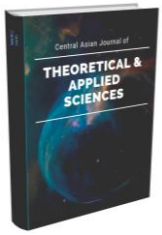

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Article

Adsorption and Extortion, Their Role in Inhibiting Corrosion Rate, and Calculating Thermodynamic Functions

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Abstract: The adsorption of reactants by a catalyst (solid) in a heterogeneous catalyst flowing in a gaseous medium or in solutions was calculated. In thermodynamic functions, adsorption is accompanied by a decrease in the standard free energy of Gibbs because it is a spontaneous process. Therefore, it is accompanied by a decrease in entropy and enthalpy The free energy values at temperatures (293, 303, 313, 323) were (58.286, 53.746, 55.846, 57.066) respectively. The free energy, enthalpy and entropy were also calculated from the Capps relationship, using the equilibrium constants with temperature. The values of corrosion rate and surface coverage ratio ($^{\theta}$) were calculated in (0.1M) sulfuric acid in the absence of inhibitors. The values of corrosion and ratio ($^{\theta}$) at a temperature of (300 K) were (12.08, 966×10^{-5}) respectively,and Each metal has a certain number of active centers, which results in the amount($^{\theta}$), which represents the center covered by molecules through chemical adsorption. The gravimetric method is also used, where vacuum devices are used, including balances, and the measurement is carried out by weighing the adsorption surface (0.0000000001) g of the substance. A corrosion cell is also used to protect the metal, where anode-type electrodes are used, made of a metal more active than the metal to be protected. The corrosion cell consists of an anode, a cathode, an electrolyte, and a salt bridge.

Keywords: corrosion, adsorption, extortion, metal, cathode, inhibitor.

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1. Introduction

Corrosion treatment using dyes such as epoxy and nanoparticles is of great importance in eliminating corrosion problems in our daily lives [1]. The corrosion rate and surface coverage of the metal were calculated after dyeing it with inhibitors, as the inhibition effectiveness depends on the inhibitor concentration and the type of metal being studied [2]. The gravimetric method was also used in 0.1 M sulfuric acid. The calculations showed that the corrosion rate is directly proportional to temperature. The higher the temperature, the faster the corrosion rate, while the surface coverage percentage remains the same [3]. The activated complex is usually bound weaker than

the adsorbed molecule, and when the surface is irregular or heterogeneous, the potential energy is irregular due to the adsorption sites being located at different energy levels [4].

Adsorption can be defined as a physicochemical phenomenon that occurs for liquid or gaseous substances that are in contact with a solid that collects ions of one substance on the surface of another substance. Extortion is the separation of adsorbed particles from the adsorbent surface, which is the opposite process of adsorption. and corrosion is an electrochemical phenomenon exposed to any metal to return to its original state, which is a complex phenomenon in all fields. The study of adsorption and extortion kinetics is useful in knowing the correlation kinetics of the adsorbed particles on the surface, and based on the theory of kinetics of gases, the speed of collision of gas molecules with a surface at a pressure (P) can be expressed in terms of the number of particles n colliding with one square centimeter of the surface per second. According to the following equation [4]:

$$\frac{dn}{dt} = \frac{p}{(2\pi mkT)\ 1/2} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (1)$$

The adsorption kinetics depends on many factors, including [5]:

1. The concentration of the adsorbent
2. The catalyst
3. Temperature
4. The surface sites involved in the adsorption.

In thermodynamic functions, adsorption is accompanied by a decrease in the standard free compression energy because it is an automatic process [6]. Therefore, it is accompanied by a decrease in entropy and enthalpy according to the compression relationship:

$$\Delta Gr = \Delta Hr - T\Delta Sr \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (2)$$

The possibility of adhesion is affected by many factors, including if the adsorption process needs activation energy, the molecules that suffer adsorption are limited to those that have activation energy

5. Types of adsorption

Adsorption is classified depending on the bonding forces between molecules Adsorption is classified into two types [7]

a. Chemical adsorption: This type is accompanied by the formation of a monomolecule layer on the surface Almaz, and occurs in certain conditions and does not occur in another surface when the same conditions, and is known as active adsorption [8].
b. Physical adsorption: defined as natural attractive forces (Vandervalls) because of the electronic saturation of its atoms so it is inert.

