Corrosion behavior of zinc in aqueous solutions

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The thesis deals with studying the corrosion behavior of zinc in aqueous solutions . The thesis comprises three main chapters;In chapter (1)This chapter discusses definition of corrosion, inhibitors corrosion, classification of corrosion inhibitors, corrosion rate measurements and literature survey on corrosion inhibition of zinc in aqueous solutionsIn chapter (2)The experimental techniques are given which deal with:Materials and solutionsElectrode preparationApparatus and techniques used for corrosion measurementsIn chapter (3)It deals with the results obtained and their discussion and this chapter is divided into four sections:Section (A)Results obtained from weight- loss methodEvaluation of the inhibitor efficiency by weight loss method for all tetrahydrocarbazole derivatives in 0.4 M HCl at 30 ± 1 °C revealed that the inhibitor efficiency increases with the increasing of the concentration and rises of temperature . These organic compounds obeyed Langmuir adsorption isotherm showing that the inhibition process is due to the adsorption of inhibitor on zinc surface. The degree of surface coverage (θ) of the inhibitors was found to increase with increasing the concentration of the inhibitors in the corrosive medium. The effect of temperature on the corrosion inhibition of zinc in 0.4 M HCl was determined over the temperature range 30-50°C using weight loss measurements. The corrosion rate decrease with increasing the temperature indicating that the inhibition occurs through chemical adsorption of the organic compounds on Zn surface. Thermodynamic parameters of activation were calculated in the presence of different concentrations of tetrahydrocarbazole derivatives.Section (B)Results obtained from potentiodynamic polarization method:The extrapolation of anodic / or cathodic Tafel lines gives the corrosion current density , icorr , at the corrosion potential Ecorr. This method is based on the electrochemical theory of corrosion processes developed by Wagner and Traud. Anodic and cathodic Tafel constants were determined from the slopes of the Tafel plots. On increasing the concentration of the inhibitor in the medium, the corrosion current (rate of corrosion) is decreased. This indicates that the presence of the inhibitors in the medium retards the corrosion of zinc in 0.4 M HCl.The degree of surface coverage () for the inhibitors on zinc surface increases with increasing the inhibitor concentration in the corrosive media. Application of Langmuir adsorption isotherm gives straight lines with slopes very closed to unity.The addition of different concentrations of tetrahydrocarbazole derivatives to 0.1M NaCl solution shifted the pitting potential towards more positive values, i.e. inhibits pitting corrosion of the zinc. The relation between pitting potential; Epit and the inhibitor concentration for corrosion of zinc in 0.1M NaCl solution, gives straight lines.Section (C)Results obtained from

electrochemical impedance spectroscopy (EIS) methodNyquist and Bode plots of Zn in uninhibited and inhibited 0.4 M HCl solution containing various concentrations of tetrahydrocarbazole derivatives are plotted, the Nyquist plots are not perfect semicircles as expected from the theory of EIS and this difference can be explained as follows: This behavior can be attributed to the frequency dispersion as a result of roughness and in homogeneity of the electrode surface. Increase in the diameters of the semicircles with the concentration of the additives indicates that an increase in the protective properties of the Zn surface. Thus, the capacitive semicircle is correlated with the dielectric properties and the thickness of barrier adsorbed film.Impedance parameters, such as, charge transfer resistance Rct, and the double layer capacitance Cdl are derived from the Nyquist plots are determined for zinc in 0.4M HCl solution. The values of Rct increase with increasing the concentration of the inhibitors and this in turn leads to a decrease in corrosion rate of zinc. The decrease in values of double layer capacitance; Cdl can result from a decrease in local dielectric constant and/or an increase in the thickness of the electrical double layer,In Bode plots the slope of log Z vs. log f relation should be -1. The high frequency limit corresponds to the solution resistance Rs(R), while the lower frequency limit represents the sum of Rs + Rct where Rct. The values of Rct and Rs calculated from Nyquist and Bode plots are in good agreement.Section (D)Results obtained from electrochemical frequency modulation (EFM) methodIntermodulation spectrum for zinc in 0.4 M HCl solution in the absence and presence of different concentrations of tetrahydrocarbazole derivatives are studied. The harmonic and inter modulation peaks are clearly visible and are much larger than background noise. The corrosion parameters such as inhibition efficiency (% IE), corrosion current density (icorr), Tafel constants (βa and βc) and causality factors; CF-2, CF-3, at different concentrations of tetrahydrocarbazole derivatives in 0.4 M HCl solution at 30ºC are calculated.The order of increased inhibition efficiency for tetrahydrocarbazole derivatives is: (I) > (II) > (III) > (IV) as indicated from the different methods..