

CORROSION STUDY OF SS316L IN ENVIRONMENT SULPHUR ACID USING WEIGHT LOSS METHOD

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Abstract -- Application of SS 316 metal is commonly used as a building material in the chemical industry. This material is commonly used because it has good mechanical properties, corrosion resistant, but in reality, the SS 316 L metal can corrosive its acid environment, making it easy to solve the problem. corrosion. Therefore, this study is aimed to study SS316L corrosion level in H₂SO₄ acid by using weight loss method with 1 day, 3 days and 5 days immersion in H₂SO₄ environment with concentration 0,1 M, 0,3 M and 0,5 M The results showed that the corrosion rate increased with increasing concentration of H₂SO₄ and yield up to 5 days with average corrosion rate (CR) 2.729078 x 10⁻⁶ mpy. Morphological damage SS 316 L is demonstrated by SEM (Electron Microscope Scanning) there is a pitting corrosion on the metal surface

Keywords: SS316L; Corrosion; Corrosion rate; Weight loss

INTRODUCTION

Stainless Steel (SS) 316 L, is a corrosion-resistant alloy, widely used in chemical, fertilizer, food and beverage industries (Raharjo et al., 2015; Morena et al., 2015; Frangini and Zaza, 2011) and one of them is used as a material on bipolar plates in PEM fuel cell, with composition (16,2% Cr; 10,3% Ni; 2,06 % Mo; 0,033 %P; 0,021% C; 1,48% Mn; 0,43% Si; 0,43% Cu; balance Fe) (Shanmugham and Rajendran, 2015). Metal corrosion mechanism in an acidic environment, oxidation reaction (Yang et al., 2011):



where M is a metal element, Mn + is a metal ion and e is a free electron which is soluble in acid solution, whereas a reduced reaction can occur; $O_2 + 4 H^{++} + 4e^- \rightarrow H_2O$ (2)

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One reason is that most metals are always associated with open air where humidity and pollutant contents may affect metal leakages. Factors such as temperature, humidity and chemical content in the air determine the degree of corrosion (Bandriyana et al., 2014). Meanwhile, metal composition, metallurgical structure, and metallurgical processes also accelerate corrosion. Corrosion is a difficult metal problem, dangerous and very expensive if not treated. Generally, corrosion is a metal deterioration due to a reaction between metals and the surrounding

environments. The important types of corrosion are uniform, galvanic, crack, current-assisted, intragranular and high-temperature corrosions (Priyandoko, 2017; Azar et al., 2010; Fontana, 1998). Corrosion results from a low pH effect of water in which H⁺ ions react with electrons in cathodes. The factors that can cause corrosive metals are pH, oxygen content, air, metal and temperature (Raharjo et al., 2015; Vadivelan et al., 2015). Corrosion prevention in a metal can be done in several ways, such as cathodic protection, coating and can use also use inhibitor. Inhibitor use green is the new trend in corrosion control (Sutharssan et al., 2017; Abu-Dalo et. al., 2012). SS 316 L metal application is commonly Corrosion used as a building material in the chemical industry, material is commonly used because it has good mechanical properties, corrosion resistant, but in reality, SS 316 L metal can corrosive its acid environment, making it easy to solve the problem (Yang et al., 2011).

Therefore, this study is aimed to study SS316L corrosion level in H₂SO₄ acid by using weight loss method with 1 day, 3 days and 5 days immersion in H₂SO₄ environment with concentration 0,1 M, 0,3 M and 0,5 M The results showed that the corrosion rate increased with increasing concentration of H₂SO₄ and yield up to 5 days with average corrosion rate (CR) 2.729078 x 10⁻⁶ mpy. Morphological damage SS 316 L is demonstrated by Electron Microscope Scanning (SEM) there is a pitting corrosion on the metal surface.

The SS 316 L metal application is commonly used as a building material in the chemical industry, this material is commonly used because it has good mechanical properties,

corrosion resistant, but in reality, the SS 316 L metal can corrosive its acid environment, making it easy to solve the problem (Antunes et al., 2010; Feng et al., 2011). Therefore, this study is aimed to study SS316L corrosion level in H₂SO₄ acid by using weight loss method with 1 day, 3 days and 5 days immersion in H₂SO₄ environment with concentration 0,1 M, 0,3 M and 0,5 M. The results showed that the corrosion rate increased with increasing concentration of H₂SO₄ and yield up to 5 days with average corrosion rate (CR) 2.729078 x 10⁻⁶ mpy. Morphological damage SS 316 L is demonstrated by SEM (Electron Microscope Scanning) there is a pitting corrosion on the metal surface.

