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Corrosion Protection in Tap water solution of Carbon Steel Reinforcement Used in Concrete Hydraulic Structure

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Abstract: The aim of this study is to investigate corrosion when using an inhibitor and without it two samples were collected from carbon steel, and each sample consisted of 3 pieces of carbon steel, rebar with a piece of 10, and through that the steel does not suffer from any pre-corrosion processes. In addition, these samples were cut into lengths of 10 cm and then tied with copper wires by using a specific type of welding, which is called dumps. This test was done by using the Potentiostatic polarization test in tap water for inhibitor and non-inhibiter, low carbon steel specimens at 30 °C, with 0.314 cm2 surface areas. Corrosion parameters (corrosion potential, corrosion current, and corrosion rate), extracted from these curves and we conclude the tests and analysis of the results, and as mentioned in the tables of the results, we find that the corrosion resistance of corrosive iron has been improved at good rates (for samples in normal water and salt water, which simulates ambient water in concrete facilities) and this is a good indication for the use of these inhibitors In the future.

Keywords: Potentiostatic, samples, water, inhibitor.

INTRODUCTION

Corrosion mitigation has gained much attention due to the great economic impact of replacing damaged parts with new ones especially in reinforced concrete structures, it is known that once corrosion begins in steel reinforcement, rust (corrosion product) occupies two to three times greater volume than non-corrosive steel. This large volume creates stresses around the reinforcing bar and causes the surrounding concrete to crack [Ormellese, M. *et al*., 2009; Diamond, S, 1986; Enevoldsen, J.N. *et al*., 1994].

Steel or reinforcing corrosion is the decomposition of steel reinforcement due to a chemical or electrochemical reaction within the concrete that occurs due to internal or environmental influences [Hussain, S.E. *et al*., 1995; Moreno, M. *et al*., 2004; Ghods, P. *et al*., 2009].

In this case, the reinforcement, that is, the iron, oxidizes to FeO or Fe2O3 to form a layer of rust around the bars causing the bars to swell or stretch, eventually causing cracks or cracks in the concrete[Liu, Y. *et al*., 2018; Wang, Y. *et al*., 2016].

The size of the steel or iron skewer increases when it rusts and this creates internal stress in the concrete. Internal stress causes crack/cracks to develop and cause concrete to fall off and dislodge the reinforcing cap from the concrete. Reinforcement corrosion seriously damages the structure, and eventually if not repaired at an early stage, can lead to serious structural damage including partial or complete collapse of the structure [Hussain, S.E. *et al*., 1995]

Concrete structures are often exposed to environments where various erosion and corrosion factors negatively affect their strength and durability Such damage can result in loss of property, unplanned maintenance, treatment and replacement, and in the worst case, loss of structural integrity and attendant safety hazards [Moreno, M. *et al*., 2004].

The effects of corrosion in reinforced concrete structures have consequences for the mechanical properties of the bars, mainly due to the reduced cross-section and adhesion between the concrete and the protruding rebar. Besides, the corrosion products generate tensions in the radial direction of the shaft axis that are not supported by the limited plastic deformation of the concrete, which leads to cracking and back displacement of the concrete cover [Abd El Haleem, S.M. *et al*., 2010; Abd El Wanees, S. *et al*., 2016; Yang, D. *et al*., 2019; Jiang, S. *et al*., 2017].

MATERIAL AND METHOD

A concrete mix (type c25) was prepared to simulate the type of concrete used in the creation of hydraulic fittings, then modeling molds were prepared. The carbon steel is installed inside the molds in a triangular shape.

Concrete is added into the mold with a thickness of 2.5 cm, then the next step is to put carbon steel on top of the concrete (where the first piece is placed and the bonding area is in the right direction, then the second pieces are placed in an opposite direction) in order to avoid problems that occur between pieces of rebar when pass an electric current.

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In the next stage, concrete is added with a different thickness of 10 cm, followed by placing a third piece of steel reinforcement and covering it with a thickness of concrete equal to 2.5 cm.

In turn, this air helps to speed up the corrosion process, and this generates inaccurate results during the next laboratory tests. All molds were prepared in this way.

The trees were used in order to collect eucalyptus leaves and they were cleaned and washed through the use of distilled water for the purpose of removing any substance or dust related to it.The mixture was placed in a stirrer for 4 hours.

After the concrete mixture was prepared without an inhibitor, here comes the step of adding an inhibitor to the concrete mix, where the test samples were made by relying on the addition of ordinary water and the addition of the inhibitor.

