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Corrosion Inhibition of Medium Carbon Steel in the Acidic Medium Using Alcoholic and Aqueous Extract of Kujarat Tea Plant

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Abstract:

This study deals with the corrosion inhibition of metal corrosion process of medium carbon steel using 1M HCl for kinetic studies and rate reaction determination. The weight loss method is applied to pieces of Medium carbon steel divided to Cubans with dimensions (0.4*2*2.4) cm, and use Tafel Extrapolation Method, the samples were polished using carbide silicon paper with dimensions of (180,200,400,600,800,1000). The samples were immersed in the alcoholic medium ethanol at a temperature 293K for 3hr. Natural inhibitor Kujarat Tea (*Hibiscus sabdariffa* L.) is used which is extracted in aqueous and alcoholic medium, different concentrations (1000, 2000, 3000) ppm have been used; The best concentration found through the results is a concentration found that is 1000 and 2000 ppm, the results indicate that the highest degree of inhibition for aqueous extract is 93.3% with the concentration of 2000 ppm and 90.5% with 1000 ppm at 293K. While the alcoholic inhibitor shows the highest efficiency 92.4% with a concentration of 2000 ppm and 88.6% with a concentration of 1000 ppm respectively. The structure of the inhibitor was investigated using infrared spectroscopy (FTIR), and the surface morphology of the tested samples was investigated using a scanning electron microscope (SEM).

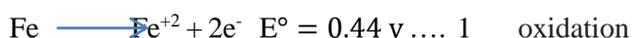
Keywords: Extracted, Inhibitor, Oxidation, Reduction, Tafel curves.

Introduction:

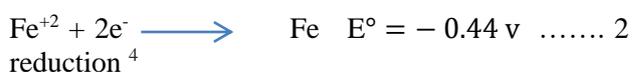
Corrosion is defined as damage of metals or alloys due to their chemical or electrochemical reaction with the surrounding environment for metal. Metals and alloys gradually change into compounds such as oxides, hydroxides, carbonates, and sulphides¹. Corrosion is the atmospheric oxidation/degradation of metals. It is an electrochemical process by which metallic surfaces react with their environment causing the metal to lose its material properties due to surface deterioration², as defined by scientists in the year (1830 A.D), a complex phenomenon that has been studied physically, chemically, electrochemically, kinetically or thermodynamically. The studies prove that it is entirely dependent on mechanical properties of metal². In general, the driving force for the completion of the corrosion reaction is the change in the free energy of the material as a result of their transformation into compounds with a generally lower free energy than their constituent metals¹, therefore they are

automatically formed if exposed to the appropriate environment. The compounds are more stable than the metal which is naturally composed of them³.

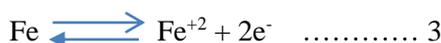
The process of corrosion of the metal leads to ions generation with some electrons that are consumed by a secondary reaction. When the metal is placed in pure water, some ions will be transferred directly to the solution⁴.



Accumulation of the negative charge on the metal and presence of metal ions in the solution makes the reaction go back:



at the end, the equilibrium obtained



The potential difference depends on the type of metal and the composition of the solution^{5,6}. The inhibitors affect the electrochemical reaction kinetics in the corrosion process and fixed on the inhibitors on the metal surface, thus the process ease the electrical double layer changes if the same active inhibitors used in the industry are organic compounds, containing oxygen, nitrogen, and sulfur atoms which can lead to adsorption of compounds on the surface of the metal⁶.

Also, biodegradable green inhibitors that do not contain heavy metals or other toxic compounds are used. Corrosion inhibitors generally control corrosion through the mechanism inhibitors, which are applied to the surface of the metal, which on adsorption on the metal surface⁷. Adsorption depends on the charged nature of the metal surface, electronic properties and, properties of solvents, the temperature and the electrochemical potential^{8,9}. There are many applications to corrosion inhibition, such as oil and gas ducts corrosion inhibition¹⁰, corrosion inhibitor tested on mild steel supported by electrochemical¹¹, evaluation of electrocoagulation

in the treatment of olive debittering wastewater (ODW), and many other applications.

The aim of this study is to use the Kujarat Tea leaves as an environmental corrosion inhibitor to control the corrosion process in the acidic medium, and to find the difference in the corrosion rate in the static phase at over time and in a range of different temperatures. 293-313 K

Material and methods:

Samples preparation

The samples were divided into small Cubans with dimensions 2 cm length and 2.4 cm width and 0.4 cm thickness¹². The medium carbon steel metal sample was obtained.

Chemical analysis

The medium carbon steel samples and the Kujarat Tea plant (aqueous and alcoholic) were analyzed spectroscopically Tables 1, 2, shows that the extract of the kujurat plant contains the elements shown below Table 2, using the atomic absorption spectrophotometer device CS.

Table 1. Elements analysis data of medium carbon steel samples

Sequence	Fe	Ni	Zn	Mn	K	Mg	Cu	Cr
Wt. %	99.5	0.01	0.06	0.4	17.0	0.004	0.01	0.01

Table 2. Elements analysis data of the leaves of the plant (aqueous and alcoholic)

Element	Mg	Mn	Zn	Ni	Fe	K	Cu	Cr
Wt. %	0.003	0.03	0.5	0.03	1.8	17.0	0.045	0.032

Preparation of Kujarat Tea extracts (inhibitor)¹³:

The plant extract was prepared using tap water to wash the plant and freeing it from the dust suspended in its limit to (40-60%) and then using polar solvents (aqueous and ethanol) as follows:¹¹.

The organic extract was prepared as follows: 50gm of the Kujarat Tea plant powder in a conical flask 500ml was mixed with 250 ml of petroleum ether, the mixture was stirred for 72hr using a magnetic stirrer and then the solution was filtered off and dried in an oven at (293-313K) for 2hr, the filtrate was keep it in a glass container in the refrigerator at a temperature of 277K.

The alcoholic extract of the Kujarat Tea plant was prepared by the following procedure. 50 gm with of the powder prepared in (3-1) was mixed with 250 ml of ethanol 99.9% and stirred for 72hr using the magnetic stirrer. The solution was then filtered off and the filtrate was evaporated under low

pressure using a rotary evaporator at 313 K and the remaining extract 50% is reserved until use^{11,12}.

The aqueous extract was prepared as mention in (3-2) by mixing 50gm with 250 ml of distilled water, and stirred for 72hr using the magnetic stirrer. The solution is then filtered off and the filtrate was evaporated under vacuum at 277 K and the remaining extract 50%^{11,12}.

