/L as the temperature increased from 30 up to 60 ^{o}c.

Figure 3, shows the effect of temperature on inhibition efficiency .Inhibition efficiency increase with increasing temperature up to 50ºc then the efficiency reaches a maximum value of 88% at 50 ºC for 50 cm^3/L . This increase in inhibition efficiency with temperature is presumably due to an increase in adsorption of the inhibitor. Above 50 ºC i.e at 60 ºC) the Values of efficiency decreases. This may be explained due to the structure degradation of existing organic compounds in the inhibitor[8].

The plot of (I %) vs. inhibitor concentration (cm^3/L) of peach juice as corrosion inhibitor is found to generally increase with inhibitor concentration and approaches 88% in 1NHCl acid at 50 ºc with 50 cm^3/L of the inhibitor. While the lowest inhibition efficiency is 58.5% at 30ºc and 5 cm^3/L inhibitor concentration it is shown in Fig 2.

The corrosion rate data can be used to analyze the adsorption mechanism.The Langmuir isotherm was expressed as

$$\theta = \frac{KC}{1+KC} \qquad (4)$$

Where K is the equilibrium constant for the adsorption isotherm representing the degree of adsorption (i.e,the higher the value of K indicates that the inhibitor is strongly adsorbed on the metal surface.

C is inhibitor concentration (cm^3/L) and θ is the surface coverage.
Rearranging equation will give:-

$$\frac{C}{\theta} = \frac{1}{K} + C \qquad (5)$$

Figure 4, shows plots of C/θ vs. C for peach juice as corrosion inhibitor in 1NHCl acid at 30, 40, 50 and 60 ºc. The data fit straight lines indicating that peach juice is adsorbed according to the Langmuir adsorption isotherm from the intercept of straight line on the C/θ axis; K values are to be calculated as given in Table 2.

Table 4 Equilibrium Constant for Langmuir Type Adsorption of the inhibitor in 1N HCl acid solution at Different Temperatures

Temperature(^{o}C)	K Value (cm^3/l)$^{-1}$	Slope
30	0.175	1.14
40	0.306	1.11
50	0.334	1.09
60	0.357	1.1

The rectilinear natures of figure 4 indicate an increase in adsorption with an increase in concentration of and that adsorption occurs in accordance with Langmuir adsorption equation. It is also noted in fig.4, that the lines accumulated and approximately looked like one line, this is due to the very close range of inhibition efficiency (58.5 – 88%).
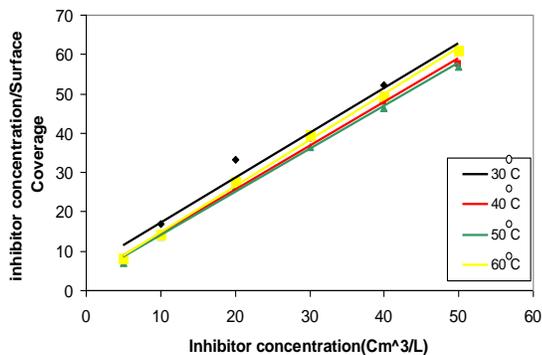

Fig. 4 Langmuir adsorption isotherm of peach juice on Low Carbon Steel in 1N HCl at Different Temperature

Effect of Temperature
Activation energies of low carbon steel in 1N HCl in presence and absence of peach juice are calculated from Arrhenius plots fig 5**.** It is observed that in uninhibited 1N HCl acid solution,the activation energy of the dissolution process is 16 kcal/mol (67.2 kJ/mol). The relationship between the corrosion rate (C.R) of carbon steel in acidic media and temperature (T) is often expressed by:

$$\log CR = \log A - \frac{Ea}{2.303RT} \qquad (6)$$

Where, Ea is the apparent effective activation energy, R the general gas constant and A the Arrhenius pre-exponential factor. A plot of Log of corrosion rate obtained by weight loss measurement vs.1/T gave straight lines as shown in figure 4.5. The values of activation energy (Ea) obtained from the slop of the lines are given in Table 3.The Activation energies in presence of inhibitor are lower than uninhibited acid i.e. 16 kcal/mol (67.2 kJ/mol) since only small differences are observed between the values of activation energy calculated **.**At different concentration, the activation energy is considered to be essentially, constant (mean) value of 15.3 kcal/mol (63.58 kJ/mol) for peach juice independent of it's concentration.. Some authors have reported values of Ea < 80 kJ/mol as an indicator of physical adsorption, While value of Ea > 80 kJ/mol are related to chemical adsorption so the lower Ea in inhibited solutions compared to the uninhibited indicated of physical adsorption mechanism[9].
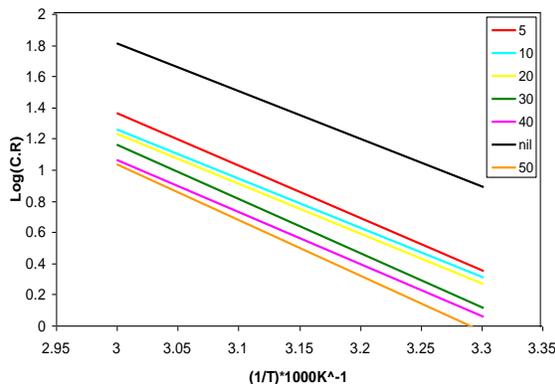

Fig. 5 Arrhenius plot for log corrosion rates (g/m^{2}h) versus reciprocal of absolute temperature at different inhibitor concentration.

Some other activation parameters such as the enthalpy change of activation (ΔH) and entropy change of activation (ΔS) were obtained from the Eyring transition state equation which is an alternative formula for the Arrenius equation[10]:-

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$$Rate = \frac{RT}{Nh} \exp(\frac{\Delta S}{R}) \exp(\frac{-\Delta H}{RT}) \qquad (7)$$

Where,

h is the Plank's constant,(i.e., h = 6.626 × 10⁻³⁴ Joule.sec)

N the Avogadro number,(N = 6.023 × 10²³ molecules g-mole⁻¹)

A plot of Log (Rate/T) vs. 1/T should give a straight line, Figure6,with a slop of (-ΔH / 2.303 R)and an intercept of [(Log (R/Nh) + (ΔS/ 2.303 R)],from which the values of ΔS and ΔH were calculated .These are listed in Table 3,The values of activation parameter (ΔH) in presence of inhibitor are less than that in the absence of inhibitor(nil) . these exhibit high inhibition efficiency at elevated temperature. The positive values of (ΔH) both in absence and presence of inhibitor reflect the endothermic nature of the steel dissolution process and means that the dissolution of steel is difficult. It is also clear that the activation enthalpies vary in the same manner as the activation energies, supporting the proposed inhibition mechanism. The values of activation ΔS in the absence and presence of inhibitor are large and negative. This indicates that the activated complex in the rate determining step represents an association rather than a dissociation step, meaning that a decrease in disordering takes place on going from reactants to the activated complex. It is obviously that the ΔS shifts to more negative values (more ordered behavior) with increasing inhibition efficiency, this can be explained that the inhibitor species may involved in the activated complex of the corrosion reaction leading to more ordered system [10].

Table 3, thermodynamic activation parameters for carbon steel in 1N HCl in the absence and presence of inhibitor concentrations

Inhibitor concentration (Cm³/L)	(ΔH) kJ/mol	(-ΔS) J/mol	Ea kJ/mol
Nil	70.43	125.2	67.2
5	66.56	145.8	64.134
10	61.1	164.33	60.186
20	61.06	165.18	61.61
30	68.98	142.4	66.36
40	65.29	155.6	64.26
50	63.25	163.02	61.32

Polarization Technique

A total of 28 runs were made,4 runs for uninhibited acid solution and the remaining inhibited acid solution at six levels of inhibitor concentrations and four levels of temperature variation by BETA CRUNCH method[12] and the same runs by Tafel Extrapolation method.The electrode potentials are expressed relative to the saturated Calomel Electrode (SCE).

The corrosion potentials obtained from polarization measurements were observed to be influenced by the variables studied. Tables 4, results of the corrosion potential of low carbon steel. It can be seen that:

1. the corrosion potential shifts to more positive direction as the inhibitor concentration increases, This shifting explain the anodic nature of inhibitor, which inhibits the anodic reaction more than the cathodic one

2. The values of E_{corr} also show that the corrosion potential shifts to more negative direction with temperature
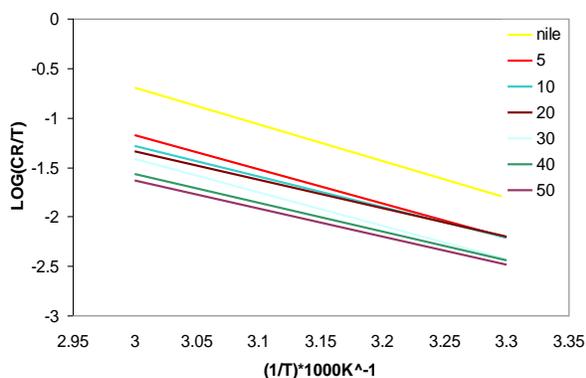

