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Steel corrosion prevention through the use of orange peels

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Abstract

Studies on carbon steel corrosion properties were conducted under particular conditions. In acid media, weight loss assays were carried out using varying inhibitor concentrations and temperatures (35, 45, and 55ºC) (0.1N H_2SO_4). Orange peels lose up to 93% of their activity in anaerobic conditions. There were numerous polarization and weighting procedures employed in aluminumpata study. Increasing temperatures and the rate of corrosion led to a decrease in the corrosion potential, which became increasingly negative. Increasing the amount of corrosion inhibitor reduces the corrosion current and raises the corrosion potential of the system.

Key words: corrosion, orange peels inhibitors, electrochemical polarization

Introduction

Inexpensive cost is the main factor of using carbon steel the building industry and in a wide variety of industries, such as automotive, pipeline, and chemical [1-3].One of the most effective corrosion factor is metals exposure to chloride-rich environments like seawater [4-6]. Carbon steel corrosion has been subjected in many research of academic and industry for many years [7, 8]to get environmentally acceptable corrosion inhibitors[9, 10]. There are many factors that make carbon steel is the primary building material for its use in several areas such as its low cost, no additional expensive with the same effect elements contents such as zirconium, Aluminum, high carbon included and it is not stainless steel[11, 12].

The nature of aqueous and atmospheric corrosion is electrochemical due to transfer of electrons metal surface to an aqueous electrolyte solution during corrosion[13, 14]. This interaction of metals like steel with undesired media like acids, bases or salts leads to high risk of some industries[15-17]. So, there are many methods were performed and can be applied on metals and buildings to resist corrosion and protect metals such as coating, electroplating, or cathodic protection [18-22]. Corrosion inhibitors that are chemical compounds that when added preventing metals from rusting and so they are an excellent choice [23]. these compounds are both cheap and frequently available, as well as environmentally friendly[10, 24], they've attracted an increasing amount of attention.

According to this survey and in continuation of our work [25] we aim to study carbon steel corrosion properties under particular conditions such as acid media (0.1N H_2SO_4), salt media (3 % NaCl) weight loss assays using varying inhibitor concentrations and temperatures (35, 45, and 55ºC).

Materials and Methods

Carbon steel specimens of 7 x 2 cm were used in a series of experiments to conduct corrosion testing. Acidic (0.1N H2SO4 solution) and alkaline (%3N NaCl solution) solutions were used to test the corrosion potential of samples for one hour at various temperatures (35, 45, and 55 °C) with inhibitors ranging from 0 to 2.5 g of orange peels. According to theory, we compared our findings to the results. This experiment used two electrodes: a saturated calomel electrode (S.C.E.) and a graphite rod electrode. The working electrode was a section of aluminum plate (28 x 10^{-4} m2). Static, without and with inhibitor, and

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electrochemical polarization methods that measure the instantaneous potential corrosion under a variable temperature for clean surfaces were used to determine the corrosion potential in carbon steel for t-loss (free corrosion) measurements to determine the corrosion rate .A water bath maintained the temperature within ± ˚C of the desired setting.

Fig.(1) Corrosion experiments conducted without the use of chemicals

Fig.(2) Experiment with polarization

Results and Discussion

Corrosion rates are influenced by temperature (35°C,45°C,55°C) and an orange peels inhibitor concentration (0.5,2.5 g) and (3 % NaCl), as shown by weight loss measurements (see Table 1). Corrosion rates rose in response to rising temperatures, as shown in graphs 3 to 5 (free corrosion), figures (4 to 6) and the polarization, figure (7 to 9). Oxygen mass transfer and activation polarization have led to an increase in corrosion [26, 27].The cathodic reactions in these solutions are as follows:

$$2H^+ + 2e \longrightarrow H_2 \quad (1)$$

$$O_2 + 4H^+ + 4e \longrightarrow 2H_2O \quad (2)$$

As a result, the total cathodic reaction current for oxygen and hydrogen is reduced (see Table 1).As a result of using corrosion inhibitors, deterioration is reduced.Anodic current increases with increasing inhibitor efficacy, even at high temperatures[27].

Table(1) Orange peels were used as an inhibitor to study the corrosion rate of carbon steel in an air-saturated 3% NaCl solution for 1 hour.

