Performance Of Grape Leaves Extract As Green Inhibitor On Corrosion Inhibition Of Mild Steel In Acidic Media

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Research Article

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***Abstract*— The inhibitive effect of grape leaves Extract (GLE) on mild steel in acidic Media with different temperatures polarization measures and weight loss have been used to investigate. The study obtained that the corrosion rate increases with increasing of acid concentration and the used green inhibitor (GLE) inhibited the electrochemical reaction to its lowest levels. Temperature and extract concentration both increase corrosion inhibition effectiveness. Grape leaf extract was adsorbed according to the Langmuir adsorption isotherm. According to the thermodynamic characteristics, there was an exothermic, spontaneous adsorption process with a rise in entropy. Polarization curves demonstrated the mixed-type inhibitory properties of grape leaves extract.**

Keywords— corrosion; mild steel; green inhibitor; grape leaves extract; acidic corrosion.

I. INTRODUCTION

Mild steel is widely used in oil industry equipment's, Metallic corrosion Causing financial costs for oil industry and with time the metallic constructions corroded due to different reasons such as acidic media. In several oil industry processes, such as industrial acid cleaning, acid descaling, acid pickling, and oil well acidizing, acidic solutions are used.[1]. To eliminate the metals aggressive green inhibitors are used, which considered an excellent type of inhibitors to reduce the rate of corrosion in acidic media. One of the most effective and affordable ways to prevent mild steel corrosion in acidic medium is to employ green inhibitors. As green inhibitors, the researchers used a variety of plant leaf extracts, including those from Cola acuminata and Camellia sinensis.[2], Tithonia diversifolia [3], Newbouldia leavis [4], Euphorbia hirta [5], Carica Papaya and Camellia Sinensis[6], Vernonia Amygdalina [7,8]. According to the results of all these investigations, plant extracts contain organic compounds that have molecules of N, S, and O that can be used to create a protective coating on mild steel surfaces and so improve inhibitory effectiveness. The objective of the current work is to get high inhibitory effectiveness (I.E.) of grape leaf extract as a mild steel inhibitor in acidic solution. Ease of Use. The Corrosion is a global phenomenon that happens because of Chemical reactions between metals and the environment Metal corrosion can be controlled in a variety of ways. Methods are noteworthy, and among many methods of regulating cathodic protection. The imprinted current method and the sacrificial anode method are two types of metal cathodic protection. Both methods deal with the transfer of electrons either from or to the metal or the atmosphere. Its offered model is extremely important which accessible energy Renewable source and operates it to secure buried steel pipelines against corrosion. It is intended to use the capacitive coupler of the Cathodic Protection by Impressed Current Device at a minor level to increase the growth of this system to a greater degree, which may be agreed with the protection process of lengthy subversive pipelines in distant areas. Impressed Current Cathodic Safety in combination with capacitive couplings indicates that there are several potential solutions to inhibit corrosion in underground. The batteries can be considered one of the electrical sources. They are applied in many applications. However, most of the batteries charging process achieved by using of power harmonies. The concept of power transfer wireless was first expressed and established by Nikola Tesla 1900's [9]. The magnets that we use to design the system ready to transfer power through the small and large air gaps. Capacitance coupling is the principle of CPT systems. The application of WPT systems is found in many fields such as transportation [10], roadway lighting [11], consumer electronics [12], and high-power transmission [13]. The statistical details showed health problems, sensitivity and depression that resulted from electromagnetic field and capacitance coupling [14]. The magnetic fields properties are forced to form closed loops from pole to pole and all of them have equal strength. So, any electronics placed in magnetic fields vicinity exposed to the above effect resulting an electromagnetic Interference (EMI) issues and because the present of EMI, extra protection would need for the electronics in the environment and pass-through difficult testing of electromagnetic compatibility. the track looks of smallest reluctance between reverse poles and effort to make a closed loop between pair of poles is another property of magnetic fields [15].