Fig. 6, Adsorption isotherm plot for Log (C.R) of Low carbon steel Versus Reciprocal of Absolute Temperature in the presence and absence of Peach Juice

Table 4, Corrosion Potential, (mV) vs. SCE at Different Temperature and Inhibitor concentration

Inh.Conc. (cm³/l)	*Temperature (°C)*			
	30	40	50	*60*
Nil	-480	-496	-505	*-513*
5	-472	-486	-488	*-496*
10	-468	-481	-485	*-489*
20	-463	-475	-481	*-487*
30	-459	-472	-470	*-482*
40	-454	-470	-469	*-479*
50	*-450*	*-465*	*-466*	*-476*

Figures 11 through 17 show the polarization curves in absence and presence of the inhibitor at different temperatures. It is clear from these figures that:

The increase in temperature shifts the anodic and cathodic curves in the direction of higher current density, Table (5 through 8) for Beta Crunch method and Table.9 through 12 for Tafel Extrapolation method, show that with increasing in temperature in absence and presence of the inhibitor at different concentration. The Corrosion Rate (Corrosion Current Density) increases, this means that with increasing temperature the efficiency of inhibitor decrease. The same behavior was observed in weight loss technique.Figures 7 through 10, show the polarization curves for each temperature 30 ,40 , 50 and 60° C at different inhibitor concentration. It is clear from these figures that The increase in inhibitor concentration shifts the anodic and cathodic curves in the direction of loss current density at all temperature studied, indicate that the peach juice have effect on both anodic and cathodic reaction of corrosion process.

Computation Polarization Resistance (R_p)

The Polarization Resistance defined as slop of Potential - current density ($\Delta E/\Delta I$), curve at free corrosion potential ($\pm 20mv$) yield the polarization resistance R_p[11] it is shown in Fig 18 through 21.

$$R_P = \left(\frac{\Delta E}{\Delta I} \right)_{\Delta E \to 0} \qquad (8)$$

The corresponding corrosion current density depends on kinetic parameters since Icorr = f (β , R_p) .Thus, the simple linear relation that defines the corrosion current density is of the form

$$icorr = \frac{\beta}{R_P} \qquad (9)$$

Where β = f (β_a, β_c)

β_a , β_c are taken as positive kinetic parameters for determining icorr of a corroding or oxidizing metallic material.This method requires knowledge of the Tafel anodic and cathodic slopes in order to calculate β

$$\beta = \frac{\beta_a \cdot \beta_c}{2.303(\beta_a + \beta_c)} \qquad (10)$$

The Tafel parameters can be determined by mean of experimental measurements carried out over a rang of potential shifting away from the corrosion potential.In the Tafel extrapolation methode ($\pm$ 50 mv) for the corrosion potential,but by the Beta Crunch method[73] Tafel parameters will be calculated with in a bout ($\pm$ 20 mv) for the corrosion potential.
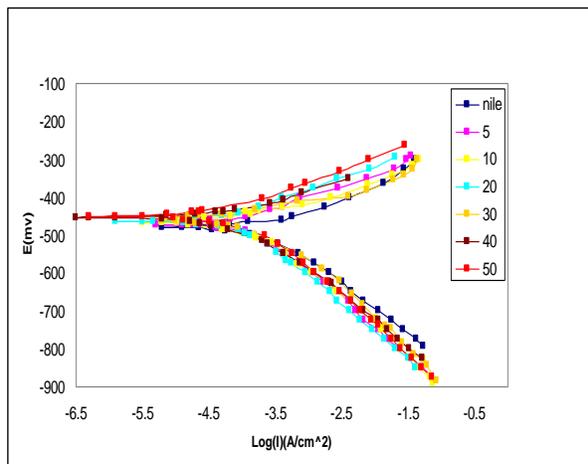

Fig 7,Polarization Curves of Low Carbon Steel in 1N HCl and containing Different Inhibitor Concentration at 30°C
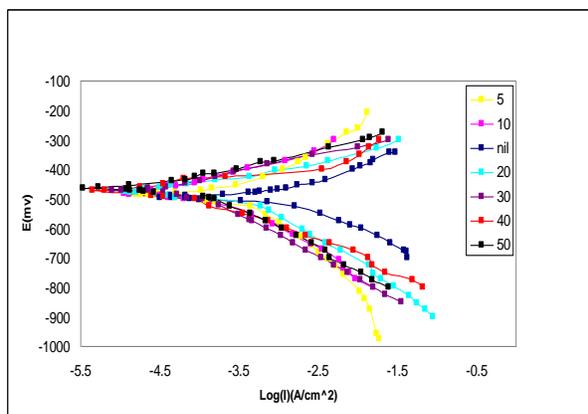