Electrochemical cell (Tafel Extrapolation Method)

The device used consists of a measuring cell and its electrodes, where the cell is made of a non-corrosive material such as glass, the capacity of the cell is one liter, and the cell includes three electrodes: the working electrode, which is the sample used, and the auxiliary electrode, which is of platinum, and the reference electrode use for find working electrode potnational is the saturated is placed in a salt bridge containing the same electrolyte solution used in the

cell, and the electrical circuit is connected to conduct the test. The test was conducted in the absence and quality of the inhibitor. The tests were done with the best concentrations and at a different temperature.¹²

The cell is filled with 1 M HCl and the auxiliary electrode and the reference electrode are placed in the cell solution, then the working electrode is prepared with an alcohol wash and then placed in the measuring cell (PRT) is ability equipped provides a constant current in the range (0-500 mA) by device voltmeter which is used to measure the potential difference between the working electrode and the reference electrode. A milliamper device was also used to measure the current passing between the working electrode and the reference, where the potential difference is changed at a rate of (10 mV / min) and the peak of the current corresponding to each value of the applied voltage and in the range (\pm 250 mV) is measured approximately at a voltage point open circuit. The total values of current density, i , were considered as the sum of two contributions, anodic and cathodic current i_a and i_c , respectively. For a potential field not too far from the open circuit, it may be considered that both processes follow Tafel's law¹³

$$i = i_{a,corr} - i_{b,corr} = i_{corr} \{ \exp[ba.(E - E_{corr})] - \exp[bc(E - E_{corr})] \} \dots\dots 4$$

The equation below was used to calculate the inhibitory efficiency.

$$IE\% = \frac{i_{corr}(un) - i_{corr}(in)}{i_{corr}(un)} * 100\% \dots\dots 5$$

Preparation of the corrosion solution:

By dilution method, 1M concentration of HCl was prepared⁸

Measurement of the weight loss:

All metal samples were placed in 100 ml of 1M HCl and then transferred to a water bath and subjected to the required temperature at the required concentration of the inhibitor 3hr. The samples were then cleaned and washed with deionized water and dried with tissue papers or smoothed papers which is type 180-1000 P and then washed with acetone and dried again. The weight loss was determined in the presence of the inhibitor at concentrations of 2000,1000 ppm at temperatures of 293,303, 313 K¹⁴.

Results and discussion:

Method of weight loss

Corrosion rates (CR) were determined in the presence and absence of inhibitor using the following Equation¹⁵:

$$(CR) = \frac{\Delta W}{A \times t} \dots\dots\dots 6$$

Where ΔW is weight loss gm , A: is surface area of the sample m² , t: is time of sample exposure for the day.

Corrosion rates were obtained in g / m². day (g.m⁻²d). The inhibition efficiency was calculated using the equation:

$$\% IE = \frac{CR_u - CR_i}{CR_u} \times 100 \dots\dots 7$$

Where CR_u and CR_i are the corrosion rates in the absence of different concentrations of inhibitors, respectively.

The inhibition efficiency IE% can be also calculated using the following equation in 5

Surface cover θ can be calculated by the following equation¹⁶:

$$\theta = \frac{IE}{100} \dots\dots\dots 8$$

Where: θ is surface coverage, (IE) is inhibition efficiency¹⁷.

Corrosion rate, inhibition efficiency, corrosion current efficiency, and surface coverage were assessed under different conditions. The results were collected in Tables 3 and 4 . It is clear that the rate of corrosion increases with increasing temperature and concentration of 1M HCl and decreases with increasing inhibitory concentrations, due to the occurrence of a reverse process due to the saturation of the metal surface with the inhibitor, which made the increase of the inhibitor leads to a decrease in the corrosion rate¹⁸.

Table 3. The influence of temperature on corrosion rate, the density of medium carbon steel corrosion current in 1 M of HCl, and surface coverage in the presence of an aqueous extract inhibitor

Sample	C _i [ppm] inhibitory	T [K]	Corrosion rate [g.m ⁻² .d ⁻¹]	I _{corr} [μ A.cm ⁻²]	θ	% IE
0		293	530	450.5	0	0
		303	900	497.6	0	0
		313	1440	682.7	0	0
1000		293	50	42.7	0.905	90.5
		303	135	74.6	0.850	85
		313	240	114	0.833	83.3
2000		293	35	30.1	0.933	93.3
		303	100	55.7	0.888	88.8
		313	210	99.6	0.854	85.4
3000		293	90	78.2	0.752	75.5
		303	180	97	0.746	74.6
		313	307	170.4	0.722	72.2

It was found that the best concentration of the plant extract is at 1000 and 2000, because the percentage of the inhibitory efficiency was the highest in it, and this shows that when the concentration is higher than these concentrations, there will be an inverse relationship with the inhibition efficiency (by increasing the concentration

of the inhibitor, the inhibition efficiency of the extract decreases). Because to the occurrence of a reverse process due to the saturation of the metal surface with the inhibitor, which made the increase of the inhibitor leads to a decrease in the corrosion rate¹⁹.

Table 4. The influence of temperature on corrosion rate, the density of medium carbon steel corrosion current in 1M of HCl, and surface coverage in the presence of an alcoholic extract inhibitor

Sample	C _i [M]	T [K]	Corrosion rate [g.m ⁻² .d ⁻¹]	I _{corr} [μ A.cm ⁻²]	θ	% IE
0		293	530	450.5	0	0
		303	900	497.6	0	0
		313	1440	682.7	0	0
1000		293	60	51.3	0.886	88.6
		303	140	77.6	0.844	84.4
		313	310	147.4	0.784	78.4
2000		293	40	34.2	0.924	92.4
		303	130	72.1	0.855	85.5
		313	280	133.1	0.805	80.5
3000		293	90	78.2	0.572	57.2
		303	180	97	0.566	56.6
		313	307	170.4	0.542	54.2

Evaluation of corrosion rate

The weight-loss method was used to calculate the corrosion rates in non-inhibitory acid solutions at different temperatures (293, 303, 313 K). The

average carbon steel corrosion rate in 1M HCl increased from 530 to (1440 g.m⁻².d) with increasing temperature (293 - 313) K. And the density of the Corrosion current of the medium carbon steel was

increased from 450.5 - 682.7 ($\mu\text{A}\cdot\text{cm}^{-2}$) with an increase in temperature 293 – 313 K. Fig. 1, Shows the increase in the rate of corrosion with an increase of temperature, the relationship between temperature as variable and the rate of corrosion, and Fig. 2, shows the increase of the density of the corrosion current with increased temperature.

