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Improvement of Electrical Characteristics of Electrochemical Cells made from Sea Water Using Electroplating Method of Cu (Ag)-Zn Electrode as Renewable Energy Source

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Abstract. The electrical characterization research of electrochemical cell based seawater by using electroplating Cu-Zn electrode with Ag (Cu (Ag)-Zn) has been done. Measurement data is performed to determine the voltage at no load and with the 12 V 3W LED and lamination load. The measurement results were compared with electrochemical cells using Cu-Zn Electrodes without electroplating. Sea water that has been used has a salinity level of 3.5% which has three times the screening process. Measurement data has been taken every hour for 72 hours by refilling sea water every 24 hours. The average voltage drop for electrodes without electroplating is 0.03%, whereas for electrodes with electroplating is 0.01%. The lamination difference is up to 72 hours which is 4 times brighter than Cu-Zn without electroplating process.

1. Introduction

Water is the most abundant resource on earth, where three-fourths of the planet's surface is covered by water. About 97% of the earth's water is saltwater in the ocean, and 3% is fresh water [1]. The use of sea water as a source of electrical energy has not been utilized optimally. The existence of electricity from sea water is a potential and inexpensive solution for the need for lighting around the coast where government electricity is difficult to access. Energy from seawater can be obtained through water waves [2], and the electrochemical method is by dipping a pair of metal materials as electrodes that have different voltaic series metals.

Analysis of the electrical characteristics of seawater as a source of renewable electric energy has been carried out using three electrode variables, namely C-Zn, Cu-Al, and Cu-Zn [3]. The results of this study indicate that the Cu-Zn pair is able to produce more electricity than the other electrode pairs.

In general, corrosion occurs between metal surfaces with oxygen, but corrosion can also occur between metal material submerged in sea water (5.42×10^{-5} mm / year) [4]. The reaction of NaCl and H₂O on the surface of Cu plate gave rise to the corrosion of Cupric Chloride (CuCl₂), where the high Cl concentration in the solution can cause serious corrosion [5]. Although cupric chloride is an inhibitor [5], it can reduce the electrical power (even stop) produced by cells due to obstruction of electrons to the surface of the electrode. So that the problem of generating electricity from seawater



electrochemistry is not only in the selection of electrode pairs (Volta series) but also in the amount of corrosion on the surface of the electrode.

Electric current flows through the surface of a conductor so as an attempt to enhance the potential difference is to replace Cu with Ag through a coating method. Plating method is carried out using electrical methods, heat or bath [6]. This method is certainly much cheaper than made with a pure Ag electrode pair, which of course costs become more expensive. Besides that the use of Cu is a step to make Ag coating more adhesive [7].

2. Materials and Methods

The procedure in this study consists of two stages: First, the tool is designed with a closed system consisting of 20 electrochemical system cells. The volume of sea water in each cell is 200 ml, each cell is connected in series. The seawater used has a salinity level of 3.5% and has undergone three filtering sizes of 1 micron. The main frame is made of acrylic material with a thickness of 3 mm. Second, electrochemical systems using Cu-Zn electrode pairs and Cu (Ag) -Zn electroplating results. Before electroplating, Cu is first washed with a solution (20% HNO₃) [6]. The size of each electrode is 4x7cm and a thickness of 3 mm. Each test is carried out with a 12 V 3 watt LED load for 3 x 24 hours. Measurements are carried out every hour for 72 hours by refilling sea water every 24 hours. Voltage measurements are carried out when the load is connected (Vb) and when it is not connected (Vbl) to the seawater electrochemical system. Measurement of LED illumination (lux) is carried out at a distance of 10 cm.

3. Results and Discussion

3.1 No-load Resistance voltage measurement

No-load measurements are taken once every hour. The load connected to the output terminal is then removed, and then the voltage measurement is directly carried out at the output terminal. After the measurement is carried out, the load is connected again. Measurement graph in the following figure 1.

