Effect of some inorganic compounds on the corrosion inhibition of some transition metals in aqueous solutions

A thesis

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By

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بسم الله الرحمن الرحيم

سبحانك لا علم لنا إلا ما علمتنا إنك أنت العليم الحكيم

صدق الله العظيم

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Introduction:

As we entered the 21th century we will be moving into a period where the cost of energy will be increasing to levels exceeding those reached during the early 1970's. Knowledge of corrosion principles will aid in minimizing losses during exposure to aggressive environments.

Corrosion is a naturally occurring phenomenon commonly defined as the deterioration of a substance, usually metal, or its properties because of a reaction with its environment. Like other natural hazards such as earthquakes or severe weather disturbances, corrosion can cause dangerous and expensive damage to everything from automobiles home appliances, and drinking water system to pipelines, bridges and public buildings [1-2].

Corrosion is very costly and has a major import on the economies of industrial nations. A 1975-benckmark study by Battelle –NBS pointed out severe impact on the U.S. economy. The estimates based on the Battelle –NBS study are that the cost of corrosion in U.S. alone was approximately $ 70 billion, which was 4.2 % of the Gross National Product (GNP)[3].

In Egypt an estimate of 475 million LE/year was given for corrosion costs in 1982 [4]. Updated figures would go up to about

1.3 billion LE/years [5]. This figure corresponds to about 4% of the GNP.

1. Corrosion

Corrosion is the destructive attack of a material by reaction with its environment. The serious consequences of the corrosion process have become a problem of worldwide significance. In addition to our everyday encounters with this form of degradation, corrosion causes plant shutdowns, waste resources, loss or contamination of product, reduction in efficiency, costly maintenance, and expensive over design. It can also jeopardize safety and inhibit technological progress.

1.1. Corrosion in aqueous solutions

Corrosion of metals and their alloys in aqueous environments is almost always electrochemical in nature. It occurs when two or more electrochemical reaction takes place on metallic surface. As a result, some of elements of metallic surface change into a non-metallic state. The products of corrosion may be dissolved species or solid corrosion products. Aqueous environments will range from very thin condensed films of moisture to bulk solutions, and will include natural environments such as the atmosphere, natural

waters, soils, body fluids, etc. as well as chemicals and food products.[6-14].

The following features characterize all corrosion in corrosion reactions in aqueous solutions:

1-The electrified interface between the metal and the electrolyte solution (the metal surface) may be film-free or partially or completely covered with films or corrosion products.

2- Transfer of positive charge from the metal to the solution with sequent oxidation of the metal to a higher valency state.

3- Transfer of positive charge from the solution to the metal with consequent reduction of a species in solution (an electron acceptor) or a lower valency state.

4- Transfer of charge through the solution and the corroding metal. It follows that corrosion is an electrochemical reaction in which the metal itself is a reactant and is oxidized (loss of electrons) to a higher valency state, whilst another reactant, an electron acceptor, in solution is reduced (gain of electrons) to lower valency state.

1.2. Corrosion theory

Humans have most likely been trying to understand and control corrosion for as long as they have been using metal objects. The most important periods of prerecorded history are named for the metals that were used for tools and weapons (Iron age, bronze

age). With a few exceptions, metals are unstable in ordinary aqueous environments.

Metals are usually extracted from ores through the application of a considerable amount of energy. Certain environments offer opportunities for these metals to combine chemically with elements to form compounds and return to their lower energy levels.

Corrosion specifically refers to any process involving the deterioration or degradation of metal components. The best known case is that of the rusting of steel. Corrosion processes are usually electrochemical in nature, having the essential features of a battery.

When metal atoms are exposed to an environment containing water molecules they can give up electrons, becoming themselves positively charge ions, provided an electrical circuit can be completed. This effect can be concentrated locally to form a pit or sometimes a crack, or it can extend across a wide area to produce general wastage.

Corrosion is the disintegration of metal through an unintentional chemical or electrochemical action starting at its surface. All metals exhibit a tendency to be oxidized, some more easily than other.