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EFFECT OF DIFFERENT CONCENTRATION OF SODIUM CHLORIDE SOLUTION ON THE CORROSION OF STEEL FOR DIFFERENT PERIODS OF TIME

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Abstract

In this research, the effect of sodium chloride on the corrosion rate was studied. Four square samples were prepared and their dimensions were accurately determined. The samples were 2 cm long, 2 cm wide, and 0.2 cm thick. Thus, the surface area of the samples was calculated. The weights of the samples were taken accurately using a sensitive balance before the immersion process was carried out. Also, different concentrations of sodium chloride were prepared and the concentrations were as follows (45%, 65%, 85%, 90%). Then the samples were immersed for different periods of time (4, 8, 12, 18, 30 hours). The corrosion rate of the samples was measured using the corrosion law. It was found that increasing the concentration ratio to the solution leads to a decrease in the metal's resistance to corrosion and that increasing the solution concentration led to an increase in the metal's corrosion rates. Resistance of corrosion changes with the change in the concentration of the medium and with the continuation of the exposure time. The importance of this research lies in knowing the behavior of the metal when exposed to a corrosive medium, and knowing the applied methods that are used to calculate the corrosion rate.

Key words- *solution, the exposure time, concentration ratio, sodium chloride*

I. INTRODUCRION

This study deals with a set of points represented in knowing the phenomena of corrosion and sedimentation that occur in metal facilities that negatively affect the production, service and manufacturing capacity of all sectors, This is what makes many of the industrially advanced countries of the world pay very high costs and conducting preventive checks, preventive maintenance and setting limited technical specifications to ensure the expected and design life of these components to limit and reduce the rate of corrosion. Without any corrosion inhibitors such as chemical inhibitors or others. The phenomenon of deadly corrosion and the resulting damage was one of the objectives of this study, by developing a laboratory conception of the effect of changes in the concentration of the corrosive medium on steel at different times, by calculating the corrosion rates that are of utmost importance to determine the economic, technical and environmental problems, and their negative impact on the institution to incur huge costs represented in the loss of production and poor production efficiency Which in turn recommends studying this problem on a small laboratory scale to reach results and conclusions through which some proposals and recommendations can be found to reduce corrosion

THE CONCEPT OF CORROSION

2- Definition of corrosion

Corrosion is defined as the decomposition of a material through contact between it and the external environment. Corrosion may occur to non-metallic materials such as concrete and plastic. [1] The factors on which corrosion depends are: temperature, environmental concentration, in addition to pressure and abrasion, which increase the rate of corrosion. Corrosion also causes material losses in addition to affecting safety, and may cause human losses.

2.1- Corrosion Types

2.1.1- Fissure Erosion

Crevice corrosion breaks down the bonding layer between two parts of a structure, allowing water to enter.[3] Oxygen cells are essential for crevice corrosion in a humid atmosphere.[4]

2.1.2- Stress Corrosion

It is also called pressure corrosion, and it occurs in a suitable environment in sequential steps, where the pressure begins to affect the metal and cause local weakness of the protective oxide coating, which leads to the occurrence of a curve in the metal, and then the formation of the hole increases over time, and then stress corrosion occurs at the sharp base of the hole, and the increase in the crack leads to the destruction of the material [5]

2.1.3- Galvanic Corrosion

This type occurs when two different metals are connected, and one of the metals corrodes in order to protect the other metal.[6]

2.1.4- Intergranular Corrosion

This type of corrosion occurs in stainless steel as well as other metals, where it occurs when the grain boundaries in the metal form the anode, and the internal grains form the cathode, and it occurs when the metal is heated to a temperature ranging between 425 and 870 degrees Celsius. Where the chromium present in stainless steel reacts with carbon, thus forming chromium carbide particles at the grain boundaries, this reducing the concentration of chromium in them, which leads to their corrosion. [7]

2.2- Metal protection methods

Painting is one of the ways that contribute to protecting metals from corrosion., as the outer layer surrounding the metal surface helps protect the metal from corrosion. The effectiveness of the coating in protecting the metal depends on the environment to which it is exposed. The goal of the coating process is to keep the metal dry and avoid exposure to moisture by coating the metal surface with another metal, as the latter oxidizes instead of the metal. Steel alloys are often coated with zinc, which is considered one of the most active elements, as zinc corrodes, making the iron catholic and preventing its corrosion. [8]. Another method is to use an anode made of a metal that is more active than the metal to be protected, in order to prevent corrosion in submerged or buried metal structures. The anode corrodes, so it must be replaced to prevent corrosion of the metal to be protected.[9]

