VOLUME-2, ISSUE-2

RESEARCH OF THERMODYNAMIC PARAMETERS OBTAINED BASED ON MALINE ANGIIRID

[1]Choriev I.K., [2]Turaev Kh. Kh., [3]Normurodov B.A.

[1,2,3]Faculty of Chemistry, Termez State University, st. Barkamol avlod, 43, Termez, Uzbekistan, 190111

Corresponding author: Email: choriyevi@tersu.uz

Abstract. In this article, the thermodynamic and kinetic parameters (Langmuir, Frumkin, and Tyomkin isotherms) of corrosion inhibitor synthesized on the basis of maleic anhydride, monoethanolamine, and phosphoric acid to determine the mechanisms of steel inhibition are studied.

Keywords: thermodynamic and kinetic parameters, Langmuir, Frumkin, Tyomkin.

Introduction

Corrosion is a reversible process, which converts pure metal to different chemical compounds[1,2]. Nowadays, corrosion is turning into a major issue in many industries, building materials, infrastructure, tools, ships, trains, vehicles, machines, and appliances [3,4]. Corrosion is not only responsible for an economic loss but also associated with safety issues because it decreases the shelf life of steel[4]. This problem turns into a major issue for the entire world, so researchers are trying to address this issue in various ways[5,6].

Results and Discussion

Adsorption isotherm. The process of adsorption is the desorption of water molecules by adsorbing inhibitor molecules on the metal surface, and this process can also be described as an exchange process. In this case, E_a values were found from the dependence of lgW on 1000/T in mediums without and with inhibitors.

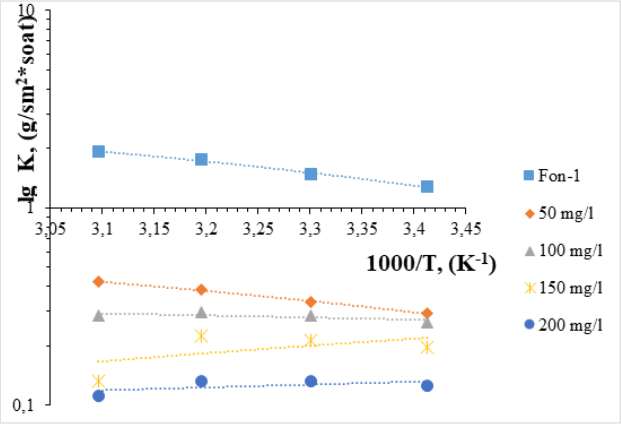

Figure 1. Arrhenius plot g for the activation energy of MMF-1 corrosion inhibitor in Fon-1 solution

According to the results presented in Table 3.13, the value of Ea was 41.45 (kJ/mol-1) in solutions without an inhibitor, this value increased with the introduction of MMF-1 brand corrosion inhibitor into the solution, and when the concentration reached 200 mg/l, it was 89.29 (kJ/mol-1). Also, the value of ΔSa in the solution without inhibitor took a positive value of 101.25 kJ/mol, but with the addition of inhibitor to the solution, this value decreased to negative -75.21 (kJ/mol-1), the smaller this value, the corrosion depends on the concentration of the inhibitor, the association is higher than dissociation in the system, and this indicates that a stable complex is formed between the inhibitor and the metal.

Table-3.1.

Values of activation parameters for steel St20 in graded water without inhibitor and in presence of green inhibitor

Ingibitor konsentratsiyasi	E_a(kJ/mol^{-1})	ΔH_a (kJ/mol^{-1})	ΔS_a(kJ/mol^{-1}K^{1})	$E_a - \Delta H_a$
0.0	41.45	38.4	101.25	2.94
50	53.26	51.43	-18.36	2.71
100	64.05	60.93	-23.12	2,64
150	76.30	72.62	-52.36	2.59
200	89.29	85.72	-75.21	2.47

The average energy difference between activation energy and enthalpy for samples without inhibitor and with different concentrations of inhibitor was approximately 2.67 kJ, which confirms the inhibition and adsorption process of St20 steel during melting.