T (ºC)	C (ppm)	Δw(g)	CR(gmd)	CR(mm/y)	CR(mpy)	η %
35	0	0.03	257.28	93.89	3696.4	-
45	0	0.041	351.62	128.32	5051.9	-
55	0	0.061	523.15	190.93	7516.9	-
35	0.5	0.0021	18.01	6.572	258.7	93
45	0.5	0.011	94.33	34.42	1355.1	73
55	0.5	0.036	308.74	112.67	4435.8	41
35	2.5	0.002	17.15	6.259	246.41	93
45	2.5	0.004	34.30	12.51	492.5	90
55	2.5	0.0072	61.74	22.53	887.25	88

Although the adsorption theory has been successful in all cases, the inhibitor can still be expected to go through a stage of preliminary adsorption. Another theory suggests that the metal's surface is coated with a layer of inhibitors, which acts as a barrier against corrosion. Physical and chemical adhesions were taken into account [28, 29]. According to figure 2 and the figures 4 to 9, inhibition of anodic reactions reduces potential.

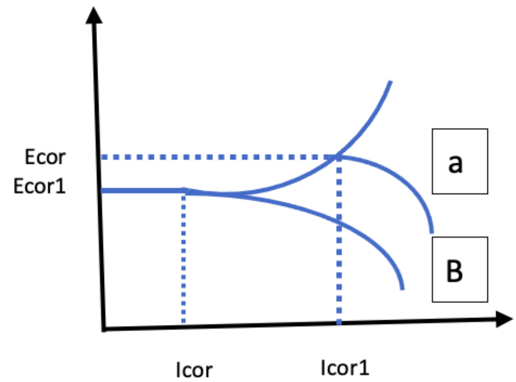

Fig.(3)When the metal is in cathodic inhibitors solution, the metal's electrochemical behavior is different from that of the metal in the same solution, without inhibitors (b)[22].

The corrosion rate of a metal increases as the temperature rises, lowering its value. Figures 4 to 6 show that for a 60-minute experiment, the results are consistent. At exactly 10 minutes into the experiment, OH-ions formed and clustered around the electrodes, causing the potential to quickly fall and the curve to slowly converge [29, 30].A decrease in the rate at which it forms is expected. Corrosion potential increases as temperature rises because the density of the limiting current increases. Anodic and cathodic regions of saturated calomel electrode in 3%NaCl solutions are shown in polarization curves (see below) to support this claim. As a result, the activation polarization was reversed when the current was reduced [31, 32].

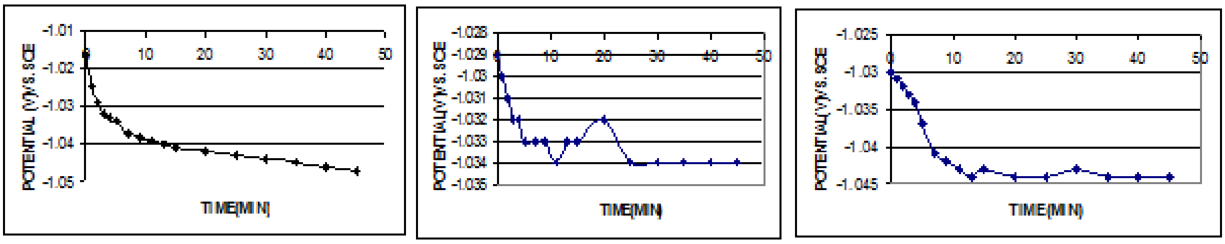

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Fig.(4) Potential vs. time for CS metal in 3% NaCl solution at (a) T=35ºC, (b) T=45ºC, and at (c) T=55ºC

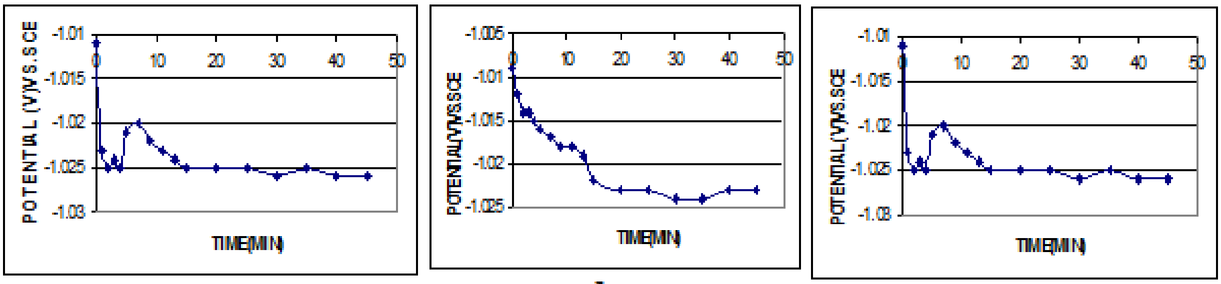

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Fig.(5) Potential vs tim for CS metal in 3% NaCl solution and 0.5g orange peels inhibitor at (a)T=35ºC ,(b) T=45 ºC, (c) T=55 ºC

