MIRJO VOL. 1, ISSUE 1, PP. 9-13, MAY 2016 eISSN 0127-6271

MALTESAS Multi-Disciplinary Research Journal (MIRJO)

www.maltesas.com

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Effect of Electrode Size on Salinity-voltage Correlation

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Abstract. Malaysia is facing an energy crisis as local resources are depleting and there is a need to find alternative sources in order to overcome the shortcoming electricity crisis. Several researchers have initiated an investigation on the feasibility of salt as sources to generate electric. However, the study on the characteristic of salt as electric source has not well documented. Hence, this study investigated the correlation between salinity and electric voltage as well as the effect of electrode size on produced voltage. Based on the results, the generated voltage was linearly increased with the increased of salinity but significantly independence with the sizes of electrode used. The finding could be useful such as a guideline to develop a saltwater electric supply or to develop salinity measurement equipment in a liquid.

Keywords— *salinity, alternative power, electrodes, electricity.*

INTRODUCTION

Malaysia is facing an energy crisis as local resources are depleting. Oil, gas and coal currently constitute 94% of the total energy generation mix [1] but the rising demand of electricity and these natural will eventually extinct, therefore there is a need to seek power supply sources diversification as dependency on imported fuels increased, and those imported fuels are getting more expensive [1]. Electricity demand in Malaysia is on the rise, having gone from a weekly peak demand of 14,245MW in the last quarter of 2009 to 15,476MW in May 2011 [1][2]. This is expected to rise to be more than 16,000MW in 2012, and to 20,847MW in 2020 and will continue to grow by about 3% every year until 2030 when it will reach 24,770MW.

Therefore, unlimited source such as solar and wind to generate electricity is in demand. However, harvesting solar and wind power has several drawbacks like expensive and high maintenance system and not all place are suitable for solar and wind setting. We have to look for other alternative to tackle the forthcoming electricity crisis.

Salt is alternative source of electric power. Several researchers such as [3][4] have started to investigate the feasibility of salt as a source to generate electric. As in [3], salt is reported to be promising as alternative to lithium for rechargeable battery and [4] reported that the mix of freshwater and saltwater could generate electricity. We know that salt acts as an electrolyte to bring electrons from anode to the cathode. Salt molecules are made of sodium and chlorine.

However, the correlation of salinity and electricity has not been well documented up till now. No report has been written to mention how much salt is needed to produce 1 V of voltage for example. In [5] we have started the investigation on the correlation between the salinity and voltage. In this study, we continue the investigation by evaluating the effect of electode size over the produced voltage value. In parallel, we will developed a measuring system in order to ease the visualisation of the salinity-electric power measurement and recording since we know that the electric power that been generated from salt electrolysis is very small.

This paper is organized as follows: in section 2, the description of the details experiment is explained. In section 3, the obtained results are presented and in section 4, results are discussed and conclusion is given.

METHODOLOGY

We study the effect of electrode size on salinity-voltage relationship by using similar electrolysis circuit as shown in Fig. 1. The system contains electrolysis circuit; two electrodes and saltwater in a jar. Coarse salt is used in this experiment as it produces more voltage than white salt as reported in [5]. Each increment of salt in grams is dissolved in 1 liter of distilled water. In every increment, new set of water, salt as well as the electrode is used. This is to ensure reliability of the measurement. The electrode is made from aluminium and copper. 4 sizes of electrode were investigated, i.e., 3x3 cm^2, 5x5 cm^2, 7x7 cm^2 and 9x9 cm^2. The voltage is measured by using voltmeter.

RESULTS

In general, it can be seen that the produced voltage increased with the increment of salinity. With respect to 3x3 cm^2 size of electrode used, 10 gram/liter of salinity produced 0.38 V and the value had increased until 0.62 V at 460 gram/liter (g/l) of salinity. From this density of salt onwards, no increment of voltage was observed as shown in FIGURE 2. With 5x5 cm^2, at 10 g/l salinity, the obtained voltage was 0.41 V. The highest voltage obtained was 0.89 V and voltage reach a constant state at 60 g/l of salinity onwards, refer to FIGURE 3.

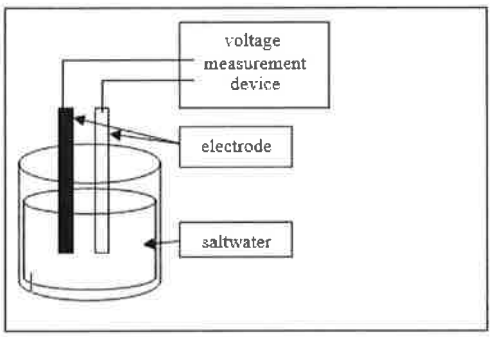

FIGURE 1. Experimental setup

When the 7x7 cm2 of electrode size was used, the voltage did not increased started at 59 g/l salinity onwards and the highest voltage obtained is 0.93V. With 9x9 cm^2, the highest voltage obtained was 0.94 V and voltage began to unchange at 50 g/l of salinity onwards, see Fig. 5.