Fig 8 Polarization Curves of Low Carbon Steel in 1N HCl and containing Different Inhibitor Concentration at 40°C.
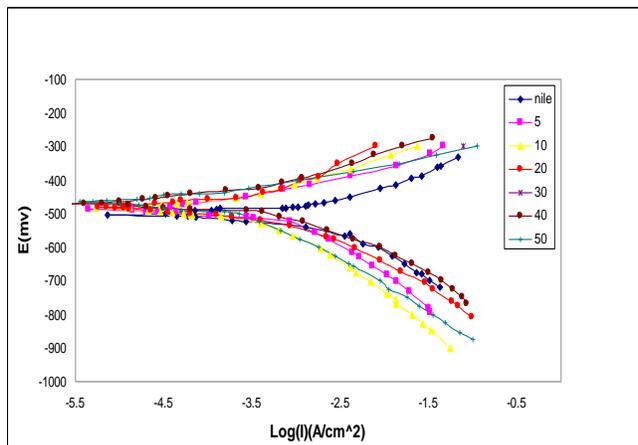
Fig 9 Polarization Curves of Low Carbon Steel in 1N HCl and containing Different Inhibitor Concentration at 50°C.
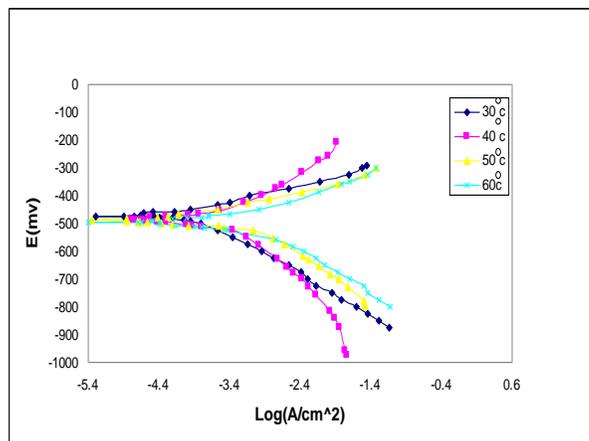

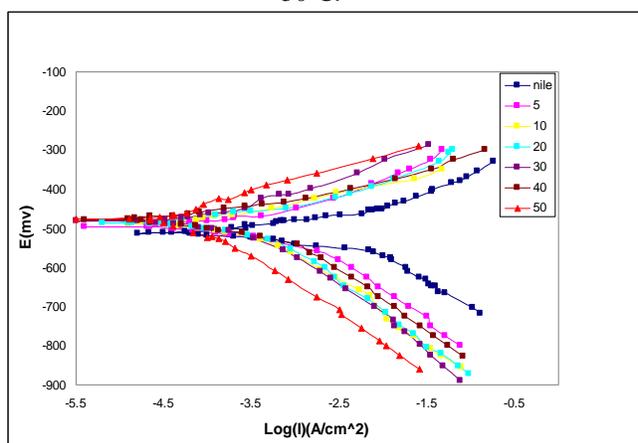Fig 12, Polarization Curves of Low Carbon Steel in1N HCl with (5cm3/l)) of peach Juice at Different Temperatures.

Fig 10 Polarization Curves of Low Carbon Steel in 1N HCl and containing Different Inhibitor Concentration at 60°C.
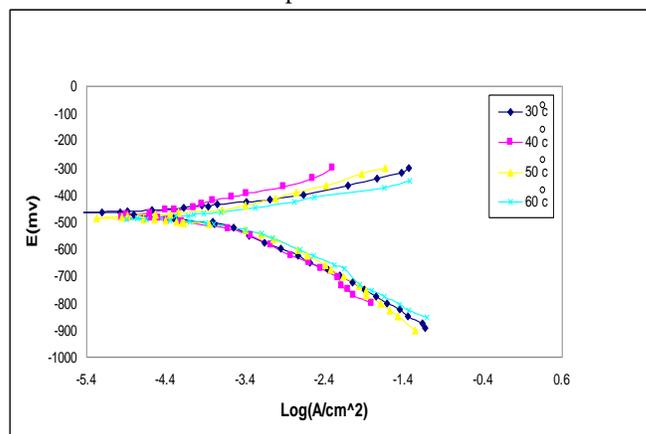