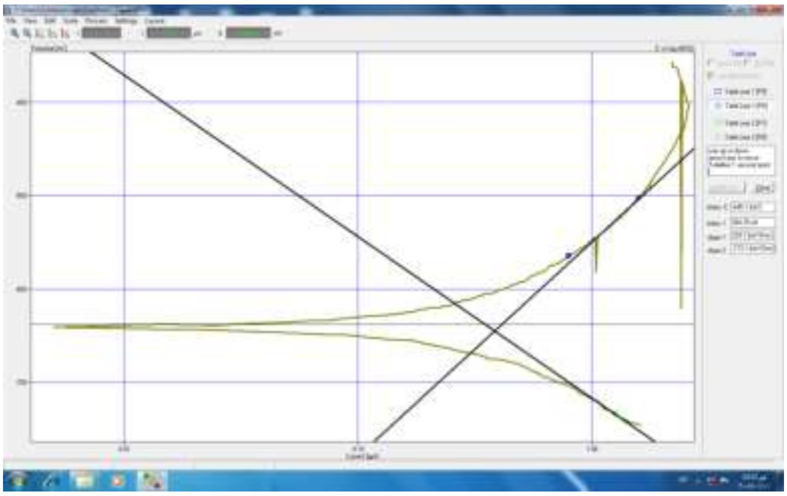
Table 1- Quantity of mix

Subject	Quantity per m3	Quantity to make 6 cubes
cement	350 kg	11.6 kg
sand	700 kg	23.3 kg
Gravel	1050 kg	35 kg
water	160 liters	5.3 liters
inhibitor solution		2 liters

Has been relied upon Fourier transform infrared (FTIR) is an analysis method widely used in industrial and scientific laboratories to study the structure of individual molecules and the composition of molecular mixtures. To study the sample in FT-IR spectroscopy, modified mid-infrared radiation is used. Infrared radiation is absorbed at certain frequencies that are directly related to the energy of the vibrations of the bonds between atoms in the molecule.

RESULTS

Corrosion test in Tap Water Solution



Figures 1: without inhibitor

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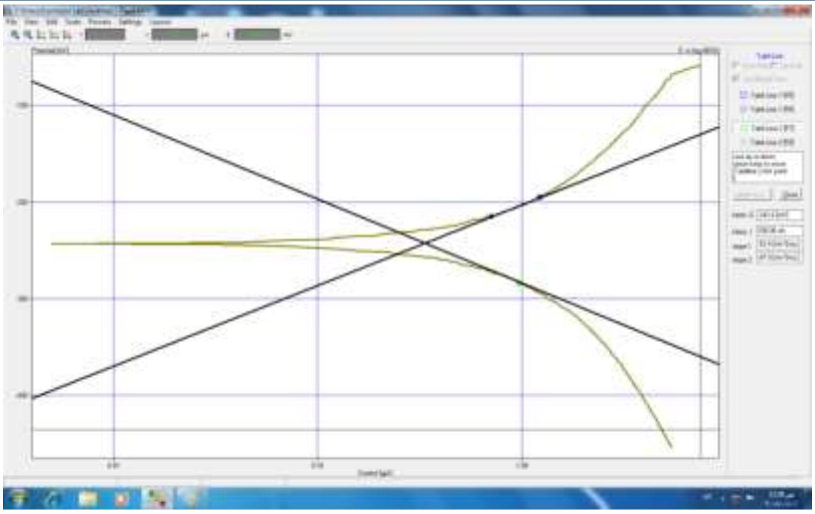

Figures 2: with inhibitor

Table 1: Corrosion rate (CR) and improvement percentage of coated specimens in Tap water

Sample code (Low carbon steel)	**$I_{corr.}$ ($\mu A/cm^2$)**	**$E_{corr.}$ (mV)**	**Corrosion Rate (mpy)**	**Improvement Percentage%**
With out inhibitor	384.25	-645.1	723.5	-
With inhibitor	336.06	-242.6	603	17

Figures (1) and (2) show the polarization diagrams of all specimens and the Ecorr. (mV), I corr. ($\mu A/cm^2$). The corrosion rates (mpy) have been demonstrated in Table (1)These results indicate a stable behaviour . Along with an improvement of corrosion resistance, this is able to make changes in the surface feature in comparison with the materials without affecting the characteristics of the bulk.

Table 2: Correlation between with inhibitor and without inhibitor

Correlations				
		Icorr	Ecorr	CR
Icorr	Pearson Correlation	1	-1.000**	1.000**
	Sig. (2-tailed)		.	.
	N	2	2	2
Ecorr	Pearson Correlation	-1.000**	1	-1.000**
	Sig. (2-tailed)	.		.
	N	2	2	2
CR	Pearson Correlation	1.000**	-1.000**	1
	Sig. (2-tailed)	.	.	
	N	2	2	2

**. Correlation is significant at the 0.01 level (2-tailed).

CONCLUSION

The efficiency of eucalyptus extraction different mediums as a corrosion inhibition increase with increase concentration extract and decrease with increase temperature and There are methodologies that allow the degree of corrosion to be assessed in other fields of engineering as well as international organizations that set standards for determining hazards in different fields of engineering. The problem presented by the identification and evaluation of corrosion risks in concrete structures focuses on poor practice in the construction of concrete structures through non-compliance with specifications for material quality, water relations, and the porosity and permeability properties of concrete. Concrete and coating thickness indicated by the specifications in each project, which leads to the occurrence of corrosion in the structures and is manifested in the effects of cracking, material separation, reduction of steel section and increase in tensile stresses. Given this scenario, it is proposed to consider based on failure and impact criteria to identify and assess corrosion risks in concrete structures.

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