Corrosion behavior of carbon steel in aqueous solutions

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This thesis comprises three main chapters; introduction, experimental work and result & discussion.Chapter (1): contains the introduction part which deals with the following fields of interest:- Corrosion and corrosion prevention by inhibitors- The effect of the structure of organic compounds on their inhibiting properties- Literature survey for corrosion of carbon steel in aqueous solutions and its inhibition.Chapter (2): deals with the experimental work. It includes the chemical composition of the carbon steel (L-52) used in this study; preparation of the sulfuric acid solutions as corrosive medium; metal salts used (CuSO4, NiSO4 and Fe2SO4); organic additives used (3-meth. pyrazolone, imidazole and 2-meth. imidazole) and the techniques used for the corrosion measurements e.g. (weight loss, galvanostatic polarization, cyclic voltammetry, potentiodynamic anodic polarization, conductometric titration and spectrophotometry) techniques.Chapter (3) involves seven sections:Section (A): contains the results of weight loss of carbon steel under investigation in 0.5M H2SO4 solutions containing different concentrations of the metal cations (Cu+2, Ni+2 and Fe+3), organic additives (3-meth. pyrazolone, imidazole and 2-meth. imidazole), and mixtures from them with different ratios. These results revealed that:- In general, for all additives, the increasing of the concentration of the metal cations, organic additives and mixtures from them leads to the decrease of weight loss, indicating the inhibiting effect of these additives.- The values of corrosion rate (k) of C-steel in 0.5M sulfuric acid was found to be decreased with increasing the concentration of the additives and obeyed the given organic additive > metal cation.Section (C): contains the results trend:Metal cation obtained from the potentiodynamic anodic polarization measurements of carbon steel in 0.5M H2SO4 in absence and presence of different additives at scan rate of 100 mV/sec. These results permitted to conclude that:- There is one anodic peak -due to the dissolution of Fe to Fe+2 ion.- The anodic cyclic voltammograms of C steel electrode in 0.5M sulfuric acid at different scanning rates, shows an increase in the peak current of all anodic peak with increasing the scanning rate. The relationship between the peak potential (Ep) and the scanning rate (1/2ע(gave a straight line indicating that, the passivation film exists on the C-steel surface is formed through the dissolution-precipitation mechanism.- Increasing the concentration of the additives shifts Ep to more positive values and ip to lower values, thus increasing the inhibition efficiency. This indicates an increased resistance to active dissolution which depends on both the type of electrode and

the inhibitor.The inhibition efficiencies of all additives increase in the following organic additive> metal cation.Section (E): represents the order:metal cation conductometric titration measurements.- The data obtained gave a strong indication for the formation of a complex compound between the two additives (organic compound and metal cation) by a molar ratio of 1.0 (M+2 cation): 2.0 (additive). This reflects the great tendency of such organic compound to form a complex compounds with metal ions, which in turn increase the efficiency of acting as corrosion inhibitors through the formation of the complex species.Section (F): represents the spectrophotometric measurements (UV-visible spectra) of M+2 cation, the organic additives and M+2 cation + organic additive mixture obtained before and after polarization measurements which conclude that:- The spectra of M+2 cation, the organic additives and M+2 cation + organic additive mixture after polarization measurements shows the same absorption band values as obtained from those before polarization measurements but at lower intensities. This means that some of the organic additive as well as M+2cation + organic additive complex that formed in 0.5 M H2SO4 solution are adsorbed on the carbon steel surface.Section G: represents the inhibition mechanism suggested for the investigated additives, which conclude that:- The inhibiting action of M+2 cation is ascribed to the plating of the corresponding metal on the carbon steel surface, which forms a protective layer with consequent more complete anodic passivation of the anodic sections of the substrate.- The inhibition of carbon steel corrosion by organic additives is attributed to, the adsorption of the inhibitor molecules on the metal surface. Imidazole and pyrazolone molecules shows three different anchoring sites suitable for surface adsorption, the nitrogen atom with its lonely sp2 electron pair, the active hydrogen atom attached to the nitrogen atom and the p-bond of the aromatic ring.- In the case of addition of M+2 cation + organic additive mixture, the results demonstrated the complex formation between the two components, which was much more effective than the inhibiting action of each additive separately. The conductometric studies revealed the participation of two organic molecules in the complex formation with M+2 cation. This finding would suggest that the molecular size of the complex formed and consequently the number of adsorption centers play an important role in the enhancement of the protection of carbon steel against corrosion.