

Corrosion Detection of Carbon Steel In Sodium Chloride Solution

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Abstract: In this study, the corrosion of A1018 Low carbon steel immersed in 10 % of sodium chloride solution under room temperature and condition was detected using its electrical properties.

1. Introduction:

Steel and Iron, the most commonly used metals, corrode in many media including sodium chloride environment. Usually they are selected not for their corrosion resistance but for such properties as strength, ease of fabrication, and cost. These differences show up in the rate of metal lost due to rusting (Roberge PR, 1999). Here we measured Electrical properties to detect the steel corrosion in Sodium Chloride environment. We find that corrosion detection method using electrical properties were more sensing than standard corrosion detection method which uses weight loss and dimensional change.

2. Objective: The objective was to detect the steel corrosion in Sodium Chloride solution with time. Also investigate the physical and electrical changes in the metal.

3. Materials and method: As testing specimen, ASTM 1018 low carbon plate sample with dimension of about 764 mm×31 mm×4.3 mm were used for this experiment. Specimen was placed in 10 % of sodium chloride solution for 1 day and was exposed to air for 2 days which corresponds to 1 cycle. At every cycle, weight & dimension of the specimen and electrical properties of the metal was noted. The material properties of steel were characterized under AC measurement using two-wire method. Also, measuring the resistance using two-wire method was associated with contact resistances at the interface of the connections (separated by 610 mm) and steel, it is very important to catch the corrosion layer as an interface between the connection and real steel substrate. R (Real part of impedance) and X (Imaginary part of impedance) of the specimen was measured varying with frequency from 20Hz to 300 kHz using LCR device.

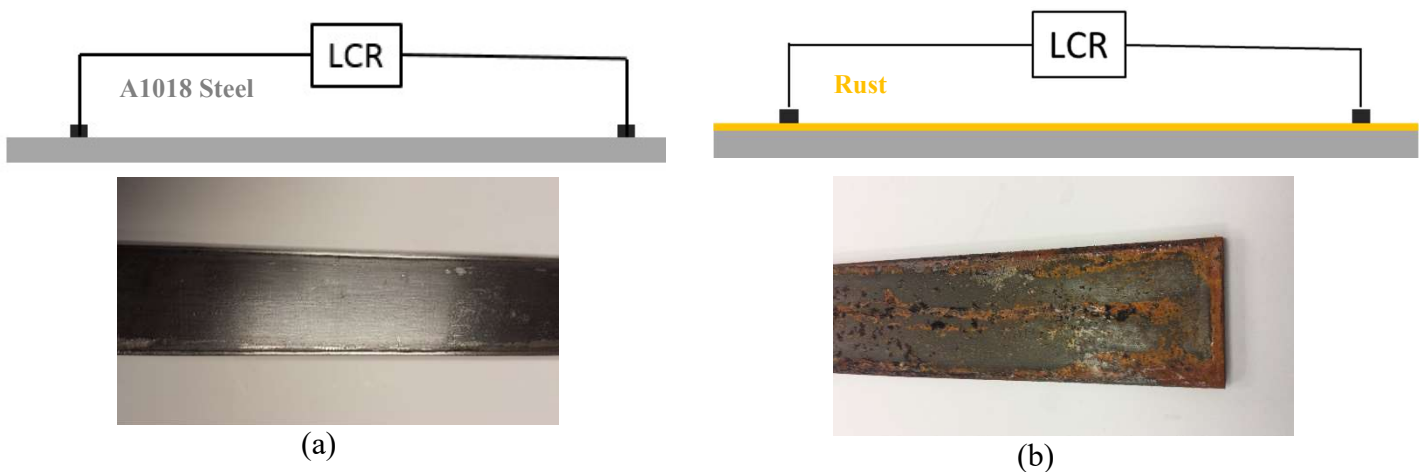


Figure 1 Schematic setup of (a) Non – Corroded steel and (b) Cycle 4 – Corroded steel

4. Results and Analyses: R and X measurement of the steel were taken from LCR device. As the rust formation happens in steel, the resistance of the material increases due to the formation of oxide layer. From Fig. 2, for the un-corroded steel resistance are in $m\Omega$, but for corroded steel, R increases to $K\Omega$ scale. The X of un-corroded steel is positive, and that of corroded is negative (Fig. 3). In Fig. 3, R of corroded steel is increasing with decreasing frequency and also R of corroded steel is around 2000-5000 times than that of un-corroded steel.