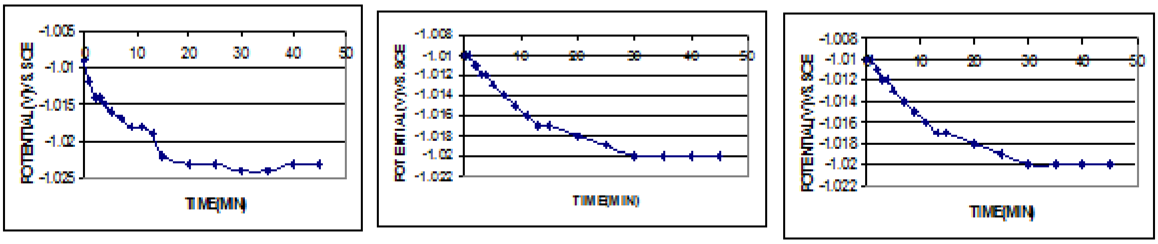

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Fig.(6) Potential vs tim for CS metal in 3% NaCl solution and 2.5g orange peels inhibitor at (a) T=35ºC ,(b) T=45 ºC, (c) T=55 ºC

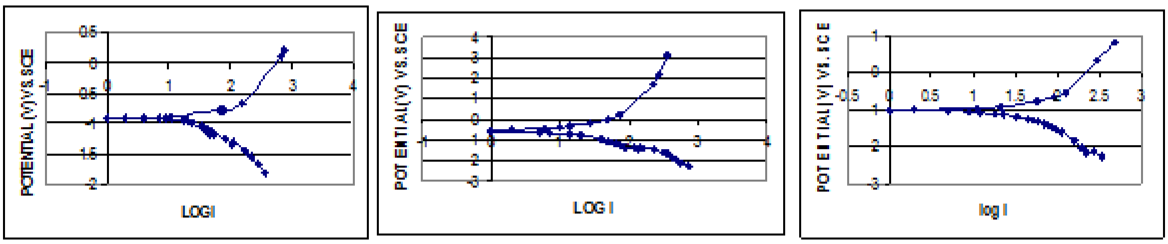

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Fig (7) Polarization curve for CS metal in 3% NaCl solution at (a) T=35ºC,(b) T=45ºC,(c) T=55º ºC

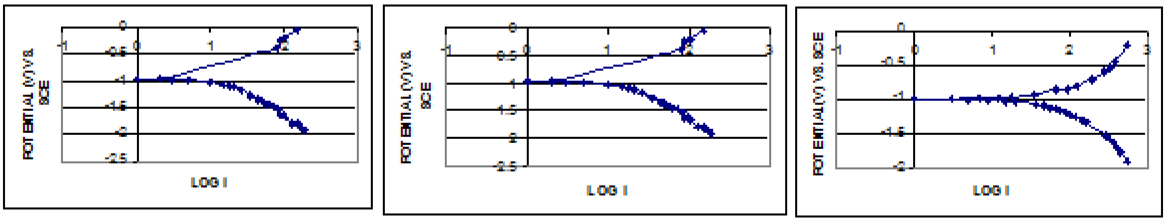

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Fig (8) Polarization curve for CS metal in 3% NaCl solution and 0.5g orange peels inhibitor at (a) T=35°C,(b) T=45°C,(c) T=55 °C

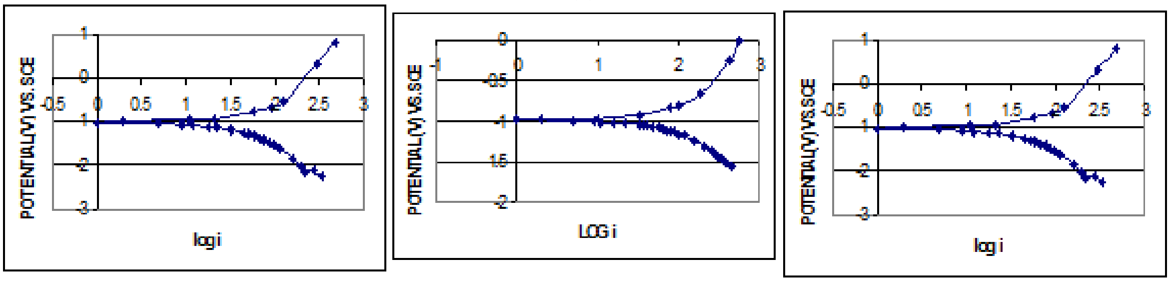

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Fig (9) Polarization curve for CS metal in 3% NaCl solution and 2.5g orange peels inhibitor at (a)T=35°C,(b)T=45 °C (c) T=55 °C

