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Planning and Design of Corrosion Rate Equipment

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ABSTRACT

Corrosion is natural process that occurred in metal structure. In the planning of construction, metal is the important part of construction. Yet it is often, corrosion phenomenon occurred due to interface with corrosive environment. In the design process, it is need to consider the metal behavior on how much the corrosion rate occurred for a certain time in order to confirm the metal structure application. This equipment is built to support the knowledge of corrosion rate for metal. The experiment shows the result of three specimens regarding the corrosion rates. The corrosive condition is created to trigger the corrosion process where the comparison corrosion rate between sub-soil water and peat water contribute to significance impact of corrosion process.

KEY WORDS: *Corrosion, Rate, Water*.

NOMENCLATURE

MPY	Mills per year
W	Weight Losses (milligram)
A	Cross Section Area ($inchi^2$)
γ	Density ($gram/cm^2$)
t	Time (hour)
m	Meter

1.0 INTRODUCTION

Corrosion is a form of the natural deterioration of a material due to interaction with its environment. Corrosion is the main threat to the infrastructures and machines which impacts to costly service and repair. In the design of infrastructures or any other machine equipment, the material is selected which based on the durability of corrosion rate for a certain period of time. Corrosion rate depends on many factors, such as the material properties of metal. In order to acquire the accurate information dealing with corrosion rate of metal, it is needed to design an equipment to trigger the corrosion as chemical process for assessing the rate of metal corrosion in a certain time. It is clearly defined the objective by using this equipment, where the corrosion test produce results that affect material selection, equipment maintenance method, and corrosion control.

2.0 BASIC OF CORROSION

2.1 Corrosion

The term corrosion is used to describe the chemical reaction of a material interface with its environment that produces measurable changes and can lead to damage. The reactions are in general of an electrochemical can be approximately assumed:

Anode: $Fe \rightarrow Fe^{2+} + 2e^-$

Cathode: $O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$

The most common method for estimating the corrosion rate is to calculate the weight losses of a metal specimen. The weight of specimen is recorded during a certain period of time. The corrosion rate is obtained by dividing by exposed area, time, and density. The formulation can be defined as below (*Collins* 1994).

$$MPY = \frac{534\ x\ W}{\gamma . A . t} \tag{1}$$

2.2 Corrosion Factor

Corrosion is the most dangerous problem where occurs in the metal structures. One of factor contribute to corrosion process is the environment such material in the fresh water system. The freshwater can be defined as water with a salinity of less than 0.5 parts per thousand. Water is soft and acidic (pH < 7.0) tends to be more corrosive but generally the accepted measure for corrosion is the stability or saturation indices. An alternative to measure the corrosion is to test directly for specimen of corrosive water such as lead and/or steel.

The system's layout, operating condition and material construction should be considered due to contact with environment which causes to be corrosion in the design stage.

3.0 DESIGN MODEL OF CORROSION TEST

3.1 Flowchart

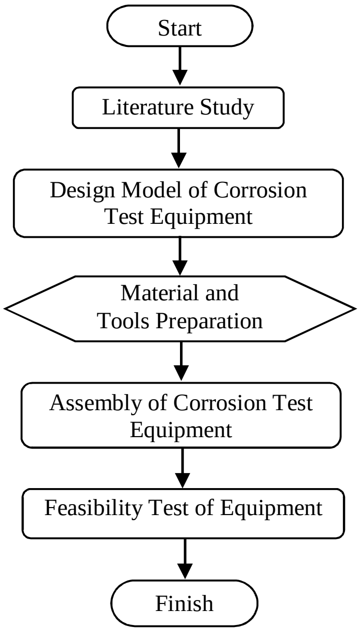

Figure 1: Flowchart of Corrosion Test Equipment

3.2 Assembling and Component Selection

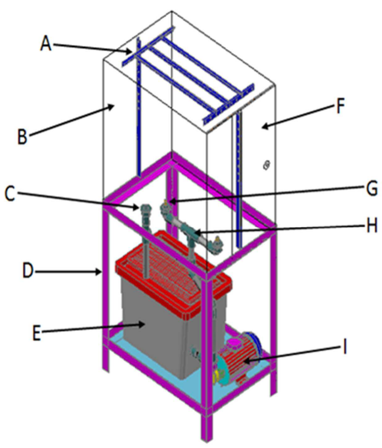

Figure 2: Component Lay-out of Corrosion Test Equipment

A. *Hanger for specimen*
B. *Chamber*
C. *Water outlet*
D. *Frame*
E. *Water Tank*
F. *Sliding window*
G. *Nozzle*
H. *Piping*
I. *Pump*