Fig 13, Polarization Curves of Low Carbon Steel in1N HCl with (10cm3 /l)of peach Juice at Different Temperatures.
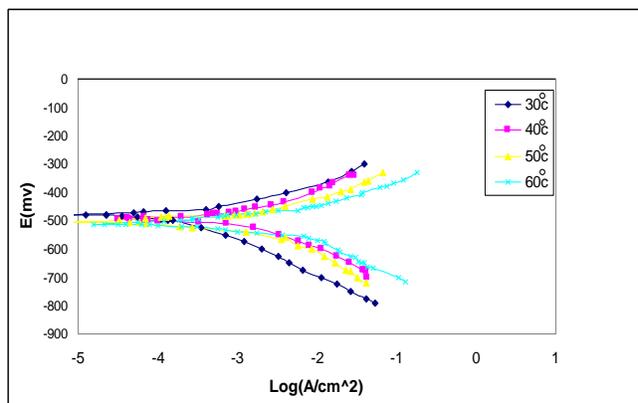

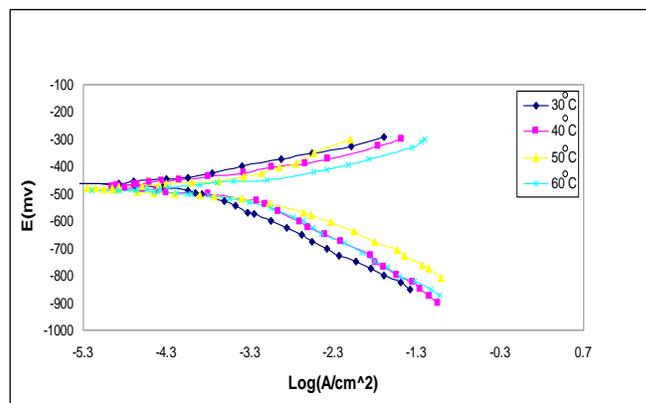Fig 11, Polarization Curves of Low Carbon Steel in1N HCl in absence of peach Juice at Different Temperatures.

Fig 14, Polarization Curves of Low Carbon Steel in1N HCl with (20cm3/l)) of peach Juice at Different Temperatures..
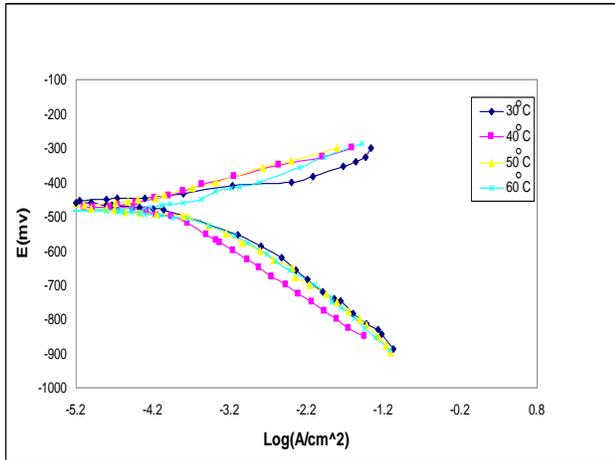
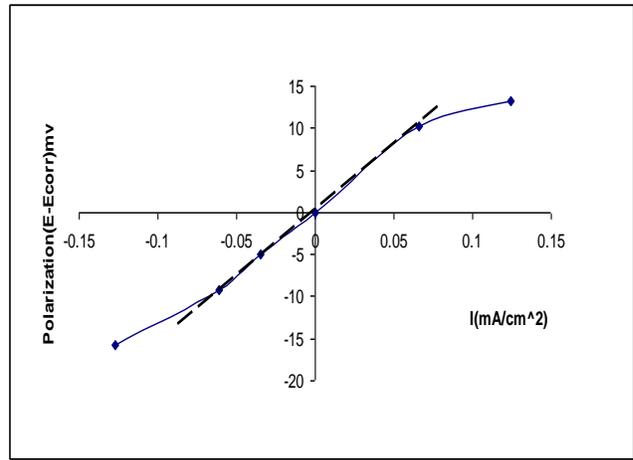Fig 15, Polarization Curves of Low Carbon Steel in1N HCl with (30cm3/l)of peach Juice at Different Temperatures.

Fig 18, Schematic linear Polarization Curve of Low Carbon Steel in1N HCl in absence of peach Juice at (30ºC).

