ENGLISH SUMMARY

SUMMARY

The aim of the present work is to study the reactivity of some pharmaceutical compounds as corrosion inhibitors for carbon steel in hydrochloric acid solution. The thesis comprises three main chapters.

The first chapter:

Deals with the Introduction, which includes corrosion theories, types of corrosion, corrosion protection, literature survey on corrosion behavior of carbon steel in aqueous environment and aim of the present work.

The second chapter :

Deals with the experimental techniques, which include the chemical composition of the investigated material and preparation of the used solutions.

Also, the experimental technique contains the instruments and the procedures used for the corrosion measurements such as potentiodynamic polarization and AC impedance techniques.

The third chapter :

Deals with the results obtained and their discussion under three separated sections; (A), (B) and (C).

Section A:

Potentiodynamic polarization measurements were carried out for carbon steel in 1 M HCl in the absence and presence of different concentrations of the investigated compounds. The polarization curves indicated that these compounds influence both cathodic and anodic processes. The order of decreasing inhibition efficiency for these additives is:

$$1 > 2 > 3 > 4$$

The effect of temperature on the corrosion rate of carbon steel in 1 M HCl over the temperature range 30-50 ^{o}C in the absence and presence of 100 ppm of the investigated compounds has been studied. The % inhibition efficiency is found to decrease with increasing the temperature; this indicated that, these compounds are physically adsorbed on the carbon steel surface. Arrhenius plots of logarithm corrosion rate (log $I_{corr.}$) against reciprocal of absolute temperature (1/T) were found to be linear and obeyed the following equation:

$$\text{Log } I_{corr.} = \log A - (E_a^* / 2.303\ RT)$$

The calculated values of the activation energy in the absence and presence of 100 ppm of the investigated compounds were found to decrease with increasing the temperature.

Plots of logarithm corrosion rate divided by absolute temperature (log $I_{corr.}$ /T) against reciprocal of absolute temperature (1/T) were found to be linear and obeyed the following transition state equation:

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

Thermodynamic activation parameters (ΔH^* and ΔS^*) are also computed and discussed. The values of the activation energy, E_a^*, and the activation enthalpy, ΔH^*, are increased with increasing inhibitor concentration while the value of the activation entropy, ΔS^*, is decreased at the same time .

Section B:

AC impedance spectroscopy measurements were carried out for carbon steel in 1 M HCl in the absence and presence of different concentrations of the investigated compounds.

From the impedance data, we conclude that:

i-The value of R_{ct} increases with increase in the concentration of the inhibitors and this indicates an increase in the corrosion inhibition efficiency in acidic solution.

ii-The value of double layer capacitance decreases by increasing the inhibitor concentration. This is due to the adsorption of these compounds on the electrode surface leading to a film formation on the Al surface.

iii-The % IE obtained from EIS measurements are close to those deduced from polarization .

The order of decreasing inhibition efficiency for the additives is:

$$1 > 2 > 3 > 4$$

This is also in agreement with the observed order of corrosion inhibition determined by potentiodynamic polarization measurements.

Section (C):

In this section potentiodynamic anodic polarization curves of carbon steel in 1M NaCl and at different concentrations of pharmaceutical derivatives was studied. It was found that the addition of these compounds cause the destruction of the passivated oxide film and initiate pitting corrosion; the pitting corrosion potential is shifted to more negative values with increasing chloride ion concentrations and to more positive values by increasing concentration of inhibitors. the order of inhibition efficiency is as follow:

$$1 > 2 > 3 > 4$$

Section D:

The influence of the chemical structure of the used compounds on their % inhibition efficiency was discussed. The order of this % inhibition efficiency depends mainly upon the type and position of the substituent's groups; quantum chemical calculations were used to predict the efficiency of the investigated compounds as corrosion inhibitors. It is clear that, the inhibition efficiency increases with increasing the energy of the highest occupied molecular orbital (E_{HOMO}), which means that the inhibitors act as electron donors when blocking the corrosion reaction sites. From the energy of highest occupied molecular orbital (E_{HOMO}), the order of inhibition efficiency is as follow:

$$1 > 2 > 3 > 4$$

In conclusion the electrochemical measurements support the assumption that corrosion inhibition primarily takes place through adsorption of the inhibitors on carbon steel surface. Agreement among these different independent techniques indicates the validity of the obtained results.

Also, the thesis contains English and Arabic summari