2.3- Economic damage caused by corrosion

The economic damages of corrosion are numerous and often cause factories to stop production, which in turn results in additional economic costs and increased periodic maintenance costs due to replacing the damaged metal part with another new one. This can lead to unexpected failure of metal parts. The continuous inspection of metal parts necessitates taking preventive measures before the corrosion level reaches the final limit due to its negative effects on performance and productivity. Corrosion is detected by several tests without damaging them, including non-destructive tests.(N.D.T) Which requires additional costs.

II. THE PRACTICAL SIDE

3.1- Materials used

1- samples were 2 cm long, 2 cm wide, and 0.2 cm thick.
2- Sodium chloride solution (Na CI)
3- sensitive balance

The surface of the samples is prepared and cleaned before and after immersion in the solution, then their weight is recorded using a sensitive balance. Table 1

Table. 1Sample weights before and after immersion

	45%	%65	%85	%95
Sample weight before immersion (gm)	**14.52**	**15.48**	**15.11**	**14.95**
After (4Hr)	**14.43**	**15.42**	**15.08**	**14.81**
After (8Hr)	**14.21**	**15.28**	**15.04**	**14.76**
After (12Hr)	**14.18**	**15.17**	**15.00**	**14.61**
After (18Hr)	**14.09**	**15.05**	**14.9**	**14.53**
After (30Hr)	**14.07**	**14.88**	**14.7**	**14.4**

Laboratory experiments were conducted on several samples of low carbon steel with different concentrations of sodium chloride solution and for different periods of time. The data and results of the experiments were also analyzed in the form of conclusions by explaining them in graphic forms that represent the relationship between corrosion rates and the time of immersion of the samples in the solution and at different concentrations, as shown in Figures (1), (2), (3) and (4). The corrosion rates of the metal were calculated at different solution concentrations and for different periods of time, as shown in Table (3). Since the corrosion that occurred is a chemical reaction, the corrosion rate was calculated using the following equation:

$$\frac{\Delta w}{A.t} = \frac{w_1 - w_2}{A.t} = \text{C.R} = \text{Corrosion rate}$$

Table.2 the corrosion rates of the samples.

	45%	%65	%85	%95
Corrosion rate after (4Hr)	**.0056**	**.004**	**.0018**	**.0087**
after (8Hr)	**.0096**	**.0063**	**.0022**	**.006**
after (12Hr)	**.007**	**.0064**	**,0028**	**.0029**
after (18Hr)	**.006**	**.006**	**.003**	**.006**
after(30Hr)	**.0037**	**.005**	**.0034**	**.0069**

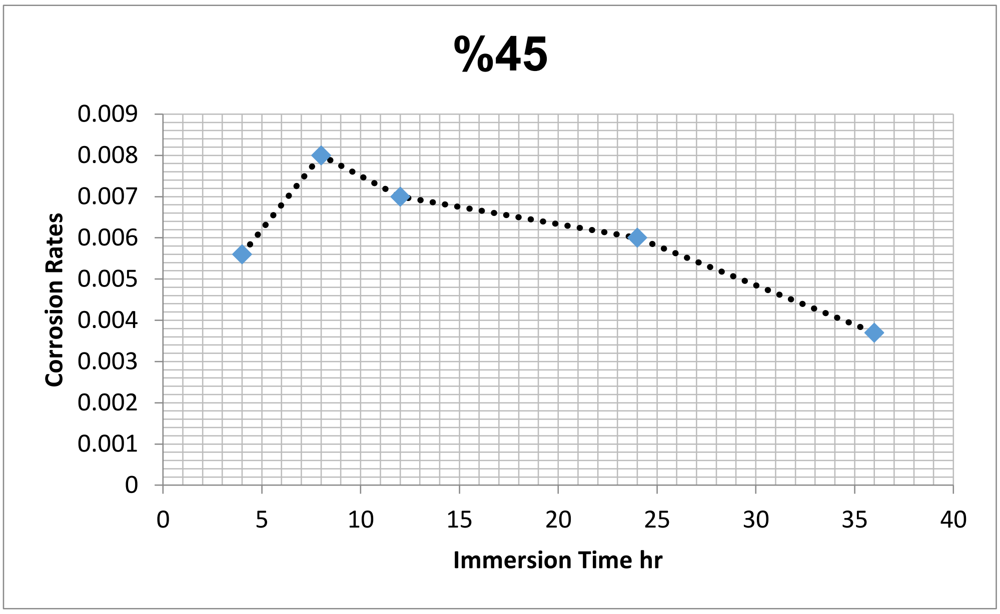

Fig 1 Relationship between corrosion rate and immersion time at 45% concentration