METHOD

The method used in this research is, by weight loss method from SS316L test sample with surface size 1cmx1cm immersed in H₂SO₄ acid solution with concentration 0.1M; 0.3M and 0.35M in immersion time 1 day, 3hari and 5 days, then weighing the initial weight and after immersion to get the value of weight loss, the corrosion rate can be calculated by the following equation (Sumarji, 2012; Ornelasari, 2015).

$$\text{Corrosion rate (CR)} = (K \cdot W) / (A \cdot T \cdot D) \quad (3)$$

where:

K = constant corrosion rate (5,44 x 10⁻²)

T = immersion time (hour)

W = weight loss (gr)

D = Density (g/cm³)

A = surface area (cm²)

The morphology and surface of 316L stainless steel specimens were examined after polishing and after explore to 0.5 M Sulphur acid (H₂SO₄) using scanning electron microscopy (SM).

RESULTS AND DISCUSSION

Weight Loss Method

Based on the result of research of SS316 L metal after soaking in an environment of sulfuric acid (H₂SO₄) with concentration 0,1 M, 0,3 M and 0.5 M at soaking for 5 days have highest average weight loss equal to 0,0062 gram, 0,0052 gram, and 0.0160 gram. Based on the calculation of the average value of corrosion rate is increasing along with the increase of the concentration of sulfuric acid (H₂SO₄), for more details can be seen the difference of weight loss at different concentration of H₂SO₄, as seen in Fig. 1.

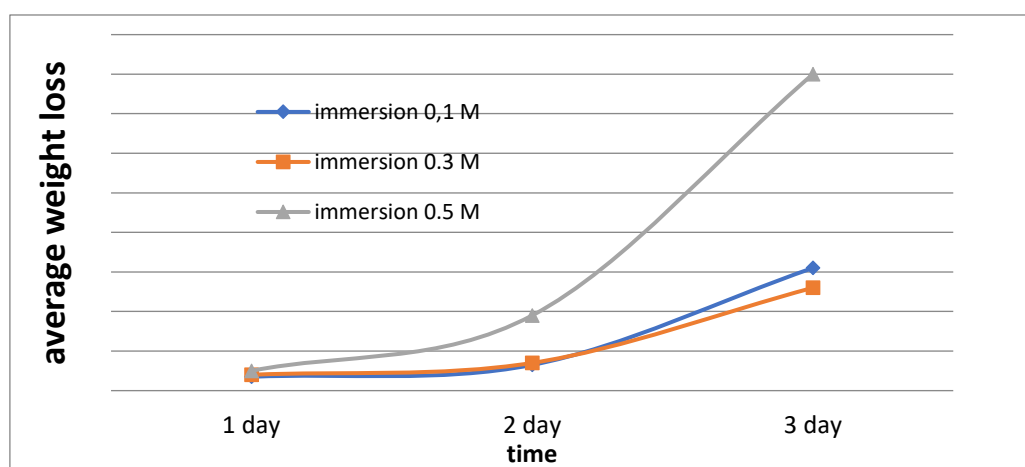


Figure 1. Graphs Weight loss of SS 316 L in H₂SO₄ environment against immersion time

The result of corrosion rate analysis (CR) using SS 316 L method in H₂SO₄ environment showed increasing of H₂SO₄ concentration and the longer the immersion was obtained, the corrosion rate value was increasing, the biggest

value was at the concentration of 0.5 M H₂SO₄ and the immersion time for 5 days 2.729078 x 10⁻⁶ mpy as shown in Fig. 2. This happens because the SS316L metal has been oxidized and corrosion due to the presence of a corrosive acid solution.

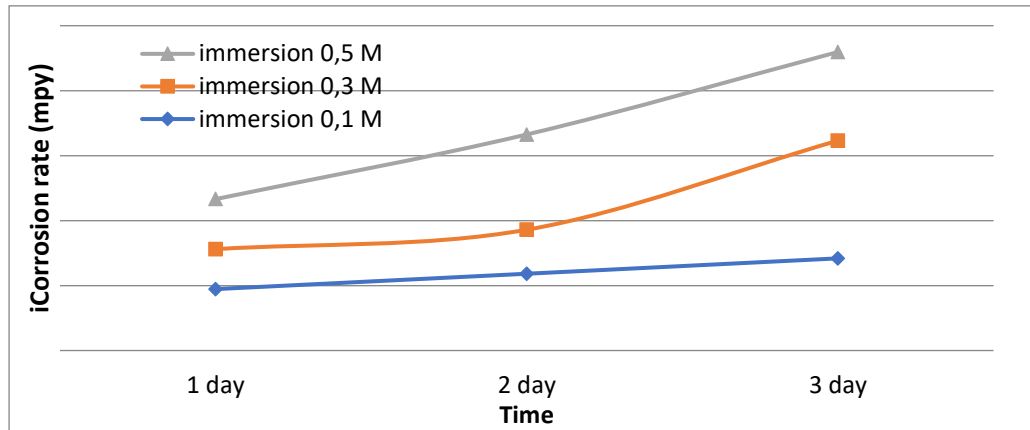


Figure 2. Graph SS 316 L corrosion rate in the H₂SO₄ environment against immersion time

To see the surface morphology of the SS 316L test material before soaking and after soaking 5 days (120 hours) it is seen that the immersion test material as shown in Fig. 3, shows that the surface has not yet detected corrosion damage which looks subtler than the test material after immersion.

holes in certain areas that have been oxidized in advance of the possibility of this occurring because locally in the initiation of damage or defects of the metal, so that the local first suffered damage due to the environment H₂SO₄ is corrosive, whereas in certain local locale is still passive as able to see in Fig. 4.

