Summary

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Preparation and evaluation of some organic and organosilicon compound as corrosion protection of petroleum equipment

Corrosion of metals is a major industrial problem that has attracted a lot of investigators in recent years. Most of the petroleum and petrochemical industrials rely on carbon steel alloys as primary backbone and skeletons. The carbon steel equipments are widely used for transportation in the oil and gas industrials. So that, corrosion problems requiring the application of inhibitors exist in the petroleum and petrochemical, gas and chemical industrials at every stage of production processing, refining and storage prior to use. The main reason of corrosion problems is attributed to the presence of formation water and various corrosive agents including carbon dioxide, hydrogen sulfide, organic acids and salts such as chlorides and sulphates. These industries are affected by strong economic losses derived from the serious damages caused by the corrosion on equipment systems. Statistical data show that failures by corrosion in the oil and gas industries oscillate between 25 and 30% of the total loss. So that, the main target of the present the study is the preparation of some novel compounds which examined as corrosion inhibitor. These compounds have many active centers.

The introduction which contains a literature survey on importance of corrosion, classification of corrosion, factors influencing corrosion, theories of corrosion, kinetics of corrosion, mechanism of corrosion processes, forms of corrosion, corrosion monitoring techniques, methods of corrosion control and the effect of various additives on the corrosion of carbon steel in acidic media .

The experimental part is contain synthesis of organoamide and organoamide silicon compounds,

preparation of inhibitor solutions, preparation of metal surface, composition of material samples, test specimens and treatment. The description of the chemical and electro chemical adopted for measuring corrosion rate, determination of inhibition efficiency and calculation of the degree of surface coverage.

The preparation of three new organoamide and three organoamide silicon compounds.

I- Amide (I), based on diamine have short chain (1,4diamino butane)
II- Amide (II), based on diamine have long chain (1, 8 diamino octane)
III -Amide (III), based on diamine have aromatic ring (1, 4 phenylene diamine)

The preparing a new organoamidesiloxane based on Sililation by dimethyl dichlorosilane of the organoamide (I, II and III) respectively with ethanolamine, to get on the three organoamidesiloxane terminated by aliphatic amine (IV, V and VI) respectively.

The chemical structure for prepared organoamide and organoamidesiloxane compounds were confirmed by FT.IR and ^{1}HNMR

These compounds are examined as corrosion inhibitor for carbon steel in acid medium (HCl) by chemical method (weight loss) in (0.5, 1.0 and 2.0 M HCl) and by electrochemical techniques (open circuit potential, potentiodynamic polarization (Tafel) and electrochemical impedance spectroscopy (EIS) finally, scanning electron microscope (SEM).

The results of weight loss measurements for carbon steel dissolution in (0.5, 1.0 and 2.0 M hydrochloric acid solution containing different concentrations (100, 200, 300, 400, 500 and 600 ppm) for each organoamides derivative (inhibitor) I - III respectively, revealed that by increasing the concentration of these derivatives, the weight loss of carbon steel specimens were decreased, the inhibition efficiency was increased. The order of inhibition efficiency increased as the following:

III > II > I

This order is depended on the chemical structure of organoamides derivative (inhibitor) I - III. The results showed that the adsorption of the (prepared compounds) inhibitors on the surface of carbon steel obeyed Langmuir adsorption isotherm.

The effect of temperature on the corrosion rate of carbon steel in 1M HCl solution in absence and presence of 500 ppm for each organoamides derivative (inhibitor) I - III has been studied. From results, it is concluded that these compounds act as corrosion inhibitors in 1M HCl acid for carbon steel at low and high degrees of temperatures. Arrhenius plots of logarithm corrosion rate (Log K) against reciprocal of absolute temperature (1/T) were found to be linear and obeyed the following equation:

$$\mathbf{LogK = -Ea^*/2.303RT + log\ A}$$

The thermodynamic parameters (ΔH^*, ΔG^* and ΔS^*) also are computed and discussed.

The results of open circuit potential for carbon steel dissolution in 1.0 M hydrochloric acid solution containing different concentrations (100, 200, 300, 400, 500 and 600 ppm) for each organoamides derivative (inhibitor) I - III

respectively, showed that the concentration of each inhibitor from I- III, increased the corrosion potential ($E_{corr.}$) shifted to more positive direction. From these results clearly that the inhibitor act as anodic protection (i.e) decreasing the anodic dissolution of carbon steel alloy. Therefore one could be noted that OCP values are very different for each inhibitor due to variation in of the molecular structure of each inhibitor. So that, the potential shifted to more positive direction in the following orders to:

III > II > I

The results of potentiodynamic polarization for carbon steel dissolution in 1.0 M hydrochloric acid solution containing different concentrations (100, 200, 300, 400, 500 and 600 ppm) for each organoamides derivative (inhibitor) I - III respectively have been investigated. The polarization curves indicated that the addition of inhibitor shifted the E_{corr} value towards the positive direction. E_{corr} shifted to-more positive direction in the following order :

III > II > I

The values of inhibition efficiency increase markedly with the increase of inhibitor concentration indicating that a higher coverage of inhibitor on the surface was obtained in a solution with higher concentrations of inhibitor. From these results clearly that the inhibitor act as anodic protection. The results obtained from the polarization technique were in good agreement with those obtained from weight loss method and OCP data.

The results of a typical Nyquist impedance plots obtained for carbon steel alloy electrode at an open circuit in 1M HCl in absence and presence of the concentration different (100, 200, 300, 400, 500 and 600 ppm) for each inhibitor (I- III) respectively. This indicated that the

increase in organoamides derivative (inhibitor) I - III concentrations raised the polarization resistance (Rp).

The increasing of Rs value verified for 1M HCl in presence of organoamides derivative I- III (inhibitors) pointed out a reduction in the alloy corrosion tendency, resulting in an I% of 80, 88 and 90.5 respectively. A slightly decrease of Cdi values has also been detected, which corroborates the above proposal that organoamides derivative (inhibitor) I - III acts as corrosion inhibitor by adsorption onto the metallic surface. The results obtained from the impedance were in good agreement with those obtained from weight loss method and OCP data and polarization technique.

Scanning electron microscopy was used to examine the surface morphology of the mechanically polished carbon steel specimens and those which had been immersed in 1M hydrochloric acid solution in absence and presence of 500 ppm of organoamides derivative (inhibitor) I – III. The obtained micrographs showed that, , the surface was strongly damaged owing to corrosion in absence of inhibitor, but when inhibitors were added there are much less damage of the surface , presumably as a result of a protective film of the inhibitor on the metal surface. From the micrographs it is clear that compounds provided good protection in the following order:

III > II > I

The prepared organoamidesiloxane IV, V and VI are evaluated as corrosion inhibitor for carbon steel in acid medium (HCl) by the same methods and conditions in the first part.

The results of weight loss measurements, open circuit potential, potentiodynamic polarization (Tafel) , electrochemical impedance spectroscopy (EIS) and

scanning electron microscope (SEM)for carbon steel dissolution in hydrochloric acid solution containing different concentrations (100, 200, 300, 400, 500 and 600 ppm) for each organoamidesiloxane IV, V and VI respectively, revealed that by increasing the concentration, the inhibition efficiency was increased. The order of inhibition efficiency increased as the following:

IV > V > VI ,

IV>I , V >II and VI >III

This order is depended on the chemical structure of organoamide and organoamide siloxane I - VI.