As shown in figure 2, the equipment consists of components such as pump, tank, piping system and two of nozzles. Pump is driven by electrical motor to result water pressure in conduit to flow the fluid. The piping system has internal pipe diameter of 23.4 mm and external pipe diameter of 26 mm, whereas the nozzles are located in the end of pipe as shown in figure 3.

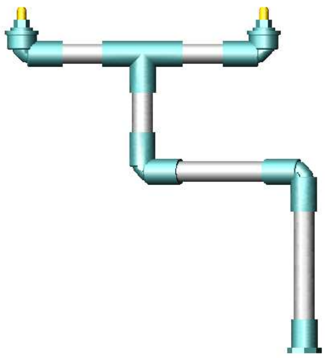

Figure 3: Piping System

The flow rate of fluid is 34 liter/min through a pipe and the velocity of nozzle orifice or water spray is 44.2 m/sec as shown in figure 4.

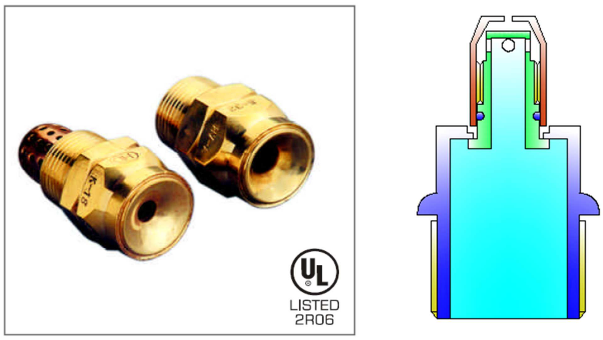

Figure 4: Nozzle

3.3 Experiment

Two of steel plates are prepared as specimen to conduct the corrosion test as to determine the corrosion rate and to observe the reliability this equipment. Two kind of fluid also are used as corrosion medium such as sub-soil water and peat water. In the experiment process, the water is atomized with high pressure through nozzle orifice to create a corrosive condition.

The specimen will experience the surface corrosion as shown in figure 5. The specimens are placed into the chamber without any loading subjected to the specimen.

