بسم الله الرحمن الرحيم

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التوثيق الالكتروني والميكروفيلم

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STUDY ON THE MECHANISM OF CORROSION AND INHIBITION OF SOME STEELS

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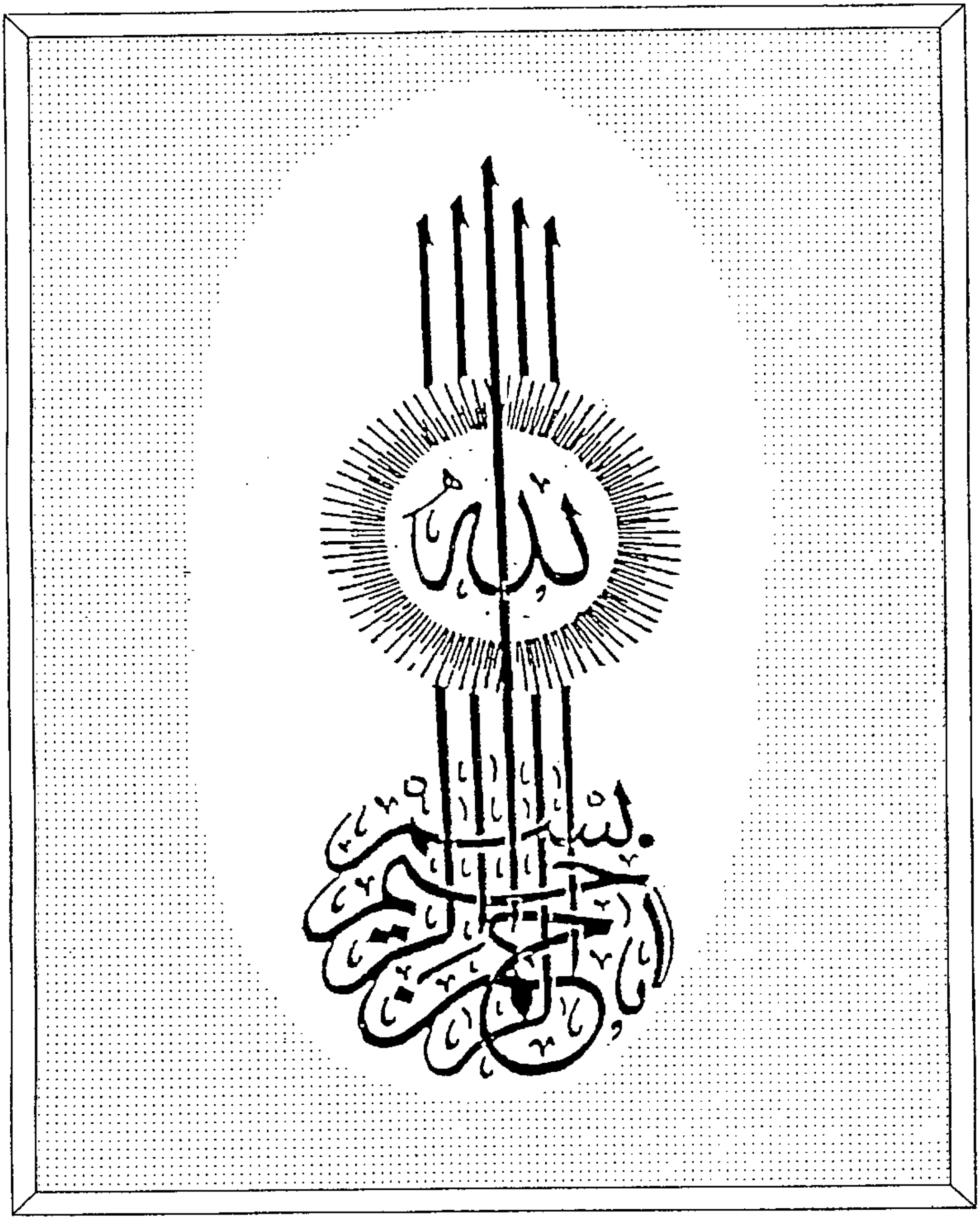
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INTRODUCTION

1-INTRODUCTION

Nearly all metals are thermodynamically reactive in most natural environments, in particular in air, especially when it is moist, polluted or hot, and in water, especially when it is saline, acid or alkaline. Exposed to dry,pure and cool air,most metals quickly develop an oxide film after that the rate of oxide growth slows down because it forms a solid barrier between the metal and oxygen through which metal and oxide ions pass only with difficulty. The air-formed oxide film, is often (e.g. unalloyed steel) not very resistant to ordinary atmospheres, ordinary waters and, especially, chemical fluids; and with its breakdown, corrosion of the metal propagates[1].