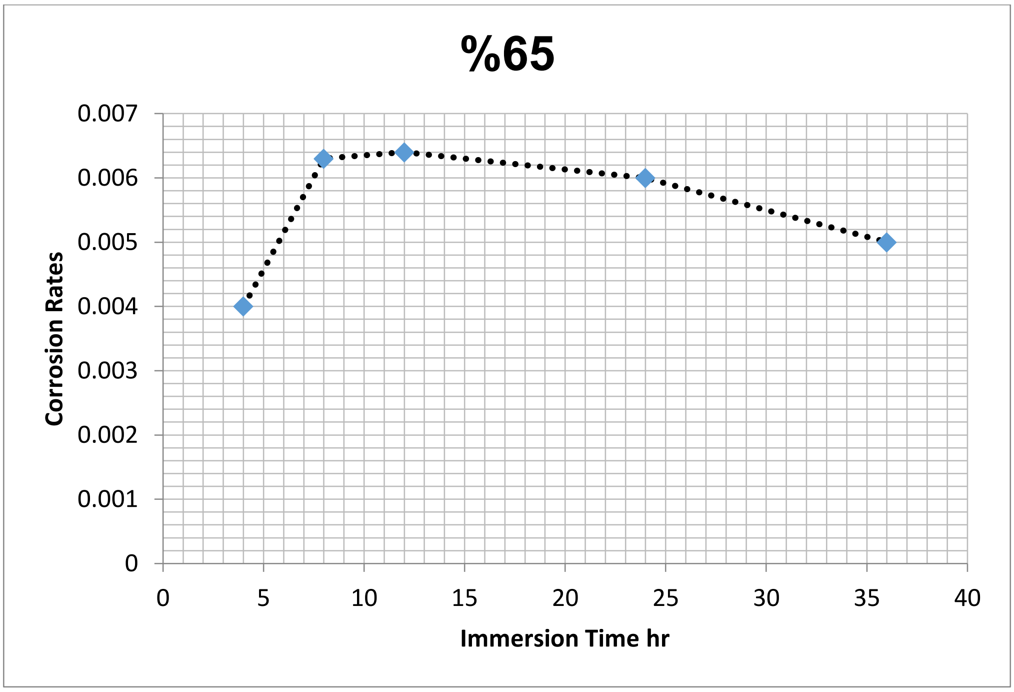

Fig.2 Relationship between corrosion rate and immersion time at 65% concentration

