INHIBITION OF CHEMICAL CORROSION OF STEEL IN HYDROCHLORIC ACID USING NEW SURFACTANTS

A Thesis

Submitted to the Graduate School
Faculty of Science, Alexandria University
In Partial Fulfillment of the
Requirements for the Degree
Of

Doctor of Philosophy

In

Physical Chemistry

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2017

ENGLISH SUMMARY

According to economic applications of steel in different fields, in this study investigation of steel properties and inhibition of its corrosion are studied via using of new surfactants.

The thesis comprises of three main chapters.

Chapter (I)

Includes introduction, which showed definition, importance, types, forms and theories of corrosion, techniques of corrosion prevention, surfactants definition, classification, literature survey and the aim of the present work.

Chapter (II)

Includes experimental techniques, preparation of solutions, test specimens and treatment, instruments, chemical techniques, electrochemical techniques, potentiodynamic, impedance (EIS) and (EFM)).

Chapter (III)

Includes the results obtained and their interpretations divided into two separated parts A and B.

Part A:

Weight loss technique : measurement for carbon steel in 1M HCl in presence of different concentrations of the investigated surfactants. The results showed that the weight loss decreases with increasing the concentration of first, second and third surfactant, but fourth surfactant showed that its weight loss increase by increasing its concentration.

A number of mathematical relationships isotherms was applied to fit to the experiment data of the study. The best fit was followed Langmuir adsorption isotherm via representation of relationship between C/Θ and C of the investigated surfactants.

Also effect of temperature on the corrosion rate of carbon steel in 1M HCl in the range (25 - 40 °C) in absence and presence of 300 ppm of the studied surfactants has been investigated. The results showed that the inhibition efficiency decreased with increasing the temperature, which indicated that these surfactants are physically adsorbed on carbon steel surface.

Arrhenius plots of logarithm corrosion rate (Log k_{corr}) against reciprocal of absolute temperature (I/T) were found to be linear which follow the following equation:

$$LogK_{corr} = LogA - (E_a^*)/2.303RT$$

Diagrams of logarithm k_{corr} divided by absolute temperature (Log k_{corr} / T) against the reciprocal of absolute temperature (1/T) were found to be linear which obey transition state equation:

$$\text{Rate } (k_{corr}) = [RT / Nh \exp(\Delta S^*/R) \exp(-\Delta H^*/RT)$$

The activation parameters (ΔH^* and ΔS^*) were also calculated and discussed.

The activation energy, E_a and Enthalpy of activation, ΔH^* increased also with increasing inhibitor concentration while the value of activation entropy, ΔS^* decreased also in the case of the four types of surfactants.

Part B:

This section includes the results of electrochemical techniques;

1. Potentiodynamic polarization method was measured for carbon steel in 1M HCl in absence and presence of various concentrations of the investigated surfactants. The obtained polarization curves proved that these surfactants influence both cathodic and anodic processes. The results were in a good agreement with the results obtained from chemical method.
2- Electrochemical (AC) impedance spectroscopy measurements were measured for carbon steel in 1M HCl in absence and presence of various concentrations of studied surfactants. From the impedance data obtained, it was concluded that;

   i. The value of R_{ct} increases with increasing the concentration of the first, second and third surfactant which indicates an increase in the corrosion inhibition efficiency in HCl medium [vice versa in fourth surfactant].

   ii. The value of double layer capacitance C_{dL} decrease by increasing first, second and third surfactants. This is due to the adsorption of the surfactant on electrode surface as a film layer.

   iii. The percentage of inhibition efficiency are close to which obtained from polarization and weight loss methods.

3- Electrochemical frequency modulation techniques was measured for carbon steel in 1M HCl in presence and absence of various concentration of the studied surfactants. From EFM results, concluded that;

   i- The corrosion current density decrease by increasing the concentration of first, second and third surfactants, vice versa in fourth surfactants.

   ii- The %IE increase by increasing the concentration of investigated first, second and third surfactants, vice versa in fourth surfactant.

In conclusion:

All measurements used in this study either chemical methods (weight loss) or electrochemical methods (potentiodynamic, EIS and EFM) confirmed the adsorption of the surfactants used on carbon steel surface. Confirmation of these various independent techniques proved validity of the obtained data.

This thesis also contains references, Arabic and English summary.