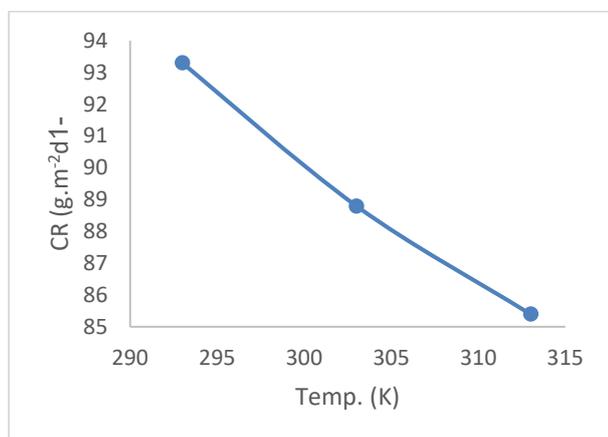


Figure 1. Effect of temperature on the Corrosion Rate carbon steel in (1) M of HCl acid

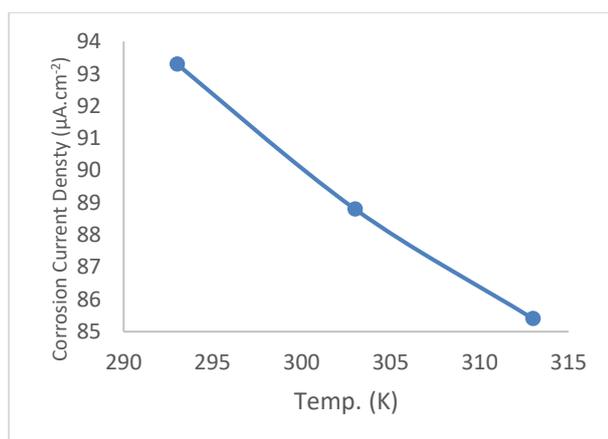


Figure 2. Effect of temperature on the corrosion current density of carbon medium in (1) M of HCl acid

The Effect of acid in presence of inhibitor at different temperatures

From Figs 3 and 4 we found that the effect of temperature on corrosion rate which was expressed for the different inhibitor concentrations. The two forms show that the corrosion rate increases with the increase of temperature and increase inhibitor concentration. When using 1000 ppm of the inhibitor at temperatures (293-313K), the highest corrosion rate was 310 $\text{g}\cdot\text{m}^{-2}\cdot\text{d}$ at 313K when (1000, 2000 ppm) concentration of alcoholic Kujarat Tea extract was used, while the lowest corrosion rate was 50 $\text{g}\cdot\text{m}^{-2}\cdot\text{d}$ at 293K with the aqueous extract.

The concentration of 2000 ppm of the inhibitor at different temperatures gave the highest corrosion

rate 280 $\text{g}\cdot\text{m}^{-2}\cdot\text{d}$ at 313K when using extract of the alcoholic. The lowest value of the corrosion rate was 35 $\text{g}\cdot\text{m}^{-2}\cdot\text{d}$ at 293K with the aqueous extract in Figs. 5-12.

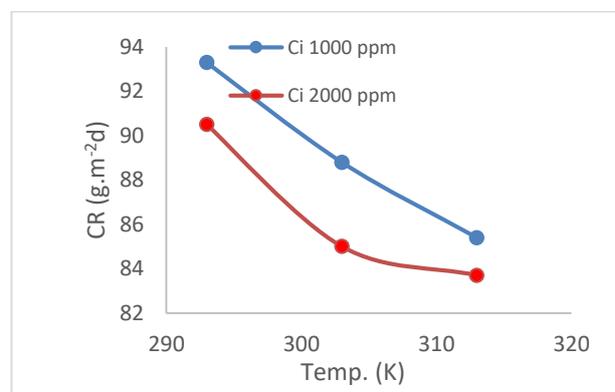


Figure 3. The effect of Temperature rate of medium Carbon in (1) M HCl with the presence of on extract alcoholic extract

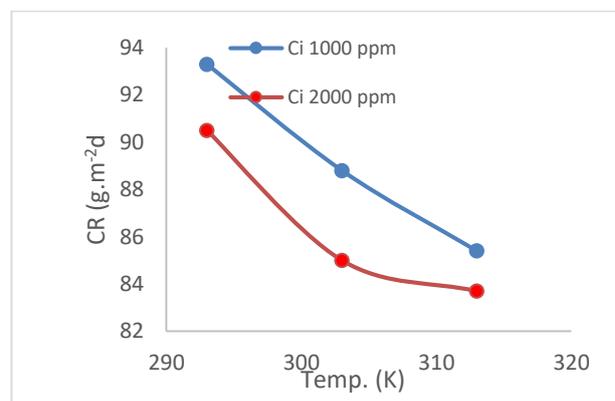


Figure 4. The effect of temperature effect on the corrosion rate of medium carbon steels in (1) M HCl with the presence of aqueous

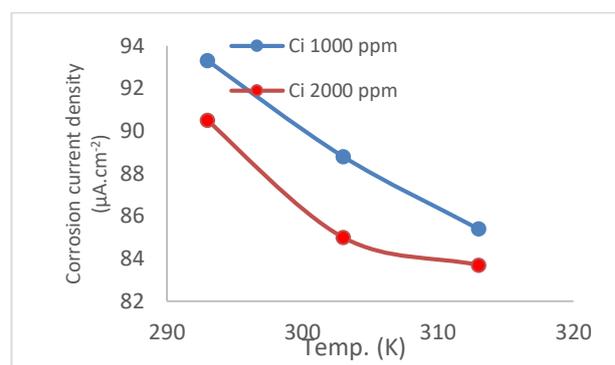


Figure 5. Effect of temperature on the density of the corrosion current in 1M HCl with an aqueous extract

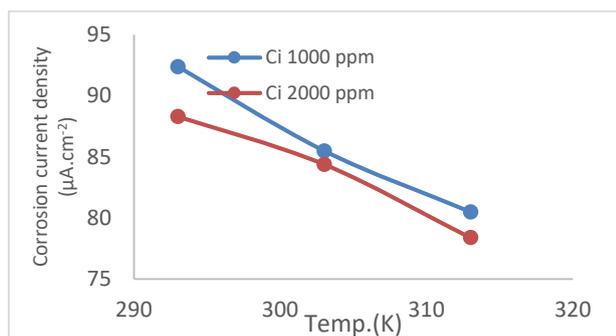


Figure 6. Effect of temperature on density of the corrosion current in (1) M HCl in presence of the alcoholic extract