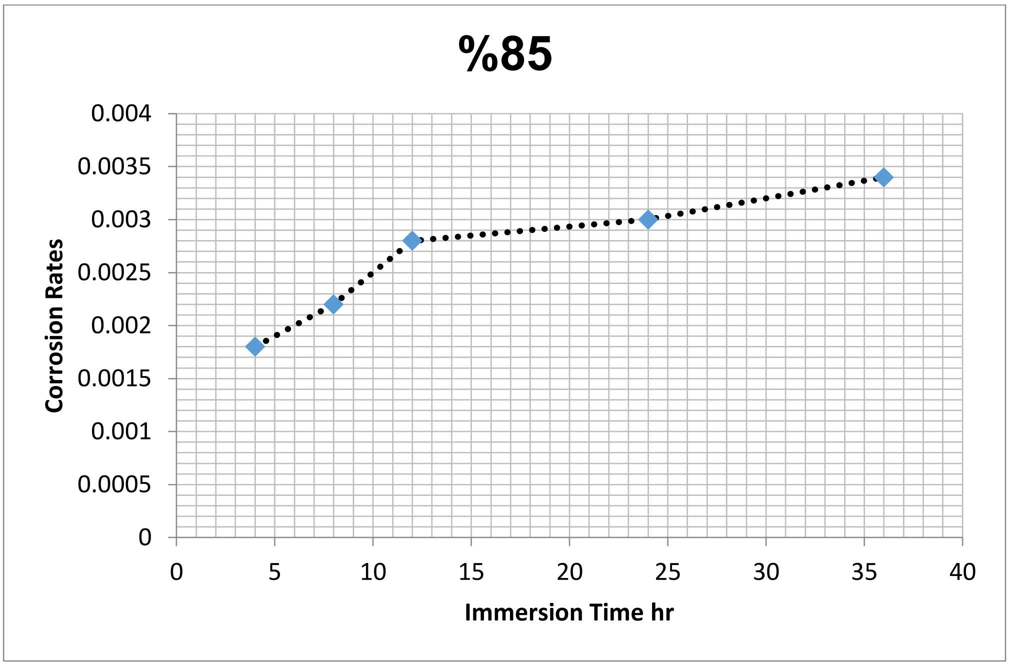

Fig.3 Relationship between corrosion rate and immersion time at 85% concentration

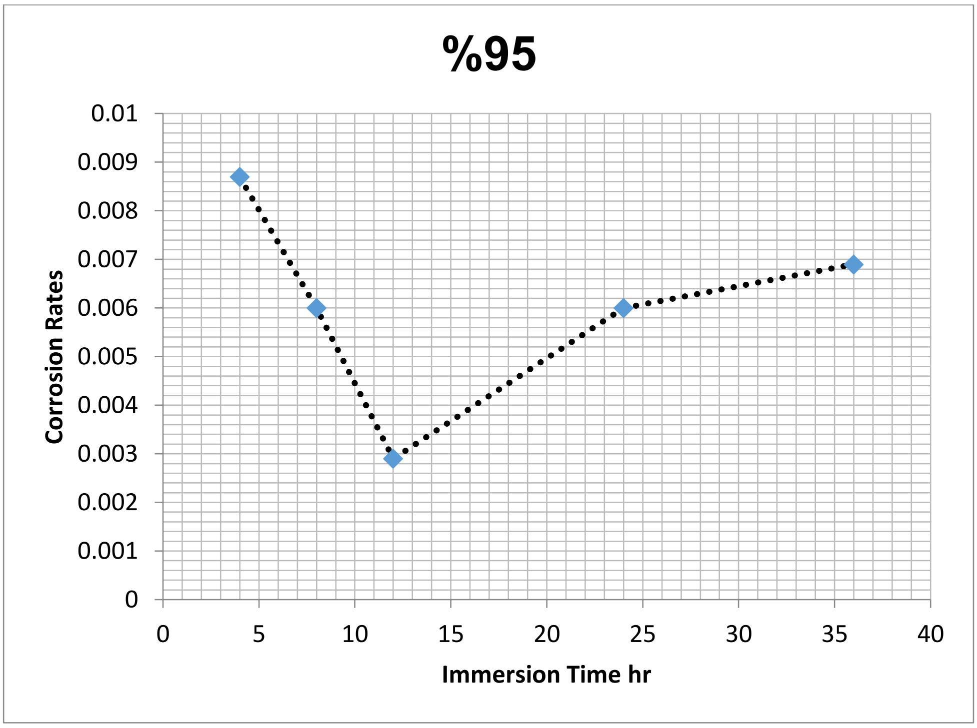

Fig.4 Relationship between corrosion rate and immersion time at 90% concentration

III. CONLUSION

The results and conclusions of this study indicate through tables and analytical graphs that:

The effect of the concentration of sodium chloride solution on the rate of steel corrosion, in figure 1,2 when concentration of sodium chloride solution 45% ,65% in figure 3 when concentration of sodium chloride solution 85% the corrosion rates increase with increasing of time period and don't effect as time period increasing . Also, the effect of the sample exposure time on the corrosion rates, the corrosion rate increases gradually with increasing the period of exposure of the sample in the solution. It was also noted that the highest corrosion rates were during the 36-hour corrosion exposure period in all media, and that the lowest corrosion rate for the same media was when the sample was exposed to corrosion for 4 hours. The increase in corrosion rates with increasing exposure time to the sample can be explained by the speed of the chemical reaction that occurred between the metal and the surrounding environment. The reason is due to the presence of chloride ions formed on the surface of the sample used, which makes the metal less resistant to the corrosive medium.

RECOMMENDATION

1. Metal plating is one of the most important recommendations, as metal plating prevents corrosion.
2. The study recommends, in such conditions and environments, using types of metals with high corrosion resistance, such as alloys containing chromium or nickel.
3. Conduct further research studies under the same conditions using longer time periods.

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