Conclusions

The use of orange peels in acidic media can decrease development by as much as 93 percent. As the temperature of the solution rises, the rate of corrosion increases, and the potential for corrosion rises. As the inhibitor concentration rises, the rate of corrosion decreases. The limiting current density increases as the temperature of the solution rises.

Abbreviation list

symbols	defined
T	Temperature °C
ΔW	weight loss (g) = W1-W2
W1	First weight (g)
W2	Second weight(g)
L	length of specimen= 2 cm
W	width of specimen = 7 cm
A	total area of metal specimen (m^2) =0.0028m^2
t	exposure time (s) = 1hr = 0.041 day.
CR	corrosion rate
gmd	corrosion rate in (gram per m^2 per day) =$\frac{\Delta W}{A*t}$
mm/y	corrosion rate in(millimeter per year) =$\frac{1}{2.74}gmd$
mpy	corrosion rate in(milli-inch per year) = $\frac{mm/y}{0.0254}$
c	concentration of inhibitor (g/l)
(η%)	efficiency of inhibitor= ΔWno inhibitor-ΔW with inhibitor /ΔWno inhibitor

References

[1] K.B. Fischer, A. Daga, D. Hatchell, G.T. Rochelle, MEA and piperazine corrosion of carbon steel and stainless steel, Energy Procedia 114 (2017) 1751-1764.

[2] F. Bentiss, M. Lagrenée, M. Traisnel, 2, 5-bis (n-pyridyl)-1, 3, 4-oxadiazoles as corrosion inhibitors for mild steel in acidic media, Corrosion 56(07) (2000).

[3] M. Hegazy, M. Abdallah, M. Alfakeer, H. Ahmed, Corrosion inhibition performance of a novel cationic surfactant for protection of carbon steel pipeline in acidic media, Int. J. Electrochem. Sci 13 (2018) 6824-6842.

[4] D. Yu, J. Tian, J. Dai, X. Wang, Anticorrosion behavior of Superhydrophobic composite coating on carbon steel in seawater, Corrosion 70(4) (2014) 329-336.

[5] M.N. Idris, A.R. Daud, N.K. Othman, Electrochemical impedance spectroscopy study on corrosion inhibition of benzyltriethylammonium chloride, AIP Conference Proceedings, American Institute of Physics, 2013, pp. 23-28.

[6] G. Koga, D. Travessa, G. Zepon, D. Coimbrão, A. Jorge Jr, J. Berger, V. Roche, J.-C. Lepretre, C. Bolfarini, C. Kiminami, Corrosion resistance of pseudo-high entropy Fe-containing amorphous alloys in chloride-rich media, Journal of Alloys and Compounds 884 (2021) 161090.

[7] J. Cruz, R. Martınez, J. Genesca, E. Garcıa-Ochoa, Experimental and theoretical study of 1-