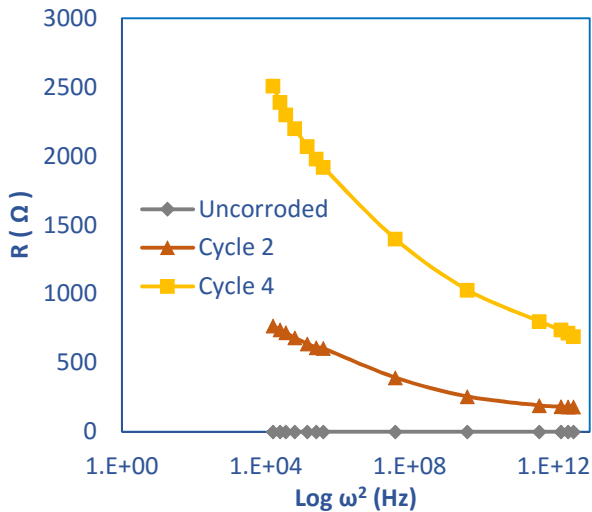


Figure 2 Real part of Impedance of the Steel specimen

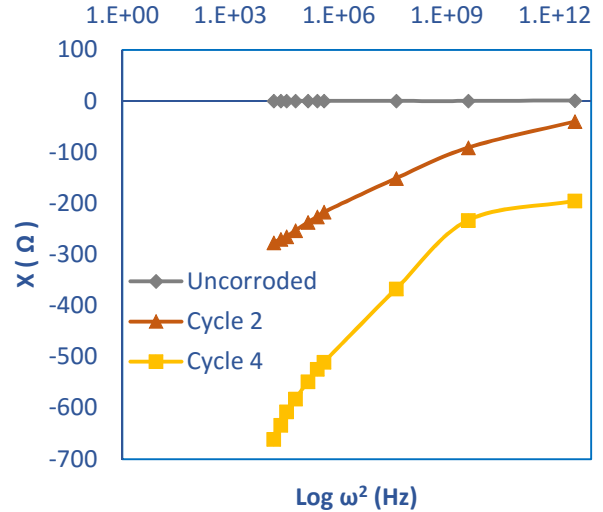


Figure 3 Imaginary part of Impedance of the steel specimen

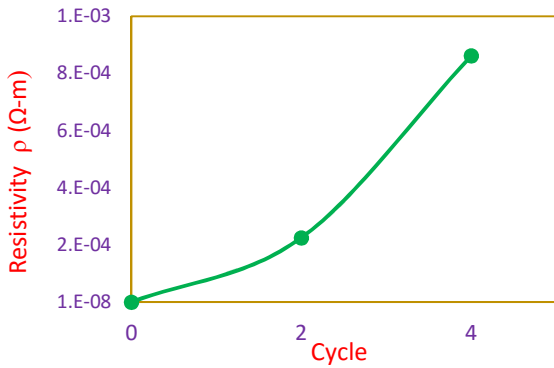


Figure 4 Resistivity of the Steel specimen

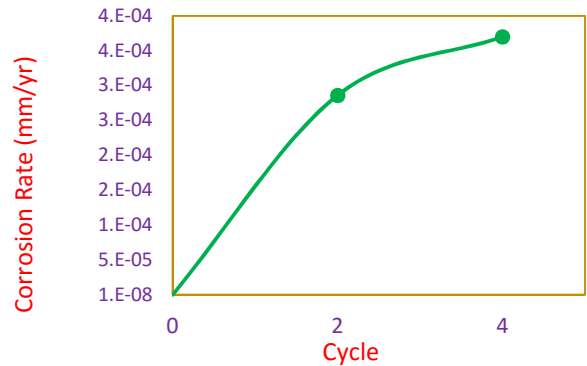


Figure 5 Corrosion rate of the Steel specimen

5. Conclusion: The corrosion of Low Carbon A1018 steel was detected using its impedance changes and this method was found more effective and sensing than regular corrosion rate measurement using weight loss and dimensional change.

6. Acknowledgement: This study was supported by the Texas Hurricane Center for Innovative Technology (THC -IT) with funding from DOE / NETL / RPSEA.

8. References: [1] Roberge PR., “Handbook of Corrosion Engineering”. New York: McGraw-. Hill, 1 P, 1999.