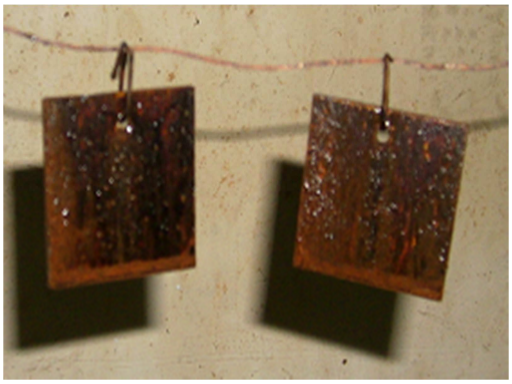

Figure 5: Specimen

4.0 RESULT AND DISCUSSION

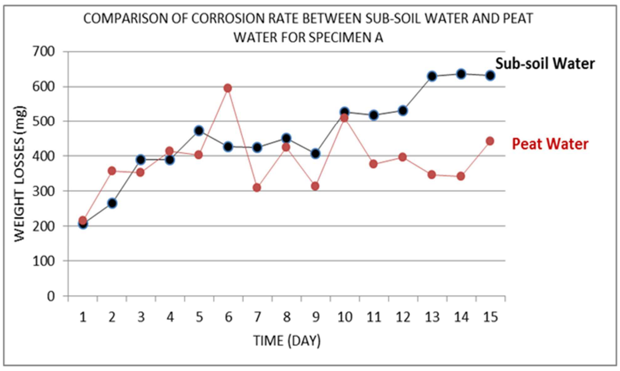

Figure 6: Corrosion Rate for Specimen A

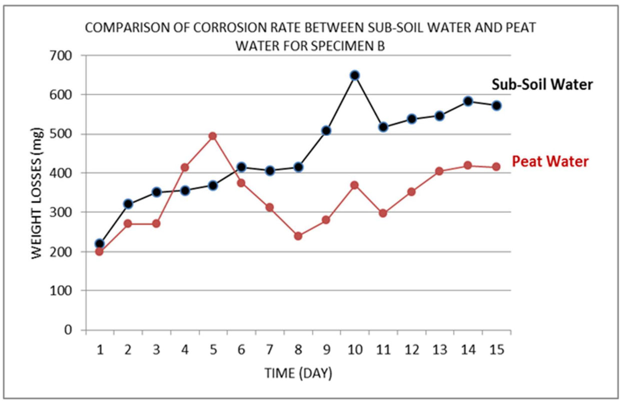

Figure 7: Corrosion Rate for Specimen B

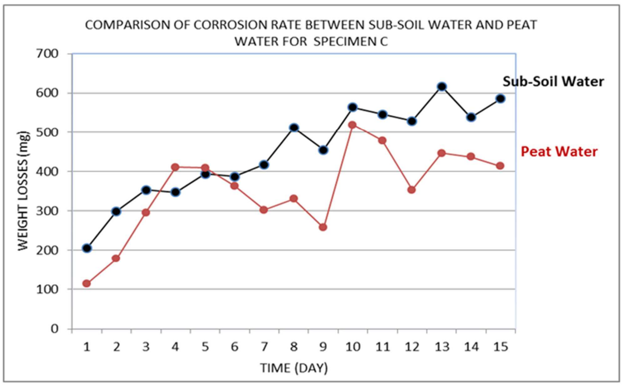

Figure 8: Corrosion Rate for Specimen C

As shown in figure 6, figure 7, and figure 8 indicate that the corrosion rate for each specimen A, B, and C are unequal for every condition. In the figure 6 and figure 7 show the comparison of corrosion rates in the first day which indicate the weight losses is equal. On the contrary, figure 8, for specimen C show the corrosion rates by comparing between sub-soil water and peat water which indicate different weight losses. It is can explained that the corrosion occurred is not spread evenly.

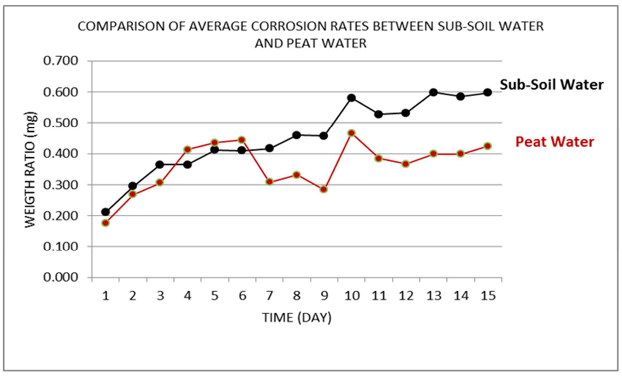

Figure 9: Average Corrosion Rates Ratio

Figure 9 shows the average corrosion rate occurring for testing period. Corrosion progress increase with variation but then the significant increase of corrosion progress occurred in the beginning start from first day to fifth day. By the increasing of time, the corrosion rate ratio will increase slightly. It means the corrosion rate of sub-soil water is greater than the corrosion rate of peat water. The different behavior of sub-soil water and peat water have many factor to influence the corrosion thus resulted in irregular corrosion progress. But the trend of corrosion is increase slightly.

5.0 CONCLUSION

In conclusion, the corrosion is triggered by using an equipment to support corrosion rate for metals. The equipment is designed and planned to ease in determination of corrosion rate. The corrosion rate calculation uses the common method namely the weight losses method. Three of specimen result the corrosion by using sub-soil water and peat water as corrosion medium. The corrosion rate is influenced by many factors with the result that the different corrosion rate ratio. The difference ratio occurred irregularly but the trend of corrosion increase slightly.

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