Fig 16, Polarization Curves of Low Carbon Steel in1N HCl with (40cm3/l)) of peach Juice at Different Temperatures.

Fig 19, Schematic linear Polarization Curve of Low Carbon Steel in1N HCl in absence of peach Juice at (40ºC) .

Fig 17, Polarization Curves of Low Carbon Steel in1N HCl with (50cm3/l) of peach Juice at Different Temperatures.

Fig.20, Schematic linear Polarization Curve of Low Carbon Steel in1N HCl in absence of peach Juice at (50ºC) .
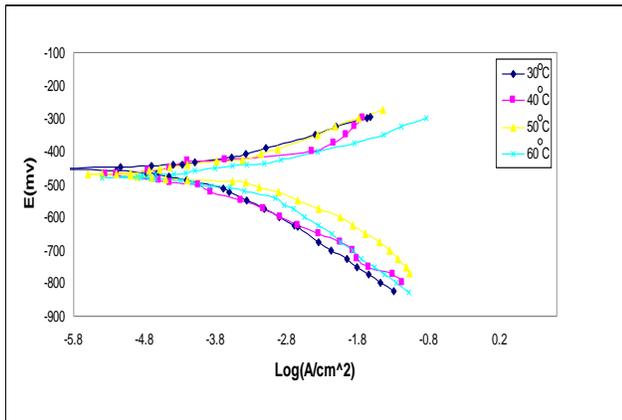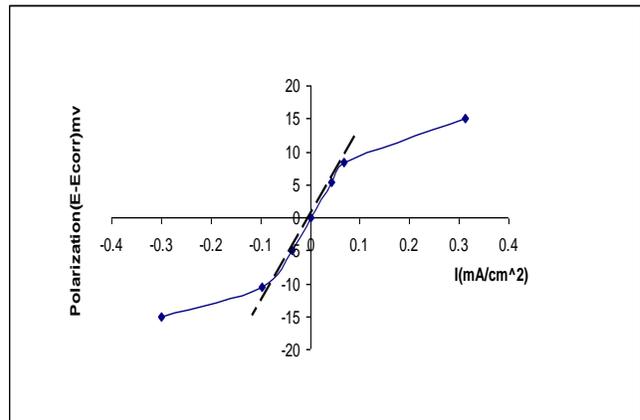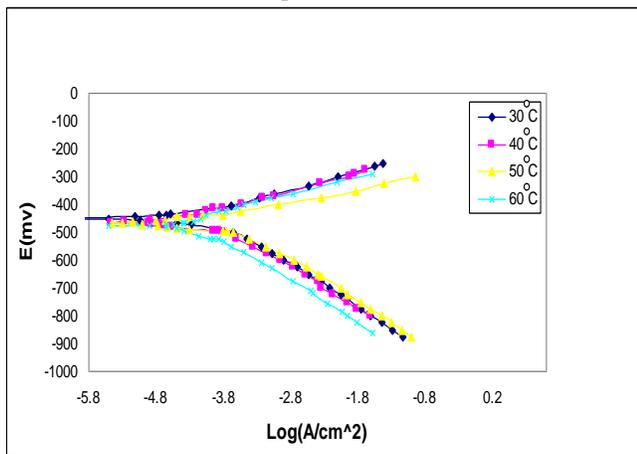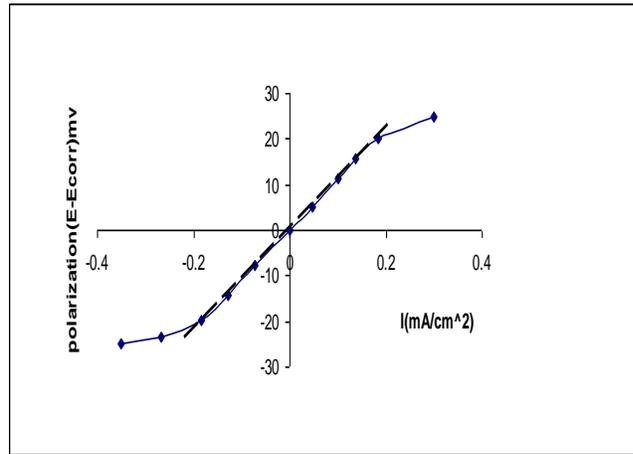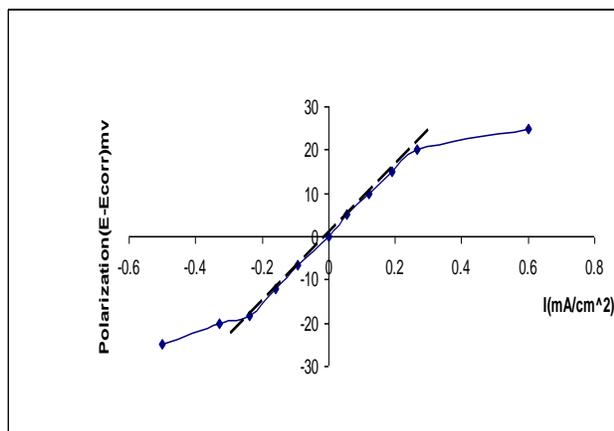
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Fig 21, Schematic linear Polarization Curve of Low Carbon Steel in1N HCl in absence of peach Juice at (60ºC) .