1.1 DEFINITION [2]:

Corrosion is a physico-chemical interaction between a metal and its environment which results in changes in the properties of the metal and which may often lead to impairment of the function of the metal, the environment, or the technical system, of which these form a part. This interaction is usually of an electrochemical nature.

Corrosion effect is the change in any part of the corrosion system caused by corrosion.

Corrosion damage is the corrosion effect which is considered detrimental to the function of the metal, the environment or the technical system of which these form a part.

1.2 SOME TYPES OF CORROSION AND FORMS OF CORROSION EFFECT:

Corrosion can be classified into some forms, the bases for this classification being the appearance of the corroded metal. In most cases, the naked eye is sufficient but sometimes magnification is helpful or required[2,3].

1.2.1(a) Types of corrosion without stress [2]:

a- Uniform or general corrosion.

b- Shallow pit formation.

c- Pitting corrosion.

d- Intergranular corrosion. .

e- Transgranular corrosion.

f- Selective corrosion.

g- Galvanic corrosion.

1.2.1(b) Forms of corrosion effect without stress[2]:

a- General even decrease in thickness.

b- General uneven decrease in thickness with formation of shallow pits.

c- Localized decrease in thickness pits.

d- Attack on grain boundaries.

e- Localized attack at segregations.

f- Specific reaction with a part of microstructure.

g- Corrosion attack of anodic areas of a corrosion cell.

1.2.2(a) Types of corrosion with stress[2]

a- Erosion corrosion.

b- Stress corrosion cracking.

c- Cavitation corrosion.

d- Corrosion fatigue.

1.2.2(b) Forms of corrosion effect with stress [2]

a- Destruction of the layer and formation of shallow pits.

b- Inter-or transcrystalline cracks.

c- Localized attack on the surface, similar to pitting.

d- Transcrystalline cracks.

1.3 DEFINITION AND CLASSIFICATION OF STEEL:

Steel is an alloy of iron with carbon, classifed into:

1.3.1 Unalloyed steel, which does not contain alloyed elements such as, Mn, Si, Cr, V) .

1.3.2 Alloyed steel which is classified according to the percentage of its alloyed elements into two types.

a-low alloyed steel:

The steel contains less than 5 wt% of alloying elements.

b-high alloyed steel:

The steel contains more than 5 wt% of alloying elements. The important group of this type contains more than 12 wt% of chromium is chemical resistant steel, which is classified into:

1-**Heat resistant steel**, contains otherwise chromium, the elements of silicon and aluminium.

2-**Stainless steel** ,contains otherwise chromium often nickel. It is classified according to its structure formation into four groups:

2(a)**Martensitic steel** with body centered tetragonal > 0,12 wt% carbon and maximum 15% chromium.

2(b)**Ferritic steel** with body centered cubic lattice, contains nearly 17 wt% chromium.

2(c)**Austenitic steel** with face centered cubic lattice . it contains nearly 18 wt% chromium and 10 wt% nickel with or without additive of molybdenum. This type of steel has a good resistant to a wide range of corrossive media, high ductility, high temperature resistance and good weldability[4].

2(d)**Ferritic-austenitic steel** give good mechanical properties and high resistance aganist chloride-induced stress corrosion cracking like ferritic steel.

1.4 CRITICAL CORROSION SYSTEM:

The reason of the pit formation on the unalloyed steel is the local difference of anodic and cathodic behaviour in the environment, due to the formation of a concentration cell. According to Fig.(1) if, for any reason, the rate of metal dissolution is momentarily high at one particular point, chloride ions will migrate to this point, to give metal chloride which hydrolyses to produce HCl that increases corrosion of an active metal. The points at which the rate of dissolution is momentairly high and at which pits are initiated may be in the form of surface scratch. During the initiation, conditions are rather unstable. When the conditions allow chloride and hydrogen ions to stay for sometimes at the anodic areas corrosion propagates. The passivity of surface is stabilized by NaOH generated at aerated cathodic areas. In the initiated pit, rapid dissolution occurs, while oxygen reduction takes place on adjacent surfaces. The rapid dissolution of metal within the pit tends to produce an excess of positive charge in this area, resulting in the migration of chloride ions to maintain electroneutrality. Thus, in the pit, there is a high concentration of MCl or MCl_2, as a result of hydrolysis, a high concentration of hydrogen ions is produced in the pit.

$$MCl_2 + H_2O \text{ -----> } (MOH^+ + Cl^-) + (H^+ + Cl^-)$$

Both H^+ and Cl^- increase the dissolution of metal in the pit. The anodic product $M(OH)^+$ migrates into the environment and is then