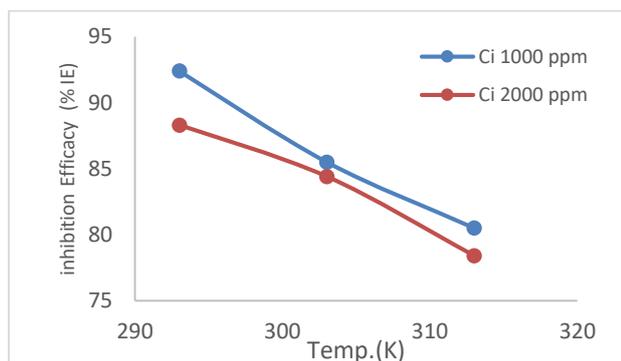


Figure 7. Effect of Temperature on inhibition efficiency in (1) M HCl in presence of aqueous extract

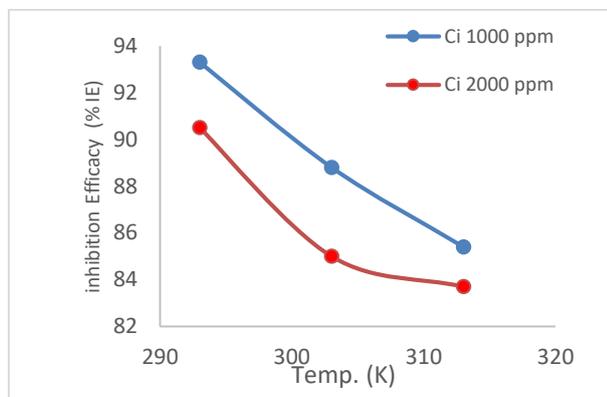


Figure 8. Effect of Temperature on the inhibition efficiency (1) M HCl in presence of alcoholic extract

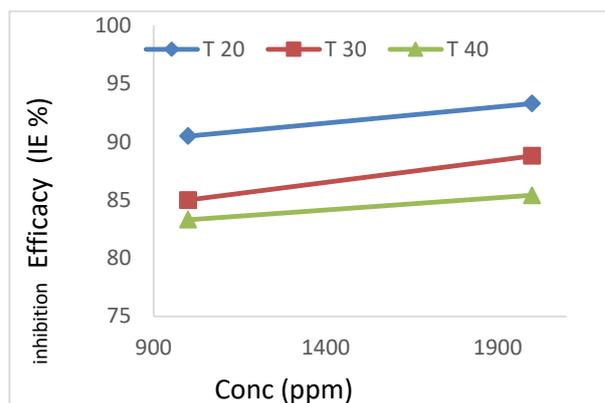


Figure 9. Effect of concentration on inhibition efficiency in (1) M HCl

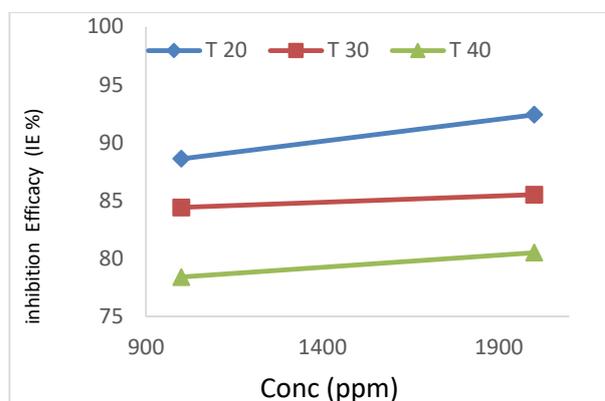


Figure 10. Effect of concentration on inhibition efficiency in (1) M HCl

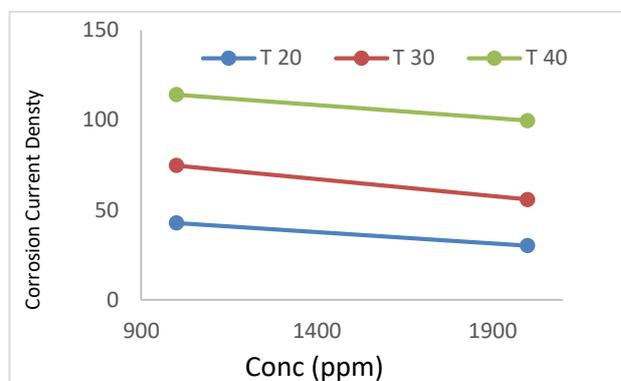


Figure 11. Effect of concentration on density of the erosion current in (1) M H with a aqueous extract

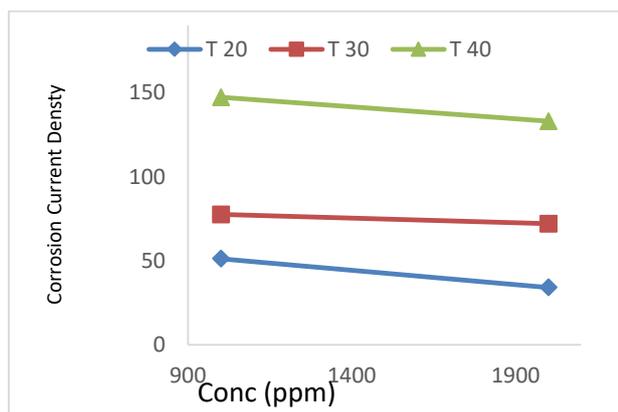


Figure 12. Effect of concentration on density of the erosion current in (1) M HCl with the presence of the alcoholic extract

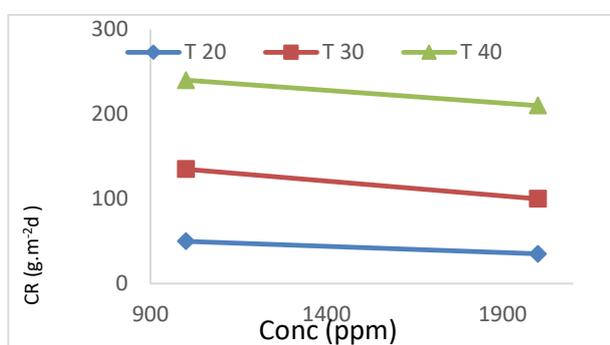


Figure 13. Effect of Concentration on The corrosion rate in (1) M HCl with aqueous extract

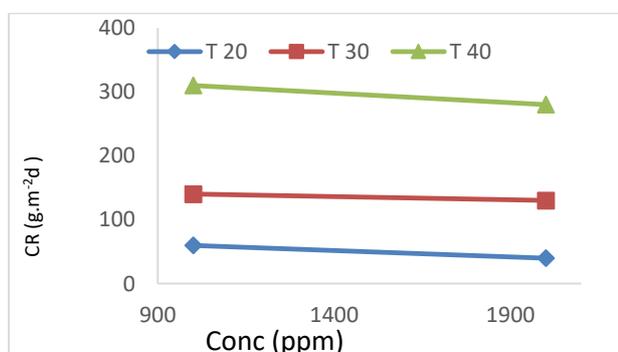


Figure 14. Effect of Concentration on Corrosion rate in (1) M HCl with alcoholic extract.