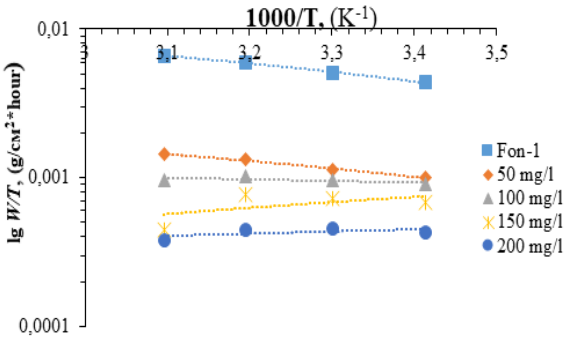

Figure 2. Transition state graph for the activation process of MMF-1 brand corrosion inhibitor in Fon-1 solution.

Several researchers have recognized that one of the reasons for the inhibition of the metal surface in the inhibitor solution is the absorption of the corrosion inhibitor on the surface. The presence of free ions in the composition of the corrosion inhibitor leads to the transport of charges, or the presence of functional groups binds to the metal surface through the donor-acceptor mechanism in exchange for negative charges. Langmuir, Frumkin, and Tyomkin isotherms of MMF-1 corrosion inhibitor were also studied. Figure 3of MMF-1 brand corrosion inhibitor. (a) Tyomkin (Figure 3 a), Frumkin (Figure 3 b), and Langmuir (Figure 3 c) isotherms are also plotted. According to the obtained results, when comparing the values of Frumkin, Tyomkin and Langmuir isotherms, the value of the Langmuir isotherm is higher than 0.99, which shows us that it matches the experimental data for the calculation of thermodynamic parameters. Langmuir, Frumkin, and Tyomkin isotherms for green corrosion inhibitors were also studied.

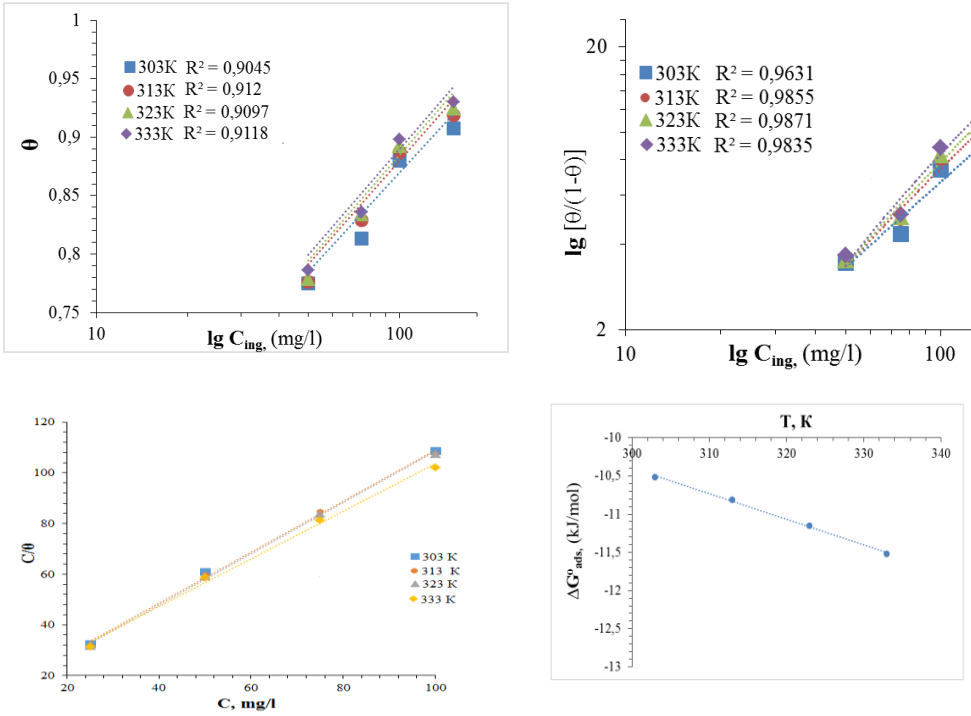

Figure 3. (a) Tyomkin, (b) Frumkin and (c) Langmuir isotherms and (d) temperature dependence of ΔG^0_{ads}

