Corrosion Inhibition of Aluminum in Hcl Acid Medium by Ketoprofen Expired Drug

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Abstract

In 0.5M HCL acid medium, expired ketoprofen was tested using chemical, electrochemical, and FESEM techniques at various concentrations and temperatures as an aluminum corrosion inhibitor. The outcome shows that when inhibitor concentration rises, so does inhibition effectiveness. Electrochemical According to studies, expired medication functions as a mixed sort of inhibitor. The findings demonstrate that inhibition occurs. The corrosion process's mechanism is changed by the inhibitor's adsorption on the metal surface. The According to Langmuir's adsorption isotherm, ketoprofen is absorbed. Temperature-related variables they were deliberate and calculated. The information gathered using the investigated strategies is highly congruent with Verify the efficacy of employing expired ketoprofen drugs as powerful HCL corrosion inhibitors for aluminum.

Keywords; Aluminum, Acid solusion, Corrosion, Expire Drug, Ketoprofen, Inhibitor.

1. Introduction

Metals are gradually destroyed by corrosion when chemicals assault them or they react with their surroundings. Although complete eradication is impossible to achieve, prevention is more realistic and attainable than eradication [1].
By introducing the corrosion inhibitor, even in small amounts, to the acidic aggressive medium, corrosion on metal surfaces can be effectively controlled [2, 3]. Due to its superior mechanical qualities, ease of availability, and ability to be easily fabricated into machinery [4].
Aluminum is frequently used as the best material [5].
This metal surface corrodes quickly when it comes into contact with an acidic substance [6].
Since sulphuric acid is frequently employed in pickling and descaling processes, it has been selected as a corrosive medium [7].
Making an alloy, applying a coating, or adding corrosion inhibitors are all potential methods for reducing corrosion on metal surfaces [8].
All organic substances with N, S, or O atoms or N-heterocyclic substances with electrons that prevent corrosion [9].
Corrosion inhibitors for Aluminum in acidic conditions have been the topic of numerous investigations [10, 11].
Due to the existence of hetero atoms, medicinal compounds have an intriguing potential for the suppression of corrosion. They are of special relevance due to their safe use, high solubility in water, and large molecular size. Some antimalarial and azosulfa medications have been described as effective corrosion inhibitors [12-18].
In this investigation, the anticorrosion of Aluminum in a 1M sulphuric acid medium has been examined using the now-expired Ketoprofen medication. In order to prevent Aluminum from corroding in HCL, attempts are made to use expired Ketoprofen [19].

2. Materials and Methods

The top of the coupons have holes drilled into the rectangular Aluminum strips of size 3 x 3 x 1 cm with a composition of 0.03 percent, 0.015 percent Si, 0.003 percent P, and the remaining Fe. The samples were mechanically polished to a mirror sheen and degreased with acetone before being thoroughly dried and stored in a desiccator. HCL 98 percent analytical grade and double-distilled water were used to make all concentrations [20]. Ketoprofen medication that had expired was used for this trial without additional purification and was acquired from neighborhood pharmacies and public hospitals [21]. The inhibitor's structure is depicted in Fig. 1.

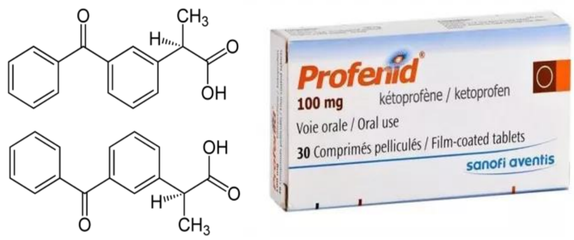

Figure (1): Appearance and chemical structure of ketoprofen

Weight Loss Method

The specimen was submerged for six hours in 100 ml of 0.5M HCL without an inhibitor after its initial weights were recorded. The effect of temperature on Aluminum corrosion has also been investigated at five different temperatures between 293K and 323K in the absence and presence of inhibitors at various concentrations (25, 75, 125, 175, 225and 275 percent) for 30 minutes [22].
The specimens were removed, dried, and weighed again after the exposure period. Using the weight loss as a starting point, the following formula was used to determine the inhibition efficiency (IE percent), surface coverage (ϴ), and corrosion rate (MPy) [23].