In Figs. 5-14 the IE was found to vary with acid temperature, acid concentration, of alcoholic extract and aqueous extract concentration and average molecular weight. Also it was found that the corrosion inhibition behavior of PEG is greater in hydrochloric acid. The adsorption of the inhibitor on the LCS surface is in agreement with Langmuir and

Frumkin adsorption isotherms. The inhibition efficiencies are increased by increase of the inhibitor's concentration and average molecular weight decreases with an increase in the concentration and temperature of the acid²⁰.

Scanning Electron Microscopy Study (SEM)

The microscopic examination of the surface of the eroded sample in the acid medium showed dark color indicating that corrosion products result from corrosion due to direct exposure to the acid medium. However, with the inhibitors, the damage is much smaller on the surface with clear color, and that because of formation protective layer on the steel surface which prevents the contact between the surface and medium¹⁷. Figs. 15-18, show SEM electron microscopy images.



200X

Figure 15. SEM electron microscopy images of medium carbon steel 200X after immersion in the middle of the corrosion medium



200X

Figure 16. SEM electron microscopy images of medium carbon steel 200X before immersion in the middle of the corrosion medium

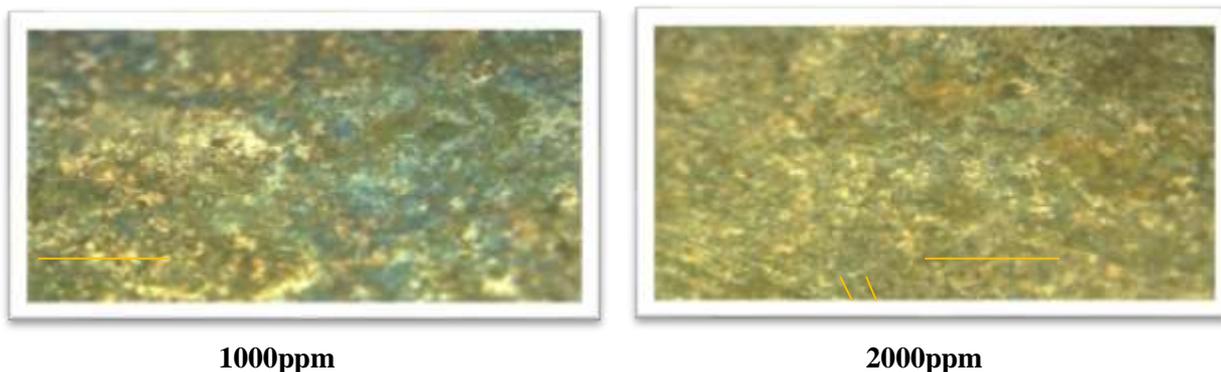


Figure 17. SEM electron microscopy images of medium carbon steel after corrosion in 1M HCl in the presence of aqueous extract in concentration (1000, 2000ppm)

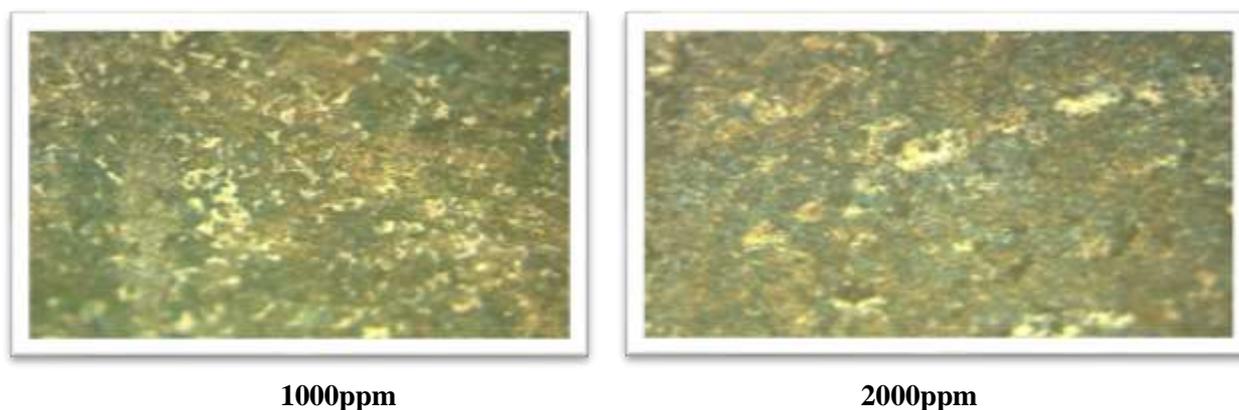


Figure 18. SEM electron Microscopy images of steel after corrosion in 1M HCl in the presence of alcoholic extract (1000ppm) extract in concentration (1000, 2000ppm)

Studies of inhibitory structures and infrared radiation

FTIR study of inhibitor composition for metal surface protection shows that the plant extract was used and the FT-IR spectra were recorded to elucidate the potential interactions between the adsorbed inhibitor Kujarat Tea and the surface of

carbon steel which are immersed in 1M HCl. FT-IR, the results in Table. 5, and Figs. 19, 20, show that the stretching frequencies of the inhibitor were shifted to lower values in comparison with the frequencies of the free extract and that may be a result of the reaction between the extract molecules and the surface of the metal¹⁹.