Correlation coefficient values were obtained at different temperatures. We can see from Figures 3a and 3b that the values of the correlation coefficients of the Frumkin and Tyomkin adsorption isotherms are not close to 1, indicating that the adsorption process does not follow these isotherms.

Table-2.

Thermodynamic parameters of MMF-1 brand corrosion inhibitor

Temperature	K_{ads}	ΔG_{ads} kJ/mol	ΔH_{ads}, (kJ/mol)	ΔS_{ads}, (kJ/mol K)
303	356,7	-23,12	-15,38	-126,5
313	433,1	-25,23		
323	490,9	-26,25		
333	580,5	-28,29		

Then the values of K_{ads} were calculated based on the intersection of Langmuir isotherms. It follows from the values of $Kads$ that the adsorption of MMF-1 brand corrosion inhibitor on the metal surface is superior to all desorption. Judging from the data in Table 3.2, the values of ΔG0ads were obtained in the range of 303−333 K, with results ranging from negative -23.12 kJ/mol to-28.29 kJ/mol provided, thus confirming that the adsorption of MMF-1 brand corrosion inhibitor on the metal surface occurs spontaneously.

Conclusion.

The inhibition mechanism of this inhibitor was studied based on Langmuir, Frumkin, and Tyomkin isotherm.

References

1. Verma, C.; Ebenso, E.; Bahadur, I.; Quraishi, M.: An overview on plant extracts as environmental sustainable and green corrosion inhibitors for metals and alloys in aggressive corrosive media. *J. Mol. Liq.* 2018, **266**, 577–590.

2. Umoren, S.; Solomon, M.; Obot, I.; Suleiman, R.: A critical review on the recent studies on plant biomaterials as corrosion inhibitors for industrial metals. *J. Indust. Eng. Chem*. 2019, **76**, 91–115.

3. Chigondo, M.; Chigondo, F.: Recent natural corrosion inhibitors for carbon steel : *an overview*. *J. Chem*. 2016. https://doi.org/10.1155/2016/6208937

4. Muthukrishnan, P.; Jeyaprabha, B.; Prakash, P.: Carbon steel corrosion inhibition by aqueous extract of Hyptis Suaveolens leaves. *Int. J. Ind. Chem*. 2014. https://doi.org/10.1007/s40090-014-0005-9.

5. Kaur, J., Daksh, N. & Saxena, A. Corrosion Inhibition Applications of Natural and Eco-Friendly Corrosion Inhibitors on Steel in the Acidic Environment: An Overview. *Arab J Sci Eng.* 2022, **47**, 57–74. https://doi.org/10.1007/s13369-021-05699-0.

6. Kouache A, Khelifa A, Boutoumi H, Moulay S, Feghoul A, Idir B, Aoudj S. Experimental and theoretical studies of Inula viscosa extract as a novel eco-friendly corrosion inhibitor for carbon steel in 1 M HCl. J *Adhes Sci Technol*. 2021, https://doi.org/10.1080/01694243.2021.195621

7. Beknazarov, K. S., Dzhlilov, A. T., Ostanov, U. Y., & Erkaev A.M, "The Inhibition of the Corrosion of Carbon Steel by Oligomeric Corrosion Inhibitors in Different Media," Int. Polym. Sci. Technol, vol. 42, no. 4, pp. 33-37. Doi:10.1177/0307174x1504200406.