6. Thermodynamic study:

Free energy, enthalpy and entropy can be calculated from a compression relationship, using equilibrium constants with temperature [9]. and the Kc relationship is given as follows:

$$Kc = \frac{CAe}{Ce} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (3)$$

CE and CAe respectively represent the adsorbed quantity on the adsorbent surface, and the adsorbent concentration.

Thermodynamic functions are calculated using the following laws:

$$\Delta Gr = - RT \ln Kc \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (4)$$

$$\underline{\text{Ln}}\ Kc = \left(\frac{\Delta s}{R}\right) - \left(\frac{\Delta H}{RT}\right) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (5)$$

7. Adsorption speed:

Suppose that V is the volume of cubic centimeters in Ns the number of molecules of a substance in a gaseous state. Ns represent, respectively, the number of empty sites and the number of activated complexes by s square centimeter [10].

8. Inhibitor:

It is chemicals added to the eating medium, the effectiveness of inhibition depends on the concentration of the inhibitor, and the type of the studied metal.

The corrosion cell is also used to protect the metal, where the electrodes of the anode type are used made of a metal that is more active than the metal to be protected. The corrosion cell consists of anode, cathode, electrolyte and a salt bridge

9. Speed of extortion

In order to express the speed of extortion, we assume that the statistical balance between adsorbent molecules and active complexes is assumed. Where the activated complex is usually bound by a weaker force than the binding of the adsorbent molecule. Therefore, he has the freedom of the largest complex activated on movement and transport [11]. Where is

$$\frac{F*}{Fa} = K = \frac{C*}{Ca} \quad \text{..... (6)}$$

Where, Fa Dalta is fragmented for active complexes and for adsorbent molecules Respectively. And, Ca the two focuses of the two debaters.

The following figure expresses the potential energy of the natural adsorption of the A2 diatomic molecule on the surface of a solid Energy is zero.

If the adsorption sites are at the same level of potential energy, the surface of the product is regular or homogeneous.

When the surface is irregular or heterogeneous, the potential energy is characterized by irregularity due to the occurrence of adsorption sites at different levels of energy.

10. Types of corrosion
    a. General corrosion

        It is the most common form inferred by the occurrence of a chemical reaction, which is one of the least dangerous types of corrosion and can be treated.

    b. Slet corrosion

        It is local corrosion that occurs frequently in metal parts exposed to corrosion.

    c. Galvanic corrosion

        It occurs when different metals are connected to each other and one metal is corroded in order to protect another meta.

    d. Intergranular corrosion

        This corrosion occurs in stainless steel.

    b. H. TIPPETING

        It is the most dangerous and results in small or large holes, and it is difficult to detect because most of its corrosion are small holes

11. Adsorption Isotar

Each metal is characterized by a certain number of active centers, which results in the amount θ, which represents the center covered with molecules by chemical adsorption

$1 \quad \theta \leq 0 \leq$

Where:

Metal cover ratio with damper$^{\theta}$=

The researchers proposed several theoretical models to link the amount of inhibitor and its concentration in the surrounding medium. Including Lancmeyer model according to the following relationship:

$$\mathbf{Kc = C = \frac{\theta}{1-\theta}}$$

C= Inhibitor concentration

K= Equilibrium constant

θ = Surface coverage ratio

Methods of measuring the amount of adsorption:

1. Volumetric method:

It depends on measuring the decrease in gas pressure as a result of adsorption, or from the pressure change in the flow systems after extortion from the surface covered with adsorbed gas.

2. Gravimetric method:

In this method, vacuum devices are used that include scales and are measured by the weight of the adsorption surface with (0.00000000001) grams of material [12-13].

3. Physical method :

One of the most important physical methods is the measurement of electrical conductivity and measurement of thermoelectric and magnetization ability.When the adsorption surface is in the form of a tape or metal wire, it is used by the extortion method to know the amount of adsorption. The amount of adsorption can be estimated by dynamic method[3].

2. Materials and Methods

Sulfuric acid (H2SO4) with a concentration of 0.1M was prepared by dilution method for use as a corrosive medium in practical experiments.

