Study of Corrosion of Carbon Steel in Sodium Chloride Environment

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Abstract: In this study, the corrosion characteristics of mild steel A1018M immersed in 3 % of sodium chloride solution under room temperature and condition was investigated. Corrosion rate of the specimen decreased with continuous exposure to sodium chloride solution.

1. Introduction: Corrosion of metals is one of the oldest problems that have ever challenged the industrial world and is defined differently based on their application. Corrosion is the gradual physiochemical destruction of materials by the action of environment. Corrosion of the metal will result in degrading many other material properties. Stainless steel is widely used for potable water storage purposes beside other metals. The extent and cost of damage caused by leakage in storage containers has been rising during recent years. The use of stainless steel in oil & gas transportation, potable water storages, heat exchangers and steam turbines is now common. Dissolved salts and oxygen mainly determine corrosive behavior of metals in aqueous solutions. In order to minimize corrosion problem, it is important to identify the mechanism of corrosion rate of ions with stainless steel, the extent to which they contribute to corrosion of stainless steel (Essam and Hussein, 2005).

2. Objective: The objective was to quantify the steel corrosion in saline solution with time. Also investigate the physical and electrical changes in the metal and corroding solution.

3. Materials and method: As testing specimen, ASTM 1018M plate samples with average dimension of about 50 mm×26 mm×5.1 mm were used for this experiment. Specimen was placed in suspended position in 3 % of sodium chloride solution without exposed to air. At different time intervals, weight of the specimen after drying it and conductivity, pH of the solution was noted.

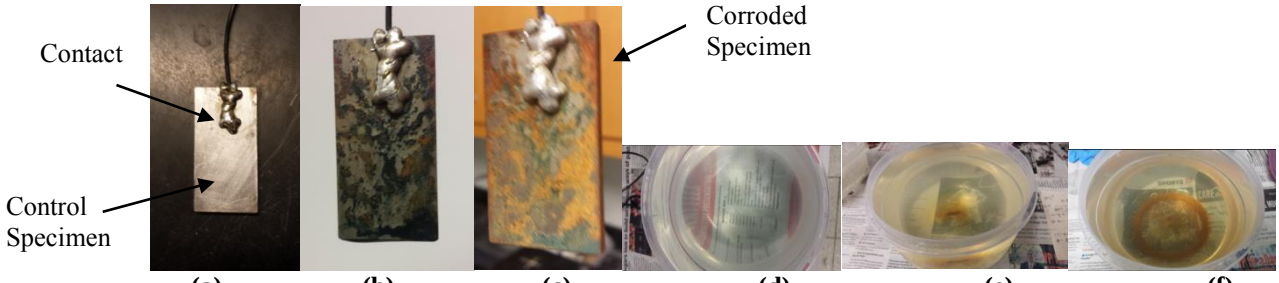

Figure 1 Steel specimen and corroding solution in this study (a) control specimen (b) specimen after 2 days of exposure in sodium chloride solution (c) specimen after 19 days of exposure in sodium chloride solution (d) Corroding solution before use (e) Corroding solution after 2 days of exposure in sodium chloride solution (f) Corroding solution after 19 days of exposure in sodium chloride solution.

4. Results and Analysis: At different time intervals the specimen was dried naturally and weighed. From Figure 2 the progressive increase in weight loss is evident as time of exposure to sodium chloride solution is from 0 to 456 hours. This signifies the dissolution of metal when it is exposed the corroding solution. The corrosion is attributed to the presence of water, H+ which accelerates the corrosion process. The pH increased with exposure time from neutral region to alkaline region at the end of the test period for the specimen .The general increase in pH of the test solutions could be attributed to the increase in the

amount of hydroxide ions in the solution due to corrosion process. Visible corrosion products (i.e. rust) were observed on the corrosion specimen during the experiment of the immersion test resulting in the changed pH values.