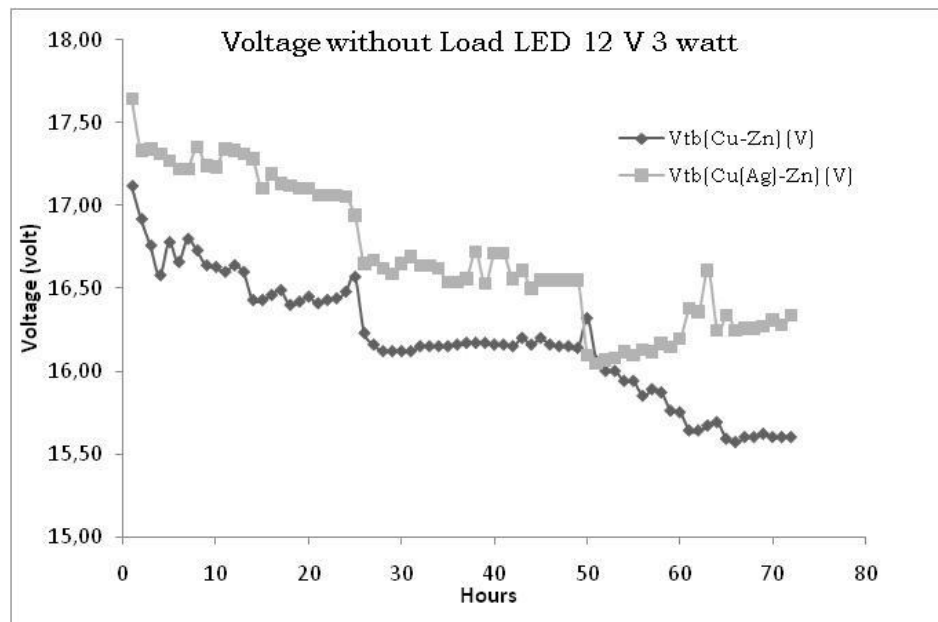


Figure 1. Voltage measurement without resistance load

Based on the graph of figure 1, at the beginning of the voltage measurement it can be seen that the voltage generated by the Cu-Zn and Cu (Ag) -Zn pairs is quite high and produces almost the same voltage. This is due to the condition of the plate is still very clean and still not contaminated by the

appearance of corrosion due to the reaction between sea water (NaCl) and Cu. The longer the condition of the plate surface, the more impurities so that it inhibits the transfer of electrons from the solution to the surface of the electrode. The presence of these impurity particles does not occur significantly to the voltage generated when refilling on the second and third days. The measurement results show that the voltage generated by Cu (Ag) -Zn electrode is always greater than the Cu-Zn electrode pair voltage. This is due to the fact that Ag has the ability to improve the electrical properties of materials [8]. On the third day the output voltage at Cu-Zn dropped significantly. Based on previous research that the Cu-Zn pair was unable to produce stress again on the fourth day. This does not apply to Cu (Ag) -Zn pairs, the voltage remains stable for longer. The average voltage drop for electrodes without electroplating is 0.03%, whereas for electrodes with electroplating is 0.01%.

3.2 Load Resistance voltage measurement

The following is a measuring measurement when given a 12 V/3 W LED load. The voltage is measured when the load is connected to the load.

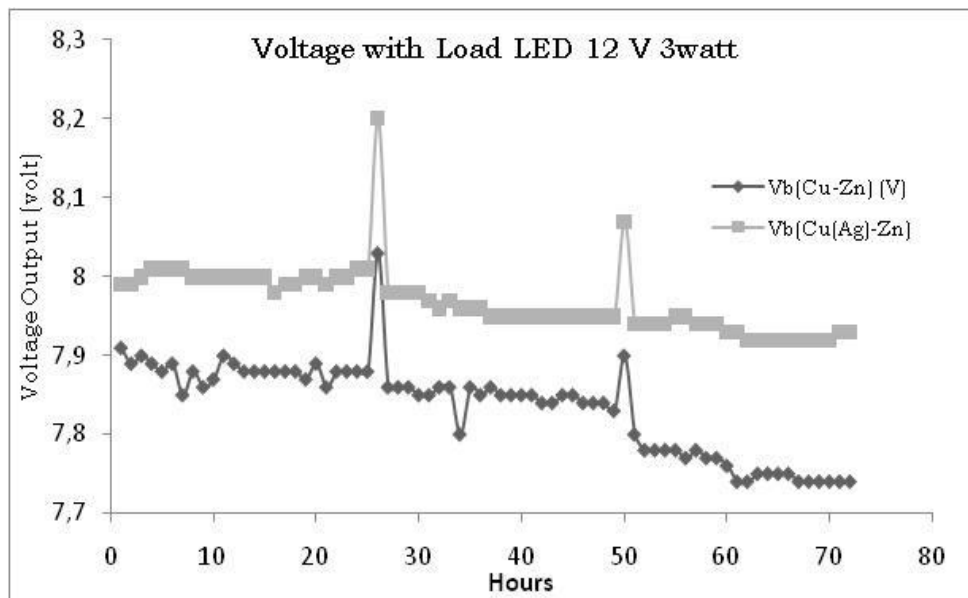


Figure 2. voltage measurement graph with resistance load

The graph in figure 2 above is the voltage measured at the resistance load when installed. The measured voltage is in the initial range of 8 volts. These results indicate that Cu (Ag) -Zn electrodes are able to show more stable results, even more than 3 days. While the measured voltage in the Cu-Zn pair decreases and then runs out. Two pieces of peak voltage are voltage conditions when changing sea water. The smaller the measured voltage is due to the smaller voltage generated by the cell (figure 1). the voltage will be divided by the internal resistance in the electrochemical cell. internal Cu-Zn cell resistance is increasing every time [3]. There is a voltage difference in the internal resistance of electrochemical cells. This shows that electrochemical cells are not yet completely perfect like most batteries. So that further efforts are needed to modify electrochemical cells.