II. FUNDAMENTALS OF CORROSION

Corrosion reaction can be achieved by formatting an electrochemical corrosion cell which is consists of Anode (corroded terminal), cathode (protected terminal) metallic path and electrolyte as shown in table 1. The electrical circuit is completed with the help of all these components, which permits electrons to flow. The positive side of the control source is attached to the inert anode in the Impressed Current Cathodic Protection technique (such as Graphite). Graphite can be considered as great conductor for power and upgrades moo values of current thickness, gives tall surface per unit weight with moo temperate Fetched moreover gives moo resistance to the electrolyte due to its tall surface-to-weight proportion. The Graphite Levels consumption is about 0.25 kilogram per Year which makes it a favorable among the different materials of anode available.

A. Mild steel Samples preparation

0.5 and 1M HCl solution , different amount (0.1, 0.25, 0.5, 0.75, 1 g/lit) of grape leaves extract were used as working media and immersion time was 24 hours. Solutions temperature was (30,40,50 °C).

B. Materials and Solutions Grape Leaves Extract preparation

0.5 and 1M HCl solution, different amount (0.1, 0.25, 0.5, 0.75, 1 g/lit) of grape leaves extract were used as working media and immersion time was 24 hours. Solutions temperature was (30,40,50 °C).

C. Grape Leaves Extract preparation

grape leaves was dried by sun light under temperature range (40 -50 °C) for three days then grinded and sifted. The resulted powder was used as an inhibitor for mild steel in different temperature and different concentration of HCl.

III. WEIGHT LOSS MEASUREMENT

A total of 40 experiments for weight loss measurements were achieved to study the corrosion rate of mild steel in different concentration of (GLE) and HCl for 24 hours as an immersion time. The results were presented in Table I ,Table II & Table III . The results can be demonstrated that the corrosion rate rose with increasing of acid concentration and (GLE) inhibits the electrochemical reaction and decreasing the rate of corrosion with increasing of HCl and temperature. It can be shown that the amount of acid present is directly proportional to the corrosion rate. The inhibition efficiency I.E. was calculated as the follow:-

$$IE\%=(Wo-Wi)/Wo\times 10 \quad (1)$$

Where, W_O and W_i are, respectively, the weight loss of the coupon in the normal and inhibited acid solutions. The I. E. increases with the (GLE) concentration as shown in TABLE I . [9].

A. Adsorption isotherm and thermodynamic parameters

adsorption isotherm calculations were performed to study the inhibition mechanism of grape extracting leaves, on the surface of mild steel, it was found best agreement with Adsorption isotherm of Langmuir. For both chemical and physical adsorption, the Langmuir adsorption isotherm is regarded as the ideal isotherm [10, 11]. moreover, it might be portrayed as:

$$Cinh/\Theta=1/Kads+Cinh \quad (2)$$

Where, Kads is the adsorption constant and Cinh is the amount of an inhibitor. The surface coverage values θ (θ =Wo− Wi / Wo) computed from the weight-loss I. E. percentage. According to equation (2) it can be observed a linear relationship when Cinh/Θ was plotted against Cinh as seem from fig (1-3) therefore the adsorption of (GLE) on the mild steel surface in (0.5 ,1M) HCl solution by the Langmuir isotherm. The standard Gibs free energy of adsorption is related to the adsorption constant. ΔG°ads as follows [12]:-

$$\Delta G°ads= -RT \ln (55.5\ Kads) \quad (3)$$

Where, R is the universal gas constant, T is the absolute temperature and the value 55.5 is the molar concentration of water in the working solution [13,14]. The results showed negative value of ΔG°ads ranges from -13.656 to -14.921 kJ /mol and this values approved physical and spontaneous adsorption (physisorption) of grape leaves extract molecules on the metal surface [15].