(2-ethylamino)-2-methylimidazoline as an inhibitor of carbon steel corrosion in acid media, Journal of Electroanalytical Chemistry 566(1) (2004) 111-121.
[8] V. Marcos-Meson, A. Michel, A. Solgaard, G. Fischer, C. Edvardsen, T.L. Skovhus, Corrosion resistance of steel fibre reinforced concrete-A literature review, Cement and Concrete Research 103 (2018) 1-20.
[9] S.H. Zaferani, M. Sharifi, D. Zaarei, M.R. Shishesaz, Application of eco-friendly products as corrosion inhibitors for metals in acid pickling processes–A review, Journal of Environmental Chemical Engineering 1(4) (2013) 652-657.
[10] P.B. Raja, M. Ismail, S. Ghoreishiamiri, J. Mirza, M.C. Ismail, S. Kakooei, A.A. Rahim, Reviews on corrosion inhibitors: a short view, Chemical Engineering Communications 203(9) (2016) 1145-1156.
[11] M.R. Ibrahim, The Study of Furniture Slider Mover, Engineering & Technology Research 1(1) (2017) 1-4.
[12] K. Ansari, M. Quraishi, A. Singh, Pyridine derivatives as corrosion inhibitors for N80 steel in 15% HCl: Electrochemical, surface and quantum chemical studies, Measurement 76 (2015) 136-147.
[13] N. Bornstein, M. DeCrescente, The role of sodium in the accelerated oxidation phenomenon termed sulfidation, Metallurgical Transactions 2(10) (1971) 2875-2883.
[14] Y. Fu, J. Li, H. Luo, C. Du, X. Li, Recent advances on environmental corrosion behavior and mechanism of high-entropy alloys, Journal of Materials Science & Technology 80 (2021) 217-233.
[15] F. Wiggen, M. Justnes, S. Espeland, Risk based management of corrosion under insulation, SPE International Oilfield Corrosion Conference and Exhibition, OnePetro, 2021.
[16] T.E. Perez, Corrosion in the oil and gas industry: an increasing challenge for materials, Jom 65(8) (2013) 1033-1042.
[17] F. Cattant, D. Crusset, D. Féron, Corrosion issues in nuclear industry today, Materials today 11(10) (2008) 32-37.
[18] D. Prasai, J.C. Tuberquia, R.R. Harl, G.K. Jennings, K.I. Bolotin, Graphene: corrosion-inhibiting coating, ACS nano 6(2) (2012) 1102-1108.
[19] H. Li, Y. Qiang, W. Zhao, S. Zhang, 2-Mercaptobenzimidazole-inbuilt metal-organic-frameworks modified graphene oxide towards intelligent and excellent anti-corrosion coating, Corrosion Science 191 (2021) 109715.
[20] B. Sameh, B. Baya, B. Louiza, H. Soraya, B. Hatem, B. Merzoug, Corrosion inhibition impact of Pyracantha coccinea M. Roem extracts and their use as additives in zinc electroplating: Coating morphology, electrochemical and weight loss investigations, Journal of the Taiwan Institute of Chemical Engineers 121 (2021) 337-348.
[21] Y. Zhou, P. Zhang, F. Yan, Corrosion resistance of a nano-Mg modified silane conversion coating with cathodic protection on magnesium alloy AZ91D, Materials Letters 284 (2021) 128930.
[22] A.K. Hussain, N. Seetharamaiah, M. Pichumani, C.S. Chakra, Research progress in organic zinc rich primer coatings for cathodic protection of metals–A comprehensive review, Progress in Organic Coatings 153 (2021) 106040.
[23] Z. Tang, A review of corrosion inhibitors for rust preventative fluids, Current Opinion in Solid State and Materials Science 23(4) (2019) 100759.
[24] A. Dwivedi, P. BHARTİ, S.K. Shukla, An overview of the polymeric materials that can be used to prevent metal corrosion: A review, Journal of the Turkish Chemical Society Section A: Chemistry 8(3) (2021) 863-872.
[25] R.Z. Jafat, E.S. Abood, Corrosion Inhibition Of Low Carbon Steel Using Green Inhibitor (Bulrush) At Variable Conditions, Egyptian Journal of Chemistry (2021).
[26]Abood, Emad Salaam. "Mn Determination by Metals Oxide Nanoparticles Mix Ions Selective Carbon Past Electrode Industrialization and Cyclic Voltammetry Application Study." Nano Biomed. Eng 13.3 (2021): 249-256.
[27] H.H. Uhlig, R.W. Revie, Corrosion and corrosion control, (1985).
[28] M. Abdel-Aziz, I. Mansour, G. Sedahmed, Study of the rate of liquid–solid mass transfer controlled processes in helical tubes under turbulent flow conditions, Chemical Engineering and Processing: Process Intensification 49(7) (2010) 643-648.
[29] Abood, E. S., et al. "Zinc oxide and Zinc oxide Nanoparticles Carbon Past Ion Selective Electrode: A Cyclic Voltammetry Comparison Study." Journal of Physics: Conference Series. Vol. 2047. No. 1. IOP Publishing, 2021.
[30] M. Aliofkhazraei, Developments in corrosion protection, BoD–Books on Demand2014.
[31] B.M.A. AL-Zaidy, COMPUTER-AIDED ANALYSIS OF GALVANIC CORROSION UNDER SIMULTANEOUS CHARGE AND MASS TRANSFER CONTROL, (2005).
[32]Abood, Emad Salaam, Ahmed Salim Abed, and Zahara Njah Salman. "New Fe2O3 Nanoparticles Modified Carbon Paste Electrode: A Cyclic Voltammetric Study." Egyptian Journal of Chemistry 64.12 (2021): 7409-7415.