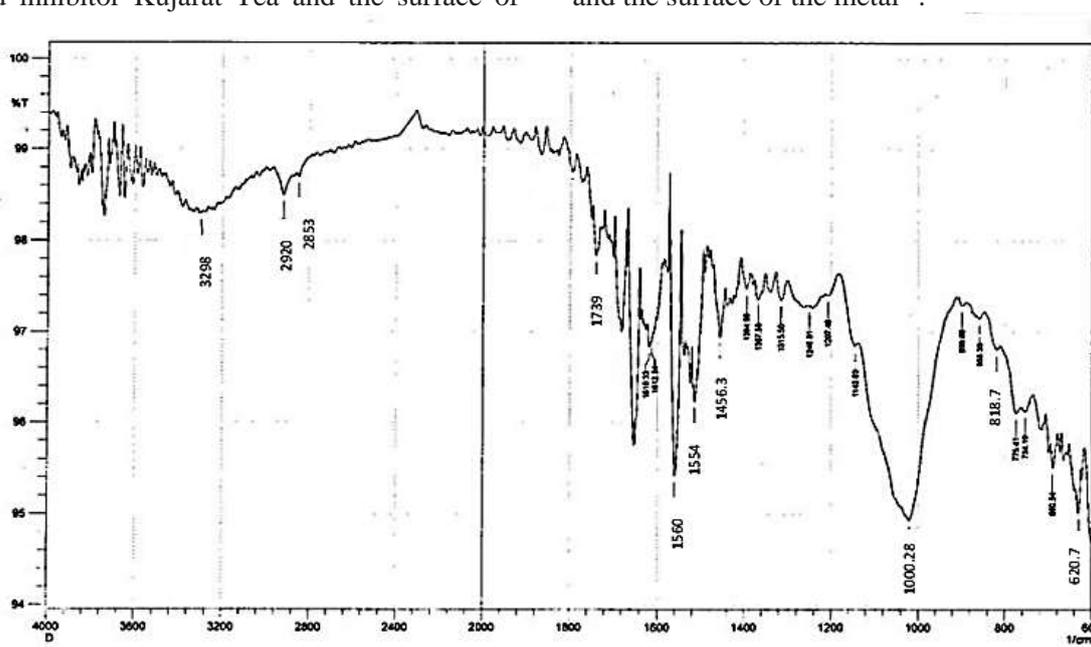


Figure19. FT-IR spectrum of Kujarat Tea extract (1M) HCl

These stretching frequencies are assigned to the presence of the alkaloids and flavone compounds which are responsible for such surface for the purpose of protecting the surface of the metal using

plant extracts and finding the best plant that provides protection²¹⁻²³. Fig. 21, show tifel curves and Fig. 22, show polarization curves, where b=bond, w=weak, s=strong.

Table 5. The important bands for the extract (cm⁻¹)

Free extract inhibitor	ν -NH	ν -CH ₃ aliph	ν -CH ₂ aliph	ν -C=O	ν -C=C Ar
	3298b	2920w	2853w	1739s	1560s
	3282b	2918w	2850w	1736s	1560s

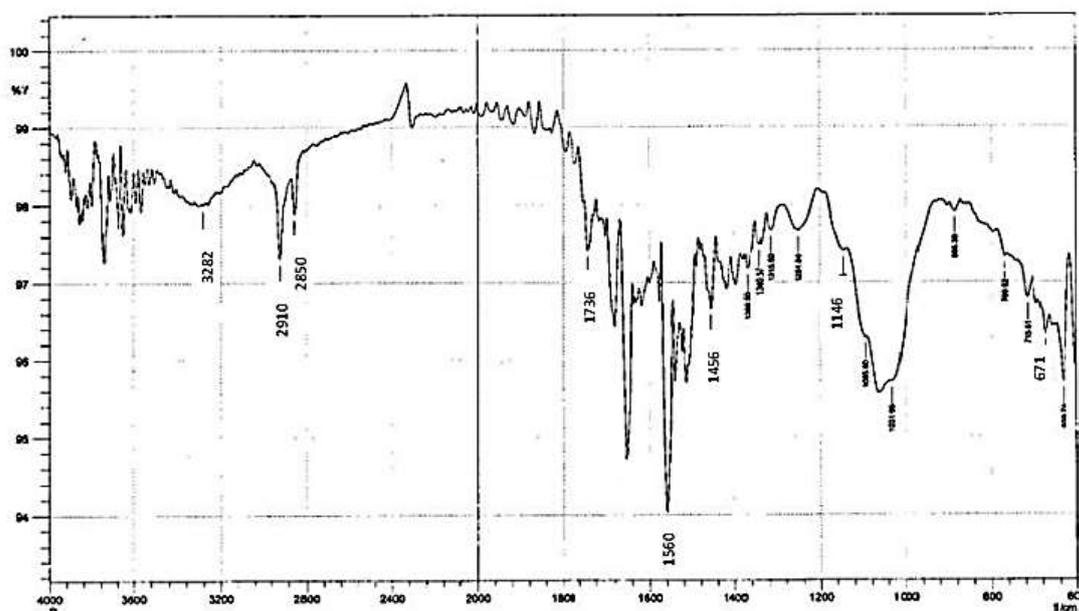


Figure 20. FT -IR spectrum of the extract for the protective layer formed on the metal surface after immersion in 1M HCl

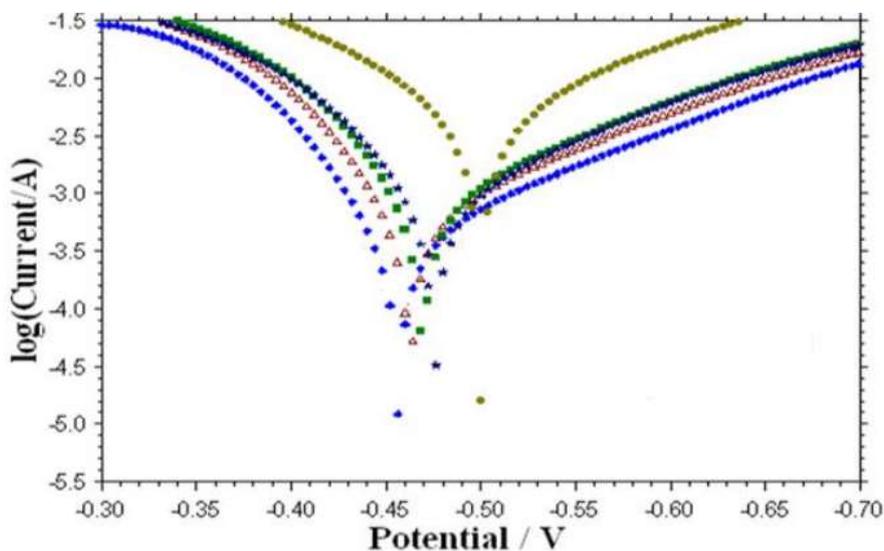


Figure 21. Tifel curves: Increasing Kujarat Tea Plant concentrations (1000,2000,3000) ppm on the corrosion of medium carbon steel in solution 1M HCl

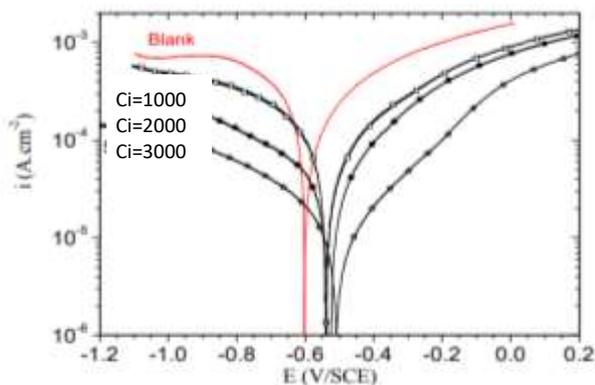


Figure 22. Polarization curves of medium carbon steel the presence of different concentrations of Kujarat Tea Plant