The practical application of adsorption and corrosion was done through the following equation , figure 4.

$$\text{ratio is equal to As the coverage} \qquad \theta = \frac{R}{100}$$

$$\text{Ln Kc} = \left(\frac{\Delta s}{R}\right) - \left(\frac{\Delta H}{RT}\right)$$

The adsorption from the reactants can be calculated by a catalyst (solid) in the heterogeneous catalyst. Which flows in a gaseous medium or in solutions . Activated charcoal is also used in gas masks.

3. Results and Discussion

The corrosion rate of the metal increases with increasing temperature. The values of the corrosion rate and the surface coverage percentage (θ) were measured in 0.1 M of sulfuric acid in the absence of inhibitors. The corrosion and ratio values were (θ) at temperature (300 K) its (12.08 ,966 * $\mathbf{10^{-5}}$) respectively. The corrosion cell is used to protect the metal, where anode electrodes are used, made of a metal that is more active than the metal to be protected, the corrosion cell consists of an anode, a cathode, an electrolyte, and a salt bridge. Increasing the temperature causes chemical changes in the inhibitor molecules, which leads to an increase in the electron density and thus increases the inhibition efficiency[14]. Increasing the inhibitor concentration leads to an increase in the activation energy. The study of adsorption and desorption kinetics helps in knowing the binding kinetics of the adsorbed particles on the surface, Based on the kinetic theory of gases, the speed of collision of gas molecules with a surface at a pressure (P) can be expressed in terms of the number of molecules n colliding with one square centimeter of the surface per second, see Table 1.

Table 1. The values of corrosion velocity and surface coverage ratio (θ) in (0.1M) of sulfuric acid in the absence of inhibitors .

EXP	T (K)	t(min)	Corrosion rate (mm/Day)	Surface coverage ratio $\frac{R}{100}\theta$ =)Adsorption efficiency(
1	300	0	12.08	966 * $\mathbf{10^{-5}}$
2		25	16.55	966 * $\mathbf{10^{-5}}$
3		50	24.88	966 * $\mathbf{10^{-5}}$
4		100	41.66	966 * $\mathbf{10^{-5}}$

5		150	51.55	966 * $\mathbf{10^{-5}}$
6		0	14.09	966 * $\mathbf{10^{-5}}$
7		25	20.02	966 * $\mathbf{10^{-5}}$
8		50	28.13	966 * $\mathbf{10^{-5}}$
9	330	100	43.01	966 * $\mathbf{10^{-5}}$
10		150	66.89	966 * $\mathbf{10^{-5}}$

Free energy increases with increasing temperature. In thermodynamic functions, adsorption is accompanied by a decrease in the standard free energy of Gibbs because it is a spontaneous process. Therefore, it is accompanied by a decrease in entropy and enthalpy. Positive values of enthalpy indicate that the reaction is endothermic. Negative values of entropy indicate that the reaction increases the order of the system[15].
The thermodynamic functions were calculated using the mathematical relationship, see Table 2.

Table 2. The relationship between (In CR / T) and 1/T (ΔH/RT) - (Ln Kc = (Δs/R)

T K)(	*SΔ J.mol^{-1} K^{-1}	H* Δ KJ.mol^{-1}	G* Δ KJ.mol^{-1})(
293	-122.6	18.88	53.746
303			55.846
313			57.066
323			58.286
333			59.506

4. Conclusion

It was found that the corrosion rate of the metal increases with increasing temperature. Furthermore, positive enthalpy values indicate that the reaction is endothermic In addition, negative entropy values indicate that the reaction increases the orderliness of the system. The temperature removes the protective layer covering the metal, making it susceptible to corrosion. The adsorption efficiency, or the percentage of surface coverage of the adsorbent, remains constant because adsorption occurs on the metal surface, and the metal surface is not affected by the corrosion rate. We notice that as the temperature increases, the free energy (ΔG*) increases, because the relationship between free energy and temperature is a direct relationship. That is, as the temperature increases, the energy of gypsum increases, as in the relationship**:** ΔGr = ΔHr - TΔSr. Where sulfuric acid (H_2SO_4) was used as a corrosive medium compared to other acids because it is very effective, its percentage reached 98%.

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