Table 5, Data of Beta Crunch for Polarization Measurements of Low Carbon Steel in 1N HCl in Absence and Presence of Different Concentration of peach Juice at T= (30º C)

Inh. Conc.(cm^3/L)	R_p (Ω.cm^2)	β_a (mv/dec)	β_c (mv/dec)	Icorr (A/cm^2)	Eff (I%)
Nil	153.5	33.244	-56.46	5.9*10^{-5}	-
5	338.1	32.54	-55.8	2.64*10^{-5}	54
10	395.8	36.65	-54.3	2.4*10^{-5}	60
20	493.8	39.3	-54	2*10^{-5}	68
30	608.9	37.135	-56.7	1.6*10^{-5}	74
40	683.6	35.2	-51.8	1.33*10^{-5}	77
50	750.5	33.7	-55.2	1.21*10^{-5}	78

Table 6, Data of Beta Crunch for Polarization Measurements of Low Carbon Steel in 1N HCl in Absence and Presence of Different Concentration of peach Juice at T= (40º C)

Inh. Conc.(cm^3/L)	R_p (Ω.cm^2)	β_a (mv/dec)	β_c (mv/dec)	Icorr (A/cm^2)	Eff (I%)
Nil	115.16	35.67	-57.66	8.3*10^{-5}	-
5	293.4	40.69	-63.49	3.6*10^{-5}	60
10	382.2	42.8	-55.227	2.7*10^{-5}	70
20	435.3	38.529	-58.63	2.3*10^{-5}	73
30	576.5	40.93	-59.74	1.8*10^{-5}	79
40	664.3	38.89	-55.39	1.49*10^{-5}	82
50	665	33.225	-48.36	1.288*10^{-5}	83

Table 7, Data of Beta Crunch for Polarization Measurements of Low Carbon Steel in 1N HCl in Absence and Presence of Different Concentration of peach Juice at T= (50º C)

Inh. Conc.(cm³/L)	R_p ($\Omega.cm^2$)	β_a (mv/dec)	β_c (mv/dec)	Icorr (A/cm²)	Eff (I%)
Nil	92.3	44.278	-76.42	$1.32*10^{-4}$	-
5	264	38.363	-61.478	$3.8*10^{-5}$	65
10	316.3	41.351	-64.968	$3.46*10^{-5}$	71
20	425.25	45.34	-60.133	$2.6*10^{-5}$	78
30	507.8	44.27	-63.361	$2.2*10^{-5}$	82
40	568	40.497	-59.84	$1.8*10^{-5}$	84
50	695	35.93	-54.35	$1.35*10^{-5}$	88

Table 8, Data of Beta Crunch for Polarization Measurements of Low Carbon Steel in 1N HCl in Absence and Presence of Different Concentration of peach Juice at T= (60º C)

Inh. Conc.(cm³/L)	R_p ($\Omega.cm^2$)	β_a (mv/dec)	β_c (mv/dec)	Icorr (A/cm²)	Eff (I%)
Nil	73.2	51.35	-68.23	$1.73*10^{-4}$	-
5	146.4	47.76	-72.81	$8.68*10^{-5}$	50
10	161.35	46.57	-70.08	$7.5*10^{-5}$	55
20	183.5	47.56	-72.42	$6.8*10^{-5}$	60
30	198.1	44.133	-69.63	$5.9*10^{-5}$	64
40	224.7	49.166	-72.3	$5.17*10^{-5}$	68
50	265.7	47.42	-68.588	$4.6*10^{-5}$	73

Table 9, Data of Tafel extrapolation for Polarization Measurements of Low Carbon Steel in 1N HCl in Absence and Presence of Different Concentration of peach Juice at T= (30º C).