The activation entropy and activation enthalpy were calculated through the equation

$$\ln\left(\frac{CR}{T}\right) = \ln\left(\frac{R}{Nh}\right) + \left(\frac{\Delta S_{act}}{R}\right) - \left(\frac{\Delta H_{act}}{RT}\right) \dots\dots\dots 9$$

where a straight line was obtained, the value of its slope is the value of the activation enthalpy ($\frac{-\Delta H^*}{T}$) and the intercept is $\left(\ln R/Nh\right) + \frac{\Delta S^*}{R}$. If it is shown by the drawing that the enthalpy value is a positive value for the inhibitors, which indicates that the adsorption of the inhibitor on the surface of the metal is endothermic due to the metal dissolution process, and the positive entropy values indicate an increase in randomness in the system. Figs. 23, 24.

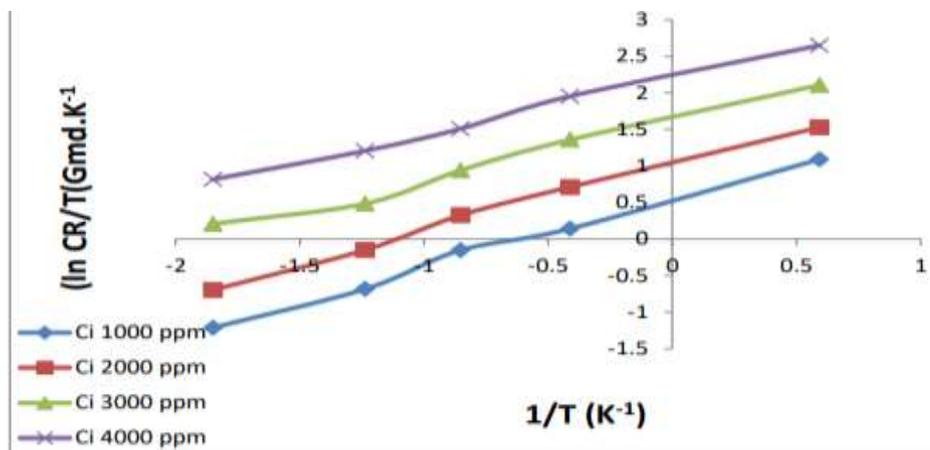


Figure 23. Transitional state of corrosion of medium carbon steel in the presence and absence of Kujarat Tea Plant

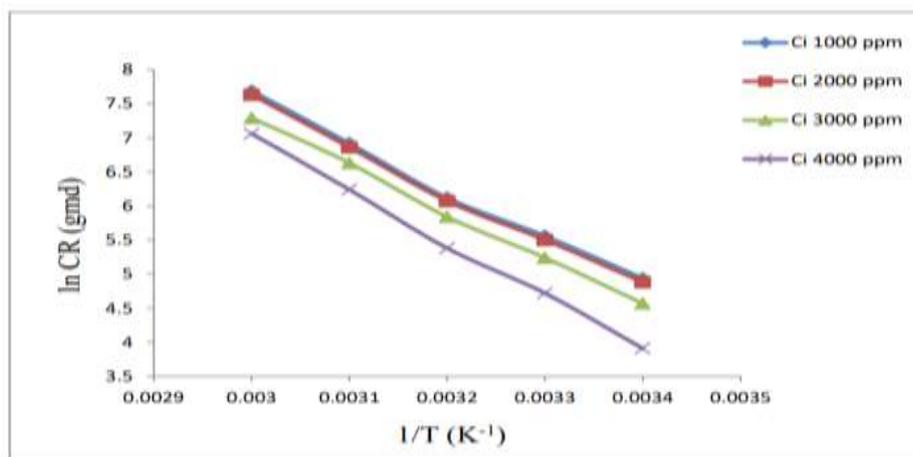


Figure 24. Diagram showing the corrosion of medium carbon steel at different concentrations of kujurat extract at different Temp.

Conclusions:

Kujarat Tea extract acts as a good inhibitor for the corrosion of Carbone carbon steel in 1 M HCl solution. The inhibition efficiency increases with increasing inhibitor concentration but decreases with

an increasing in temperature. The results obtained from polarization measurements revealed that *Kujarat Tea* extract behaves as a mixed type of inhibitor. Kujarat Tea alcoholic extract is a beater from Kujarat Tea aqueous extract at a lower

concentration. FT-IR shows that the compounds present in the plant extract form corrosion inhibitive layer by complications with iron ions present on the medium carbon steel surface

Author's declaration:

- conflicts of Interest: None.
- I hereby confirm that all the Figures and Tables in the manuscript are ours. Besides, the Figures and images, which are not ours, have been given permission for re-publication attached with the manuscript.
- Ethical clearance: The project was approved by the local ethical committee in University of Baghdad.

Authors Contribution:

S S.M and L A.A certify that we have participated title of MS (**Corrosion and Scale Inhibition of Medium Carbon Steel by Alcoholic and Aqueous Extract of Kujarat Tea Plant**) in different roles as follows: Conception, design, acquisition of data, analysis, interpretation, drafting the MS, revision and proofreading

References:

1. Al-Turkustani AM, Arab ST, Al-Qarni LS. Medicago Sative plant as safe inhibitor on the corrosion of steel in 2.0 M H₂SO₄ solution. *J Saudi Chem Soc.* 2011 Jan 1;15(1):73-82.
2. Sathishkumar P, Kumaravelan V. Dhivya priya D. Comparative study of mild steel corrosion using hydrochloric acid and phosphoric acid medium with ocimum tenuiflorum (l) plant extract. *Int J Adv Res.* 2015; 3(4): 643-51.
3. Ajeel A, Mohammed Waadulah H, Sultan DA. Effects of H₂SO₄ and HCL concentration on the corrosion resistance of protected low carbon steel. *AREJ.* 2012 Dec 28; 20(6): 70-6.
4. Trivedi V, Saxena V, Srivastav A. Scanning Electron Micrographic Investigation of Explanted (Used) Metallic Biomedical Implants for Corrosion and Other Mechanical Damage Responsible for Failure. *Mater Sci Appl.* 2015; 6(10): 869.
5. Nnanna LA, Owate IO, Oguzie EE. Inhibition of mild steel corrosion in HCl solution by pentaclethra macrophylla bentham extract. *Int J Mater Sci.* 2014; 4(5): 171-9.
6. Revie RW. Corrosion and corrosion control: an introduction to corrosion science and engineering. John Wiley & Sons; 4th Ed, 2008:1-43.
7. Mwakalesi AJ. Corrosion inhibition of Mild steel in Sulphuric Acid solution with Tetradenia riparia leaves aqueous extract: Kinetics and Thermodynamics. *Biointerface Res Appl Chem.* 2022 ; 13(1): 1-13.
8. Faraj L, Khan GM. Application of Natural Product Extracts as Green Corrosion Inhibitors for Metals and Alloys in Acid Pickling Processes-A. *Int J Electrochem Sci.* 2015; 10: 6120-34.
9. Khayatkashani M, Soltani N, Tavakkoli N, Nejatian A, Ebrahimian J, Mahdi MA, Salavati-Niasari M. Insight into the corrosion inhibition of Biebersteinia multifida root extract for carbon steel in acidic medium. *Sci Total Environ.* 2022 August ; 836(25): 155527.
10. Merimi I, Bitari A, Kaddouri Y, Rezki N, Mohamed M, Touzani R, Hammouti B. Metal corrosion inhibition by triazoles: A review. *Int J Corros Scale Inhib.* . 2022; 11(2): 524-40.
11. Habeeb HJ, Luaibi HM, Dakhil RM, Kadhum AA, Al-Amiery AA, Gaaz TS. Development of new corrosion inhibitor tested on mild steel supported by electrochemical study. *Results Phys.* 2018 Mar 1; 8: 1260-7.
12. Mothilal KK, Perumal S, Muthumanickam S, Elangovan A, Muniyappan N. Inhibition of mild steel corrosion in 1n hcl and 1n h₂so₄ by leaves extract of gossypium herbaceum *J Adv Sci Res.* 2022 Apr 30; 13(03): 151-60.
13. Khadom AA. Dual function of benzotriazole as copper alloy corrosion inhibitor and hydrochloric acid flow improver. *Surf Eng Appl Electrochem.* 2014 Mar; 50(2): 157-72.
14. Faraj L, Khan GM. Application of Natural Product Extracts as Green Corrosion Inhibitors for Metals and Alloys in Acid Pickling Processes-A. *Int J Electrochem. Sci.* 2015; 10: 6120-34.
15. Ameer MA, Fekry AM. Corrosion inhibition of mild steel by natural product compound. *Prog Org Coat.* 2011 Aug 1; 71(4): 343-9.
16. Dahmani M, Et-Touhami A, Al-Deyab SS, Hammouti B, Bouyanzer A. Corrosion inhibition of C38 steel in 1 M HCl: A comparative study of black pepper extract and its isolated piperine. *Int J Electrochem Sci.* 2010 Aug 1; 5(8): 1060-9.
17. Mahmoud ZS, Shams AK, Salman TA. Study the Inhibition Effect of Amoxicillin Drug for Corrosion of Carbon Steel in Saline Media. *Baghdad Sci.J.* 2022; 19(1): 0121. <https://doi.org/10.21123/bsj.2022.19.1.0121>
18. Jassim RA, Kadhim NJ, Farhan AM. Experimental and Theoretical Study of Neomycin Sulfate as Corrosion Protection for Titanium in Acid Media. *Baghdad Sci J.* 2021; 18(2). <https://doi.org/10.21123/bsj.2021.18.2.0374>
19. Gadaw HS, Motawea MM. Investigation of the corrosion inhibition of carbon steel in hydrochloric acid solution by using ginger roots extract. *Rsc Adv.* 2017; 7(40): 24576-88.
20. Majeed, Jafar Ghani, Basim Ajel Sadkhan. Comparison of the Corrosion Inhibition Efficiencies of Low Carbon Steel In Different Acidic Mediums Using Some Polyethylene Glycols. *JEASD .*2013; 17(4): 165-181.
21. Hamdy A, El-Gendy NS. Thermodynamic, adsorption and electrochemical studies for corrosion inhibition of carbon steel by henna extract in acid medium. *Egypt J Pet.* 2013 Jun 1; 22(1): 17-25.
22. Isa WA, Ahmed ZW. Corrosion Inhibition of Aluminium in Acidic Medium using Amino Acid (Methionine). *Ibn al-Haitham J Pure Appl Sci.* 2017 Mar 9; 28(3).

23. Ali EH, Himdan TA, Ahmed ZW. Gallic acid as corrosion inhibitor for aluminum 6061 in alkali solutions. *Ibn al-Haitham J Pure Appl Sci.* 2019 Jan 20; 32(1): 17-27.

تنشيط تاكل الفولاذ الكربوني المتوسط في الوسط الحامضي باستخدام المستخلص الكحولي والمائي لنبات شاي الكوجرات

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الخلاصة :

اجريت دراسة عملية تنشيط تاكل المعدن medium carbon steel عن طريق وضعه في وسط اكال (وسط حامض 1 M HCl) باستخدام الطريقة الحركية وإيجاد ثابت السرعة باستخدام طريقة فقدان الوزن طبقت على قطع معدن كاربون ستيل التي قسمت بشكل مكعب مع انصاف اقطار ، حيث قطعت العينات بأشكال مكعبة وبابعاد (2.4*2*0.4)سم ، ثم تم صقل العينات باستخدام ورق كربيد السيليكون بأبعاد (180,200,400,600,800,1000) واستخدم طريقة تافل للقياسات وضعت العينات في وسط حامضي وبدرجة حرارة (293) كلفن في وسط ساكن ولمدة اختبار (3ساعات) . تم استخدام مثبت طبيعي هو نبات شاي الكوجرات (*Hibiscus sabdariffa L.*) Kujarat Tea حيث تم استخلاص النبات عن طريق مستخلصين (مائي وكحولي) وعند تراكيز مختلفة (ppm 1000,2000,3000) ، وان افضل تثبيط التاكل وجد عند التراكيز (ppm1000,2000,3000) وجد ان اعلى كفاءة للمستخلص المائي هي (93.3%) عند درجة حرارة (293كلفن) بتركيز 2000 ppm ، وكانت نسبة (90.5%) مع تركيز (ppm1000) عند (293كلفن) ، بينما كانت نسبة التثبيط عند استخدام المثبط الكحولي هي (92.4%) بتركيز 2000 ppm و (88.6%) عند تركيز ppm1000 ، صيغة التثبيط تم دراستها بواسطة الاشعة تحت الحمراء (FT-IR) ومن خلال المجهر الماسح الالكتروني SEM .

الكلمات المفتاحية : مستخلص , مثبت , اكسدة , اختزال , منحنيات تافل.