Vant Hoff equation as follows below used to calculate the adsorption heat ΔH°ads of inhibitor molecules by plotting (ln Kads) against 1/T and the slope of the resultant straight line is representing ΔH°ads /R[16]:

$$\ln Kads=(-\Delta H°ads)/RT+constant \quad (4)$$

TABLE I. WEIGHT LOSS PARAMETERS FOR THE CORROSION OF MILD STEEL IN THE PRESENCE AND ABSENCE OF (GLE) AT 30 °C.

HCl Conc.(M)	**0.5 M**		**1M**	
Inhibitor Conc.(g/lit)	***Corrosion rate (mg /m² .d)***	***IE%***	***Corrosion rate (mg /m² .d)***	***IE%***
Blank	572.90		680.55	
0.1	121.3617	78.816	144.6098	78.75
0.25	85.87843	85.009	120.90782	82.23
0.5	79.25366	86.166	109.7458	83.87
0.75	62.31448	89.122	87.92488	87.08
1	56.31993	90.169	67.29465	90.11

TABLE II. WEIGHT LOSS PARAMETERS FOR THE CORROSION OF MILD STEEL IN THE PRESENCE AND ABSENCE OF (GLE) AT 40 °C.

HCl Conc.(M)	**0.5 M**		**1M**	
Inhibitor Conc.(g/lit)	***Corrosion rate (mg /m² .d)***	***IE%***	***Corrosion rate (mg /m² .d)***	***IE%***
Blank	692.14	0	731.37	
0.1	134.69	80.54006	137.40	81.21
0.25	95.47	86.20655	97.29	86.69
0.5	85.53	87.64267	82.43	88.72
0.75	62.75	90.93392	64.12	91.23
1	55.36	92.00162	56.20	92.315

TABLE III. WEIGHT LOSS PARAMETERS FOR THE CORROSION OF MILD STEEL IN THE PRESENCE AND ABSENCE OF (GLE) AT 50 °C.

Hcl Conc.(M)	**0.5 M**		**1M**	
Inhibitor Conc.(g/lit)	***Corrosion rate (mg /m² .d)***	***IE%***	***Corrosion rate (mg /m² .d)***	***IE%***
Blank	772.24		830.93	
0.1	103.8415	86.55	104.2845	87.449
0.25	85.05064	88.98	103.251	87.57
0.5	72.29537	90.63	78.65764	90.53
0.75	68.46623	91.13	60.85994	92.67
1	59.07047	92.35	54.84422	93.39

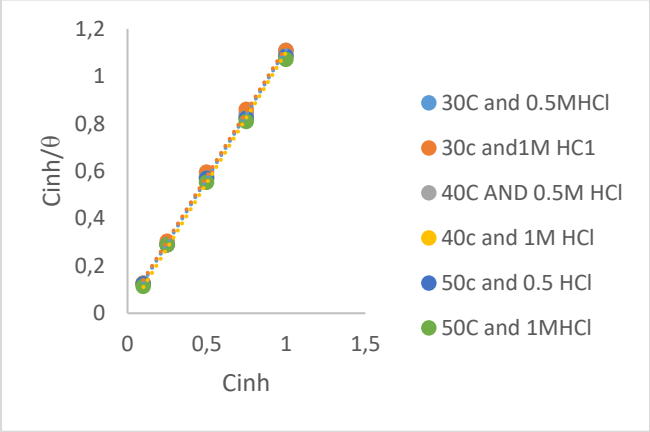

Fig. 1. Langmuir adsorption isotherm for grape leaves extract at 30 ,40 and 50 °C.