3.3 Lumination Measurement

Lumination measurements are carried out to see how far the voltage generated is directly generated at a load, in this case a 12 volt 3 watt led. The following figure is a graph of lumination measurements on these loads.

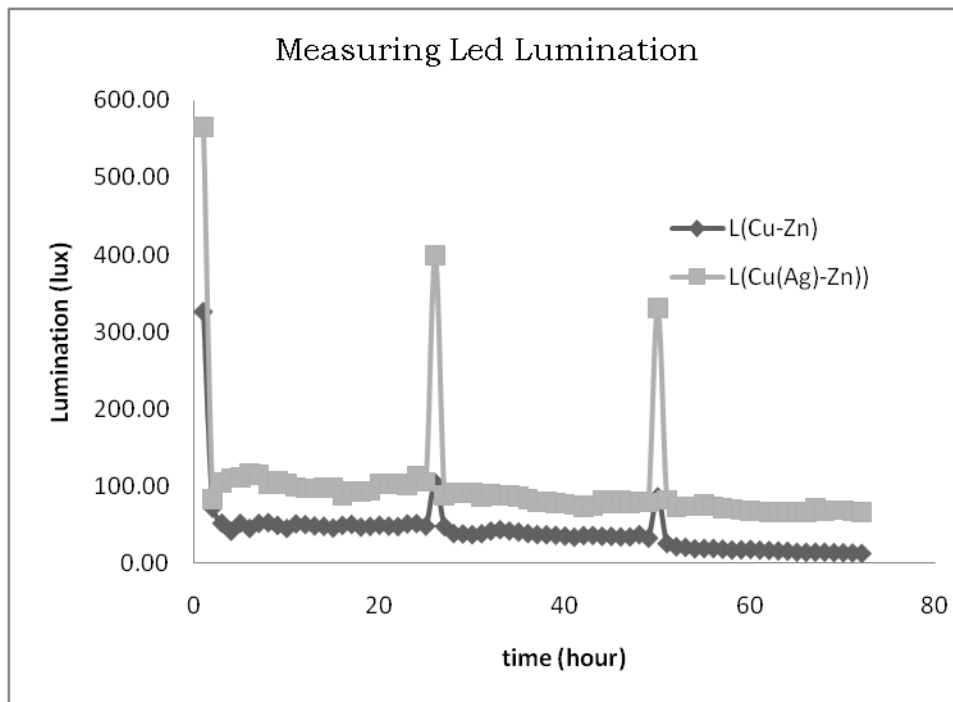


Figure 3. Lumination measurements on both electrode pairs

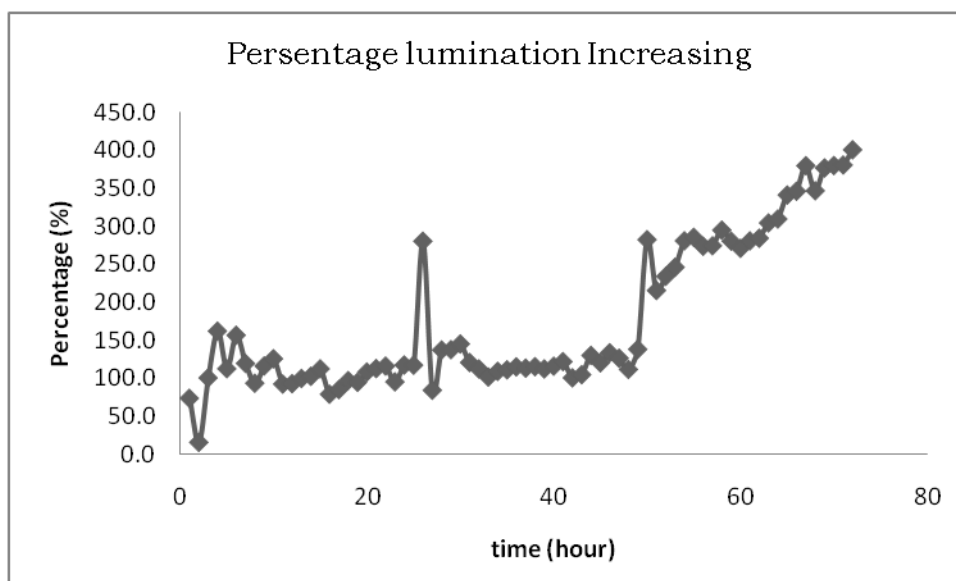


Figure 4. Percentage increase lumination in Cu (Ag) -Zn and Cu-Zn

4. Conclusion

Electrochemical cell research with Cu (Ag) -Zn electrode showed better performance compared to Cu-Zn electrode. Increases are found at no-load stresses and with loads. The resulting led lumination showed that the Cu (Ag) -Zn electrode was four times brighter than without electroplating.

Acknowledgment

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