Metallic surfaces in certain locales are damaged by passive layers in the form of pitting

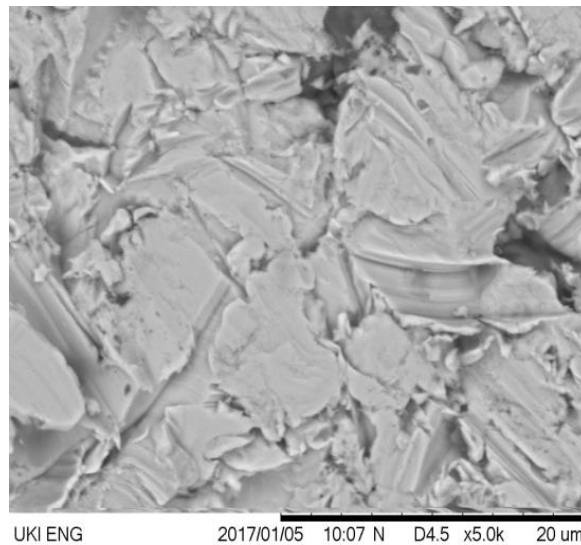


Figure 3. Photo SEM surface morphology SS136L without immersion 0.5 M H₂SO₄

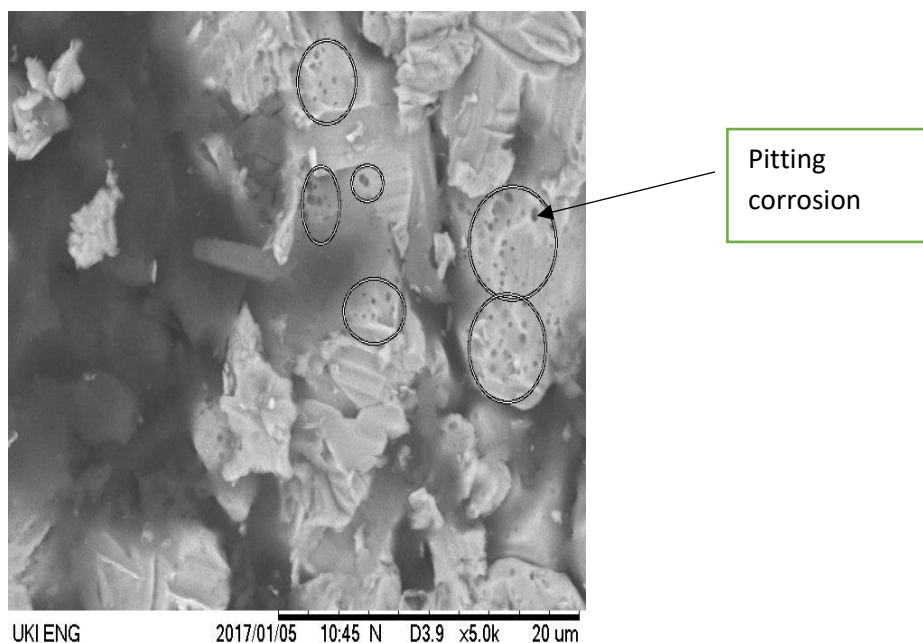


Figure 4. SEM photo, surface morphology of SS316L, with immersion of 5 days in 0.5 M H₂SO₄

CONCLUSION

Result of analysis of SS316L using weight loss method and SEM (Scanning Electron Microscope) got the value of corrosion rate (CR) SS316L after immersion with sulfuric acid (H₂SO₄) with concentration 0.1 M, 0.3 M and 0.5 M which has the biggest corrosion is 1.055319×10^{-6} mpy and immersion time for 5 days with a concentration of 0.5 M. while for the smallest corrosion rate of 1.41844×10^{-7} mpy, the longer the immersion time will get the value of corrosion rate is increasing. Using the SEM device with 5000x magnification can see the surface morphology of the SS316L test material immersion value of corrosion that will occur will be marked by the presence of local blasting corrosion of the metal surface, it indicates that the local defect on the metal surface will be the first corrosion and corrosion to rise with an increase sulfuric acid concentration.

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