B. *Adsorption Entropy*

Table IV showed all the Adsorption thermodynamic parameters. Spontaneous adsorption of the grape leaves extract on mild steel surface proved by the negative value of ΔG°ads which concluded that physical Adsorption occurred by the extract on the mild steel surface .The negative value of ΔH°ads suggest that the process of adsorption of inhibitor on mild steel surface is exothermic. It can be assume that the increase in temperature leads to the increase in desorption of the adsorbed inhibitor molecule from the mild steel surface and can be calculated as:

$$\Delta G°_{ADS}=\Delta H°_{ADS}-T\,\Delta S \qquad (5)$$

TABLE IV. ADSORPTION THERMODYNAMIC PARAMETERS FOR THE GRAPE LEAVES EXTRACT ON MILD STEEL SURFACE

Temperature (°C)	**Hcl Conc.(M)**	**Kads kJmol⁻¹**	**ΔG° k J mole⁻¹**	**ΔH° k J mole⁻¹**	**ΔS° J mole⁻¹**
30	*0.5*	*32.894*	*-8.8*	*26.189*	*115.475*
	1		*-8.8*		*115.475*
40	*0.5*	*32.894*	*-9.09*		*115.30*
	1	*62.631*	*-10.31*		*115.30*
50	*0.5*	*32.894*	*-9.38*		*115.876*
	1	*62.631*	*-10.64*		*114.021*

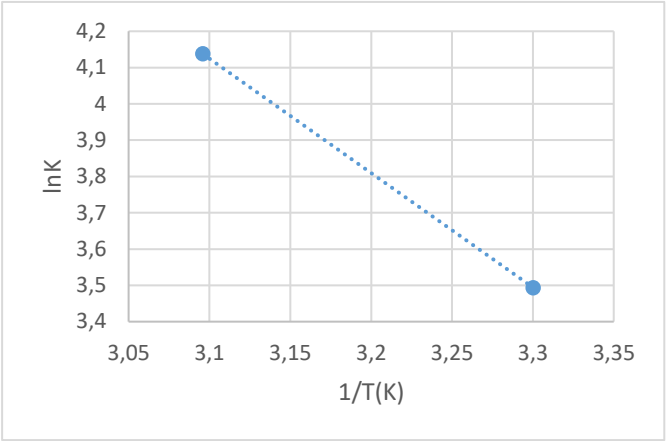

Fig. 2. Von't Hoff plot for grape leaves extract at 30 ,40 and 50 °C.

V. CONCLUSIONS

In this research, the effect of grape leaf extract was studied as an inhibitor of corrosion reaction in acidic media and different conditions of temperature, exposure time and concentration using two methods, the first is calculating weight loss, which is a chemical method, and the second is using the polarization method, which is an electrochemical method. The research revealed that the corrosion rate increased as the temperature and acid concentration increased, but that the grape leaf extract was able to lower it to the lowest levels, and that the effectiveness of the inhibitory effect increased as the extract's concentration and temperature increased. It was found that the corrosion inhibition process is subject to the Langmuir adsorption curves, and that the inhibition process is spontaneous, accompanied by the release of thermal energy and the inhibitor.

It may be used for another purpose in the future, Like vine leaves or fig leaves and to get the best results and prevent corrosion that occurs in metals.

REFERENCES

[1] Ahanotu, C. C., Onyeachu, I. B., Solomon, M. M., Chikwe, I. S., Chikwe, O. B., & Eziukwu, C. A. (2020). Pterocarpus santalinoides leaves extract as a sustainable and potent inhibitor for low carbon steel in a simulated pickling medium. Sustainable Chemistry and Pharmacy, 15, 100196.

[2] Samiee, R., Ramezanzadeh, B., Mahdavian, M., Alibakhshi, E., & Bahlakeh, G. (2019). Graphene oxide nano-sheets loading with praseodymium cations: Adsorption-desorption study, quantum mechanics calculations and dual active-barrier effect for smart coatings fabrication. Journal of industrial and engineering chemistry, 78, 143-154.