Electrochemical Methods

The working electrode was an Aluminum specimen, and the reference electrodes were SCE at room temperature with and without an inhibitor. The experiments were

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conducted in a standard three-electrode cell as FESEM. The corrosion potential and corrosion rate were computed using the polarization Tafel slopes. The formula was used to calculate the inhibitor efficiency.

FESEM

The composition and surface morphology of the corrosion product on Aluminum in 0.5M HCL in the absence and presence of 275 percent Ketoprofen were investigated using a scanning electron microscope and an energy dispersive spectrometer with an ED's analyzer. The FESEM image was taken at an accelerating voltage of 20 KV [24].

3. Results and Discussion

Weight Loss Studies

Table 1 lists the weight loss findings of Aluminum in 0.5M HCL in both the absence and presence of different inhibitor concentrations. The greatest efficiency was discovered at 275 percent of the inhibitor's concentration, and the corrosion rate decreased when the inhibitor's concentration was increased. It demonstrates that as inhibitor concentration grows, the effectiveness of the inhibition increases as well [25].

Table (1) The effect of temperature on the corrosion rate, inhibition efficiency and surface coverage of aluminum pure in (0.5M HCL) in absence and presence of Ketoprofen extract.

Time (3h)							
Run	C_{inh} (ppm)	T (°C)	A. T	Δ W. T	CR (gmd)	Θ (surface coverage)	IE%
1	Blank	20	84.1433	0.8754	2496.88	0	0
2		30	83.8621	0.8771	2510.12	0	0
3		40	82.6095	0.8718	2532.78	0	0
4		50	81.9329	0.8739	2559.85	0	0
5	25	20	87.1623	0.1565	430.92	0.827	82.7
6		30	86.3569	0.1482	411.87	0.835	83.5
7		40	84.9214	0.1309	369.94	0.853	85.3
8		50	83.6012	0.1149	329.85	0.871	87.1
9	75	20	87.1334	0.1452	399.93	0.839	83.9
10		30	86.5262	0.1315	364.74	0.854	85.4
11		40	85.9981	0.1132	315.91	0.875	87.5
12		50	85.1022	0.1028	289.91	0.886	88.6
13	125	20	86.2679	0.1301	361.94	0.855	85.5
14		30	86.1505	0.1180	328.72	0.869	86.9
15		40	86.1139	0.0936	260.86	0.897	89.7
16		50	85.5980	0.0898	251.78	0.901	90.1
17	175	20	88.5305	0.1180	319.88	0.871	87.1
18		30	87.4123	0.1056	289.93	0.884	88.4
19		40	85.3903	0.0843	236.93	0.906	90.6
20		50	84.9880	0.0793	223.93	0.912	91.2
21	225	20	87.7881	0.1101	300.99	0.879	87.9
22		30	87.6253	0.0974	266.77	0.893	89.3
23		40	86.0026	0.0713	198.97	0.921	92.1
24		50	84.2456	0.0596	169.78	0.933	93.3
25	275	20	88.3658	0.1016	275.94	0.889	88.9
26		30	86.1197	0.0796	221.83	0.911	91.1
27		40	83.9009	0.0587	167.91	0.933	93.3
28		50	81.6312	0.0462	135.83	0.946	94.6

Effect of Temperature

Measurements were made between 293 and 323 K to determine the impact of temperature on the corrosion behavior of Aluminum surfaces with and without inhibitors in a 0.5 M HCL acid medium. Fig. 2 illustrates graphically how temperature affects Aluminum's ability to suppress corrosion in the presence of an inhibitor. The protective film of these compounds formed on the surface of Aluminum is less stable at higher temperatures, which may be caused by the desorption of some adsorbed molecules from the surface of the metal at higher temperatures, exposing more of the metal to the acidic environment, as evidenced by the increase in inhibition efficiency with temperature.

Thermodynamic Consideration

For Aluminum in HCL medium with and without an inhibitor, Table 2 displayed the computed values for activation energy (Ea), free energy of adsorption (Ea), enthalpy of adsorption (H), and entropy of adsorption (S). At a concentration of 275 percent, the inhibitor's activation energy (Ea) is - 0.1646kJ/mol, while the blank's value is -0.0234 kJ/mol.The activation energies with inhibitors may be greater, comparable, or less than those in the absence of these [26].