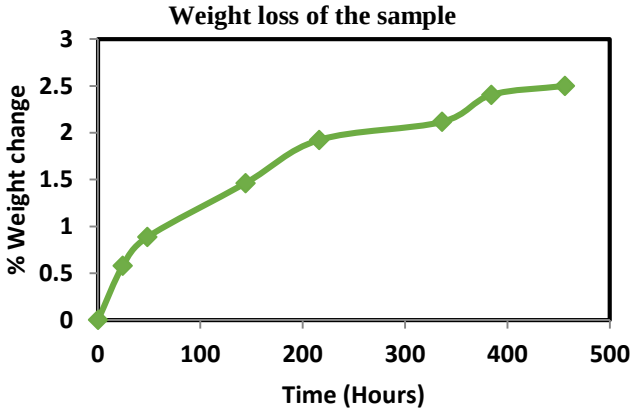

Figure 2 Weight loss of the steel specimens under sodium chloride solution

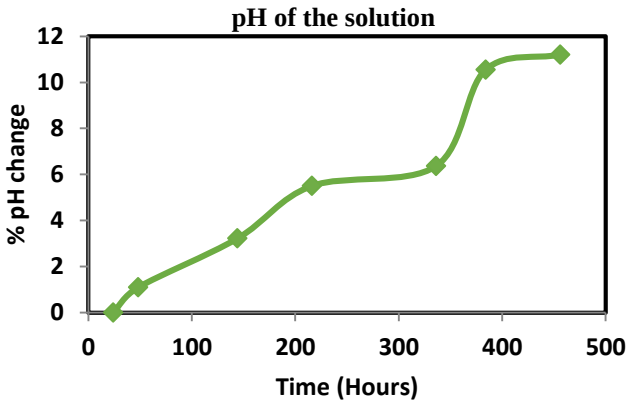

Figure 3 pH of the solution of the steel specimens under sodium chloride solution

Conductivity of the corroding solution gradually increased with exposure time as OH- and Fe2+ concentration increased as corrosion takes place.

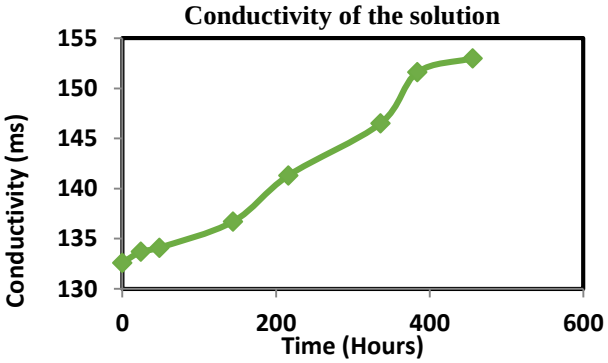

Figure 4 Conductivity of the solution of the steel specimens under sodium chloride solution

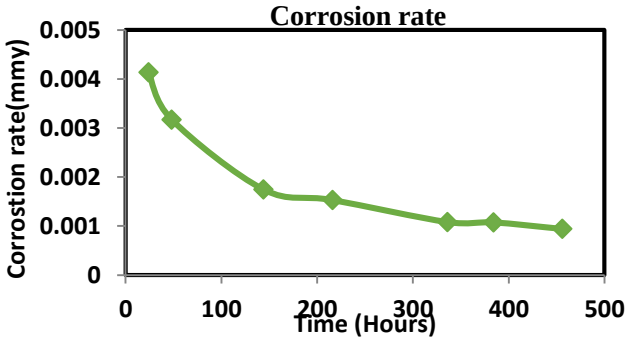

Figure 5 Corrosion rate of the steel specimens under sodium chloride solution

The corrosion rate of the specimen decreased with time. The decrease in corrosion rate is due to adherence of the formed oxides on the metal surface, the corrosion rate progressively declines as a result of passivity. During this period where the corrosion rate decreased, the pH of the solution increased from acidic region to neutral/alkaline region. This transition is expected to stifle the chemical reactivities as well.

5. Conclusion: The corrosion of A1018M steel was studied under sodium chloride solution. Corrosion of the mild steel increased with time of exposure and also corrosion rate of the steel was evaluated as a decreasing trend with exposure time.

6. Acknowledge: This study was supported by the Center for Innovative Grouting Materials and Technology (CIGMAT), University of Houston, Houston, Texas with funding from the Ultra Deepwater Program DOE/NETL/RPSEA (Project No. 10121-4501-01).

8. References: 1.Essam Hussein and Hussein A., (2005), Erosion – Corrosion of Duplex Stainless Steel Under Kuwait Marine Condition, Desalination, Volume 183, Issues 1–3, 1 ,November 2005, Pages 227–234, doi:10.1016/j.desal.2005.02.051.