Electrochemical behavior of some metal alloys in aqueous soluions

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Metals and alloys have a vital and important role in human life. Corrosion is the main dangerous faces the great part of different industrial fields containing metals and alloys in their equipments and machines. Trials have been carried out in this study to decrease, for a great extent, the corrosion of different carbon steels used in petroleum refining tanks and transportation pipelines through the usage of new clean inhibitors.Literature survey expanding over the past years up to 2008, dealing with the corrosion of carbon steels, was surveyed and reported here prior to this study. Nearly 132 references covering this period have been cited. Different studies, reviews, and publications of this survey spot generally on the corrosion behaviour of carbon steel alloys in different corrosive media with special interest to the acid media due to the common application of carbon steels in this media as in petroleum industry.Two carbon steel alloys with carbon ratio of 0.27% and 0.28% were supplied kindly from Cairo Company for petroleum refining and Petroleum Pipelines Company for petroleum transportation, respectively, and tested in their simulated working media. On the other hand; two inhibitor series were used to decrease the corrosion rate of the tested carbon steel samples; the first is commercial chemicals known as Triton X-series, while the second is synthesized chemicals prepared using rice bran oil as a base material reacting with diethylenetriamine, triethylene tetramine, and tetraethylene pentamine to produce ro- amide series.The carbon steel supplied from Cairo Company for petroleum refining was tested in the presence of triton X-series in both 0.1M and1M HCl corrosive media while; it was tested in the presence of ro- amide series in the latter media only. But the carbon steel alloy supplied from Petroleum Pipelines Company was tested in the presence of triton X-series in Red sea water. Also; both supplied carbon steel alloys were tested in the presence of triton X-series in sodium chloride corrosive media.The corrosion rate of the tested samples and its inhibition were measured using some known methods of corrosion rate measurements such as; weight loss measurements, potentiostatic and cyclic voltammetry measurements, and potentiodynamic anodic polarization measurements.Chapter three shows the results obtained from weight loss measurements. Generally, the corrosion rate of the tested carbon steel alloys was decreased with increasing the concentration of the tested inhibitor, triton X- series or ro- amide series, up to certain limit due to the largest molecules of the inhibitor series.For the presence of Triton X- Series in different corrosive media the results showed the following:1- in 0.1M HCl; 100ppm

of Triton X- 100 was sufficient to obtain 100% inhibition efficiency after 3days of immersion.2- in 1M HCl; 200ppm of Triton X- 100 was sufficient to obtain 97.42% inhibition efficiency after 7days of immersion.3- in Red sea water; 400ppm of Triton X- 100 was sufficient to obtain 92.42% inhibition efficiency after 7days of immersion.While in 1M HCl containing 200ppm ro- amide III, 100% inhibition efficiency was attained after 2 days of immersion only.from the polarization measurements discussed in chapters four and five the following conclusion could be drawn:a- Potentiostatic techniqueThe potentiostatic measurements confirmed that the two tested inhibitor series worked as mixed type inhibitors in both acidic solutions and Red sea water. The addition of these inhibitors hindered the acid attack on the surface of the steel electrode and suppressed the cathodic and anodic reactions without change in the corrosion potential. The data showed that icorr decreased with the addition of different concentrations of the two inhibitor series up to certain limit, due to the increase in the blocked fraction of the electrode surface (θ) by adsorption.b- Cyclic voltammetry techniqueCyclic voltammetry technique confirmed the results obtained from both the weight loss and potentiostatic measurements where at different concentrations of the used two inhibitor series, the amount of charge density were calculated under both anodic and cathodic cycles. It was found that the amount of charge density decreased with increasing the tested inhibitor concentration up to a certain limit, after which further increasing in the concentrations led to more increase in the charge density again. This indicates that the tested inhibitors were adsorbed on the metal surface, causing the inhibition of the steel corrosion. As a result, the rate of the anodic dissolution and cathodic reactions (hydrogen evolution or oxygen reduction) at the working electrode was slowed with the increase of the tested inhibitor concentration. The adsorbed molecules formed a barrier for charge transfer leading to decrease the charge density. This effect increased by increasing the tested inhibitor concentration due to increasing the number of adsorbed molecules. However, beyond a certain concentration, a competition arises between the molecules adsorbed on the electrode surface leading to a weakness of the formed film. Consequently, the charge transfer process increases again. This argument is in agreement with the dependence of inhibition efficiency on tested inhibitor concentration.c- Potentiodynamic anodic polarization techniqueThis technique was used to determine the pitting potential of the tested carbon steel samples at different concentrations of NaCl in the presence of triton X- series as inhibitors. The pitting potential was shifted to more negative direction as the chloride ions increased. On the other hand, the pitting potential was shifted to more noble direction with increasing the concentration of triton X-series.Generally; the mechanism of adsorption was also studied at different concentrations of the two tested inhibitor series. It was found that, the adsorption of both triton X- series and ro-amide series followed the Langmiur adsorption isotherm. The calculated Gibbs free energy values of the corrosion process suggested a spontaneous chemisorption mechanism. The apparent activation energy was also calculated at different temperatures in absence and presence of the best concentrations of each triton X-series and ro-amide series using potentiostatic technique. It was found that;In the case of triton X-series:1- The inhibition efficiency decreased with increasing the

temperature. This recommended the usage of triton X-series is preferred at the room temperature.2- The activation energy in the presence of the triton X-series is higher than that in the free corrosive solutions. This ensures that the tested -compounds formed a barrier for mass and charge transfer.While in the case of ro amide series:1- The inhibition efficiency was not affected by increasing the temperature. This suggested that the ro-amide series can be used at room and at elevated temperatures.2- The activation energy in the presence of ro-amide series is higher than that in the free corrosive solutions (1M HCl). This indicates the formation of a barrier for the mass and charge transfer by the ro-amide compounds at the metal surface. The high activation energy in the presence of ro-amide series more than that in the case of triton X-series ensures the more stability of adsorbed molecules of ro-amide series as a result of the presence of nitrogen atoms which are less electronegative than oxygen, in addition to the presence of double bonds of the amide compounds (as active centre of adsorption).