It is clear from the table that chemical adsorption causes the activation energy (Ea) to drop as the inhibitor's concentration is added to Aluminum in 0.5M HCL.

The increase in inhibition efficiency with temperature and the decrease in activation energy when the inhibitor is present imply that the inhibitor has chemisorption on the metal surface. The results show that a uniform layer spontaneously formed because of the negative values of G and S.

On the metal's surface, adsorbed. The positive values of H demonstrate that endothermic reactions occur here. The values listed above don't represent increases or declines. With regard to the concentration of the hinder [21].

The Arrhenius plot of the is shown in Fig. 3 The rate of Aluminum corrosion in 0.5M HCL Ketoprofen's presence and absence at various temps.

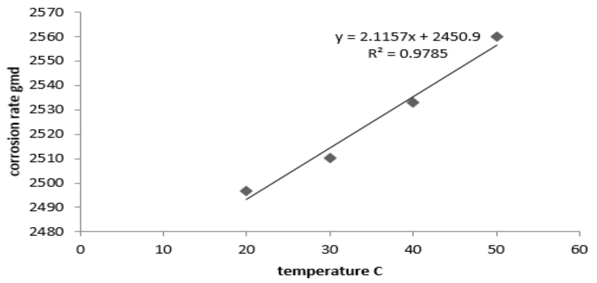

Fig.(2):Effect of temperature on the corrosion rate of aluminum after immersion in(0.5M HCL) for (3h).

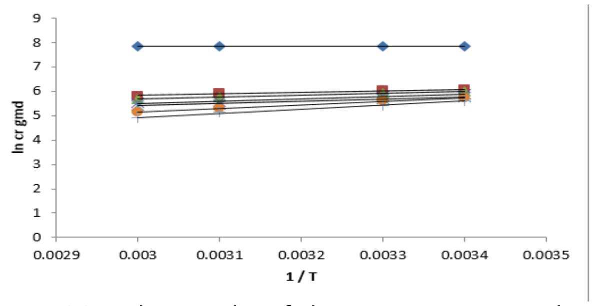

Fig. (3): Arrhenius plot of aluminum corrosion with various concentrations of ketoprofen extract at different temperatures in (0.5 M HCL).

Adsorption Consideration

Evidently, it is thought that the development and maintenance of a protective coating on the metal surface is what prevents corrosion. The correlation between log ϴ 1- ϴ and inhibitor concentration at various temperatures is seen in Fig. 4. When it is plotted, a straight line is formed, indicating that the compound adheres to Aluminum's surface according to Langmuir's adsorption isotherm. These findings showed that all of the slopes are nearly equal to one, indicating that the inhibitor's adsorption followed the Langmuir adsorption isotherm. This isotherm holds true for species that chemisorb to form a monolayer on the surface.

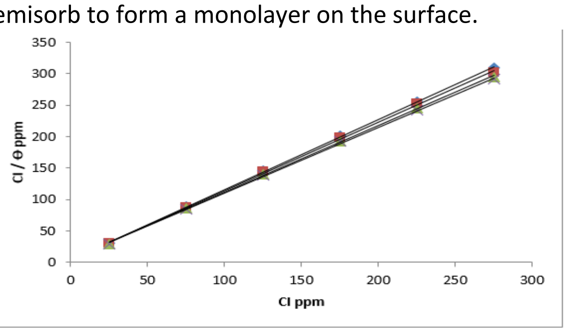

Fig. (4): Langmuir adsorption isotherm of (ketoprofen extract) for aluminum corrosion in (0.5M HCL).