[3] Fawzy, A., Abdallah, M., Zaafarany, I. A., Ahmed, S. A., & Althagafi, I. I. (2018). Thermodynamic, kinetic and mechanistic approach to the corrosion inhibition of carbon steel by new synthesized amino acids-based surfactants as green inhibitors in neutral and alkaline aqueous media. Journal of Molecular Liquids, 265, 276-291

[4] Zeino, A., Abdulazeez, I., Khaled, M., Jawich, M. W., & Obot, I. B. (2018). Mechanistic study of polyaspartic acid (PASP) as eco-friendly corrosion inhibitor on mild steel in 3% NaCl aerated solution. Journal of Molecular Liquids, 250, 50-62.

[5] R. Nicole, "Title of paper with only first word capitalized," J. Name Stand. Abbrev., in press.

[6] Wang, L., Wu, W., Sun, W., Yang, Z., Wang, S., & Liu, G. (2019). Partially dehydrated zinc hydroxide sulfate nanoplates reinforced coating for corrosion protection. Chemical Engineering Journal, 373, 8-22.

[7] Y. Yorozu, M. Hirano, K. Oka, and Y. Tagawa, "Electron spectroscopy studies on magneto-optical media and plastic substrate interface," IEEE Transl. J. Magn. Japan, vol. 2, pp. 740–741, August 1987 [Digests 9th Annual Conf. Magnetics Japan, p. 301, 1982].

[8] M. Young, The Technical Writer's Handbook. Mill Valley, CA: University Science, 1989.

[9] Ahmed, R.K., Zhang, S. (2019): Alchemilla Vulgaris Extract as Green Inhibitor of Copper Corrosion in Hydrochloric Acid, International Journal of Electrochemical Science, 14, 10657-10669. DOI: 10.20964/2019.11.43

[10] Alibakhshi, E., Ramezanzadeh, M., Haddadi, S.A., Bahlakeh, G., Ramezanzadeh, B., Mahdavian, M. (2018.): Persian Liquorice extract as a highly efficient sustainable corrosion inhibitor for mild steel in sodium chloride solution, Journal of Cleaner Production, 210, 660-670. DOI: 10.1016/j.jclepro.2018.11.053

[11] Bouammali, H., Ousslim, A., Bekkouch, K., Bouammali, B., Aouniti, A., Al-Deyab, S.S., Jama, C., Bentiss, F., Hammouti, B. (2013): The Anti-Corrosion Behavior of Lavandula dentata Aqueous Extract on Mild Steel in 1M HCl, International Journal of Electrochemical Science, 8, 6005-6013.

[12] Bouammali, H., Ousslim, A., Bekkouch, K., Bouammali, B., Aouniti, A., Al-Deyab, S.S., Jama, C., Bentiss, F., Hammouti, B. (2013): The Anti-Corrosion Behavior of Lavandula dentata Aqueous Extract on Mild Steel in 1M HCl, International Journal of Electrochemical Science, 8, 6005-6013. B

[13] Bozorg, M., Farahani, T.S., Neshati, J., Chaghazardi, Z., Ziarani, G.M. (2014): Myrtus Communis as Green Inhibitor of Copper Corrosion in Sulfuric Acid, Industrial & Engineering Chemistry Research, 53, 4295-4303. DOI: 10.1021/ ie404056w

[14] Cech, M., Davis, P., Guijt, W., Haskamp, A., Huidobro Barrio, I. (2021): Performance of European cross-country oil pipelines Statistical summary of reported spillages in 2019 and since 1971, Report. Brussels, 4/21

[15] Cordeiro, R.F.B., Belati, A.J.S., Perrone, D., D'elia, E (2018): Coffee Husk as Corrosion Inhibitor for Mild Steel in HCl Media, International Journal of Electrochemical Science, 13, 12188-12207. DOI: 10.20964/2018.12.29

[16] Da Rocha, J.C., Ponciano Gomes, J.A.C., D'elia, E., Gil Cruz, A.P., Cabral, L.M.C., Torres, A.G., Monteiro, M.V.C. (2012): Grape Pomace Extracts as Green Corrosion Inhibitors for Carbon Steel in Hydrochloric Acid Solutions, International Journal of Electrochemical Science, 7, 11941- 11956.