Inh. Conc.(cm³/L)	R_p ($\Omega.cm^2$)	β_a (mv/dec)	β_c (mv/dec)	Icorr (A/cm²)	Eff (I%)
Nil	153.5	80.64	-103.98	$1.3*10^{-4}$	-
5	338.1	56.87	-124.16	$5.11*10^{-5}$	60.6
10	395.8	62.3	-127.195	$4.74*10^{-5}$	63.5
20	493.8	57.93	-125.044	$3.52*10^{-5}$	72.9
30	608.9	57.48	-89.27	$2.52*10^{-5}$	80.6
40	683.6	63.09	-108.02	$2.5*10^{-5}$	80.7
50	750.5	64.174	-133.68	$2.49*10^{-5}$	80.9

Table 10, Data of Tafel extrapolation for Polarization Measurements of Low Carbon Steel in 1N HCl in Absence and Presence of Different Concentration of peach Juice at T= (40º C).

Inh. Conc.(cm³/L)	R_p ($\Omega.cm^2$)	β_a (mv/dec)	β_c (mv/dec)	Icorr (A/cm²)	Eff (I%)
Nil	115.16	105.38	-109.59	$1.93*10^{-4}$	-
5	293.4	134.9	-166.83	$1.13*10^{-4}$	40
10	382.2	64.64	-128.7	$5.09*10^{-5}$	73
20	435.3	58.94	-156.02	$4.31*10^{-5}$	77
30	576.5	55.121	-131.9	$2.9*10^{-5}$	84
40	664.3	116.12	-94.43	$3.4*10^{-5}$	82
50	665	61.81	-114.98	$2.63*10^{-5}$	86

Table 11, Data of Tafel extrapolation for Polarization Measurements of Low Carbon Steel in 1N HCl in Absence and Presence of Different Concentration of peach Juice at T= (50º C).

Inh. Conc.(cm^3/L)	R_p ($\Omega.cm^2$)	β_a (mv/dec)	β_c (mv/dec)	Icorr (A/cm^2)	Eff (I%)
Nil	92.3	87.97	-126.5	2.62*10^{-4}	-
5	264	60.85	-132.88	6.78*10^{-5}	74
10	316.3	77.433	-120.45	6.69*10^{-5}	74
20	425.25	98.5	-109.87	5.24*10^{-5}	80
30	507.8	61.59	-116.9	3.52*10^{-5}	86
40	568	77.93	-91.6	3.33*10^{-5}	87
50	695	49.44	-113.4	2.2*10^{-5}	91

Table 4.12, Data of Tafel extrapolation for Polarization Measurements of Low Carbon Steel in 1N HCl in Absence and Presence of Different Concentration of peach Juice at T= (60º C).

Inh. Conc.(cm^3/L)	R_p ($\Omega.cm^2$)	β_a (mv/dec)	β_c (mv/dec)	Icorr (A/cm^2)	Eff (I%)
Nil	73.2	79.47	-138.24	3.22*10^{-4}	-
5	146.4	79.23	-87.7	1.29*10^{-4}	60
10	161.35	48.9	-123	9.5*10^{-5}	70
20	183.5	73.25	-125.01	1.04*10^{-4}	67
30	198.1	70.53	-118.13	9.33*10^{-5}	71
40	224.7	57.19	-158.24	8.3*10^{-5}	74
50	265.7	56.7	-131.3	6.76*10^{-5}	79

Conclusions

1. It was found that the activation energy in absence of inhibitor was 16 kcal/mol (67.2 kJ/mol) .This value decreased down to a constant mean 15.3 kcal/mol. This mean that the activation energy of the reaction is inhibitor concentration independent.
2. Inhibition efficiency increase with increasing temperature to 50ºC and then decreasing with temperature while this efficiency increased with increas inhibitor concentration.
3. The positive value of ∆H both in absence and presence of inhibitor reflect the endothermic nature of the steel dissolution process. The values of ∆S are large and negative meaning that decrease in disordering takes place on going from reactants to the activated complex.
4. It was found that the corrosion current density increase with increasing temperature and decrease with increasing inhibitor concentration.

5. The resistance polarization decrease with increasing temperature and increase with increasing inhibitor concentration.
6. This investigation shows that Peach Juice is an effective friendly inhibitor, Max. Efficiency obtained was a bout 91%.
7. Peach Juice was found to effect both anodic and cathodic reaction
   as mixed effect inhibitor, but more is anodic inhibitor.

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