Tafel Polarization Studies

The Tafel polarization curves for Aluminum in 0.5M HCL with and without the Ketoprofen inhibitor are displayed. It was discovered that the inhibitory efficiency value increased from 58.15 to 70.76 percent. The computed polarization resistance (Rp) increased from 29.81 to 94.98 cm2 with an increase in inhibitory efficiency from 58.49 to 68.61 percent for concentrations ranging from 2.0% to 9.0%. As the inhibitor concentration rises, the inhibition efficiency rises and the corrosion current falls. The Icorr values of because inhibited acids have a lower pH than uncontrolled acids, it may be assumed that the increase in corrosion inhibition property is caused by an increase in the fraction of ions blocked by inhibitor molecules adhering to the electrode surface. When an inhibitor's ER value is higher without one than with one, it means that the inhibitor has a mixed type. It is obvious that the drug ketoprofen significantly polarizes both the cathode and the anode. It has been noted that the inhibitory effect is mixed [27].

Table (2): Enthalpy and Entropy of aluminum corrosion activation values with various concentrations of ketoprofen extract in (0.5M HCL).

Ci (ppm)	ΔH*(KJ.mol-1)	ΔS*(KJ.mol-1.K-1)
Blank	20.0331	-0.0234
25	10.2598	- 0.1208
75	11.9227	- 0.1125
125	13.6762	- 0.1331
175	13.2694	- 0.1627
225	19.4211	- 0.1527
275	22.6971	- 0.1646

4. Morphology Examination

FESEM

Figures 5 and b show an image of Aluminum in 0.5M HCL with and without a ketoprofen inhibitor. According to an examination of Fig., the immersed specimens were rough and severely corroded in the presence of 0.5 M HCL depth of surface corrosion brought on by Aluminum exposure to acid, as evidenced by shallow pits, pores, and cracks [28]. The FESEM images of Aluminum exposed to acids with inhibitors in Fig. 6 -7 demonstrate less surface damage, which amply supports the inhibition action because the chemical components in the inhibitor form a protective film on the surface of the Aluminum, reducing the amount of contact between the metal and the acid [29].

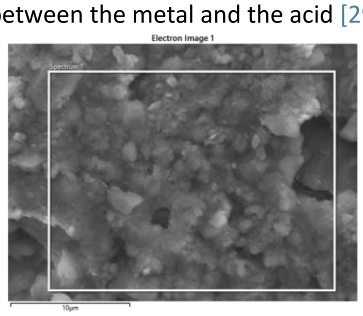

Fig.(5): FESEM images of Aluminum and surface before immersion in corrosion solution in order.

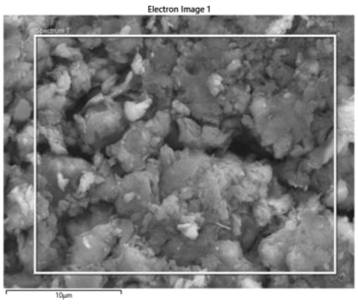

Fig.(6): FESEM images of Aluminum and surface after immersion in a corrosion solution(0.5M HCL) for (3h).

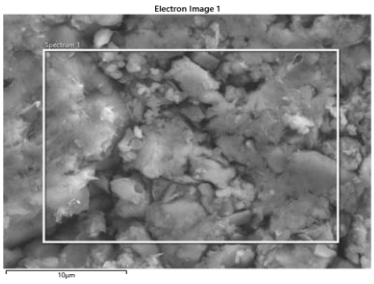

Fig. (7): FESEM images of aluminum and surface after immersion in presence of inhibitor (ketoprofen) in a corrosion solution (0.5M HCL) for (3h).

5. Conclusion

When used with 0.5 M HCL acid, the expired Ketoprofen medication effectively inhibits corrosion on Aluminum. The values for inhibition effectiveness rise with by increasing the inhibitor's concentration, the The maximum inhibitory efficiency is 95.54 percent. At an inhibitor dosage of 9.0 percent (v/v). Additionally, the fact that the effectiveness of the inhibition increases with temperature suggests that it acts as an effective inhibitor at higher temperatures the results of a polarization research show that it functions as a hybrid inhibitor. The inhibitor adheres to Langmuir's adsorption isotherm when it is adsorbed on Aluminum. The study's findings on thermodynamic characteristics, such as the free energy of adsorption (Gads), suggested that the inhibitor was adsorbing spontaneously to the metal's surface. The great performance of the Ketoprofen inhibitor's inhibitive effect has been established by the FESEM morphology of the adsorbed protective coating on the Aluminum surface. The weight loss method's results were in excellent agreement with the electrochemical approaches.

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