By using individual Mann–Whitney U tests ($p<0.05$), the correlation between salinity and voltage for the electrode of size 5x5 cm^2, 7x7 cm^2 and 9x9 cm^2 was not different significantly . However, they were different significantly with the reading of 3x3 cm^2.

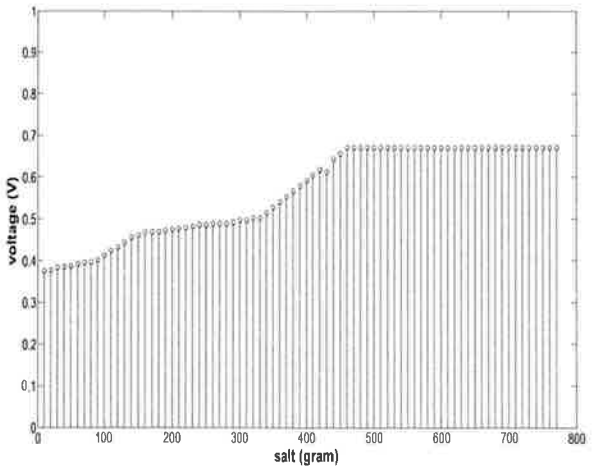

FIGURE 2. Voltage obtained with increment of salt in 1 liter of water with electrode size of 3x3 cm^2

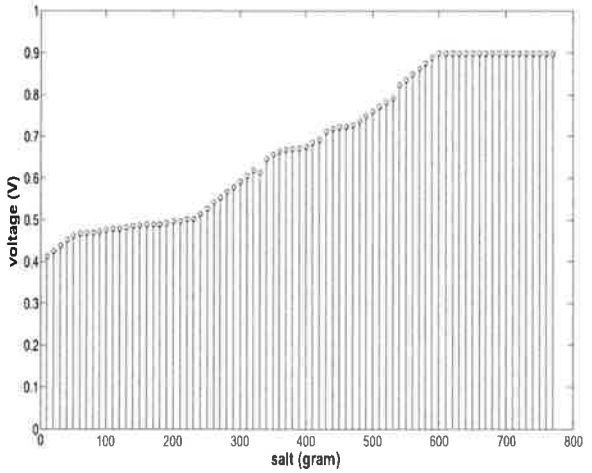

FIGURE 3. Voltage obtained with increment of salt in 1 liter of water with electrode size of 5x5 cm^2

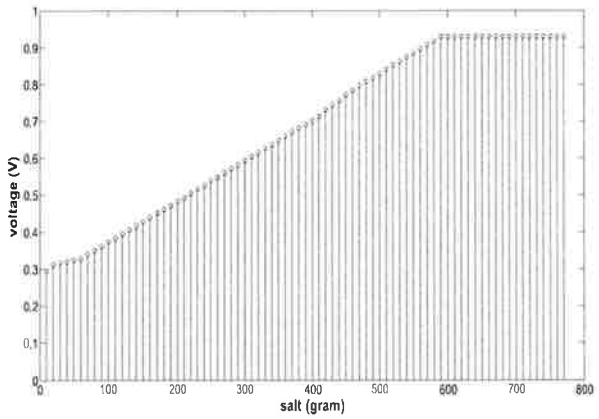

FIGURE 4. Voltage obtained with increment of salt in 1 liter of water with electrode size of 7x7 cm^2

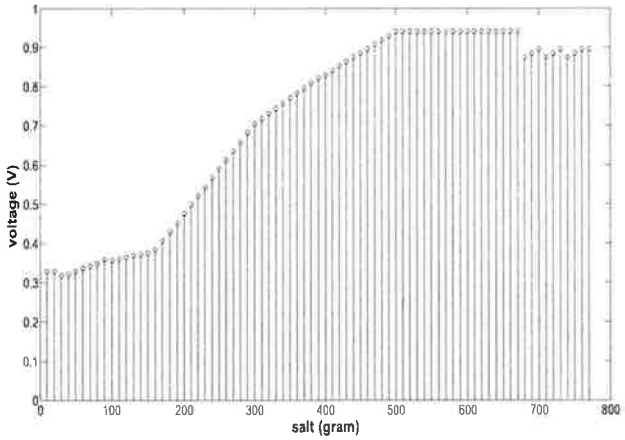

FIGURE 5. Voltage obtained with increment of salt in 1 liter of water with electrode size of 9x9 cm^2

DISCUSSION AND CONCLUSION

Salt water (NaCl) contains ions: sodium (Na+) and chloride (Cl-). The salt acts as a conductor to carry charge through the salt water. Copper serves as a source of electrons and denoted as cathode. In the salt water, the copper (Cu) donate electrons : Cu(s) -> 2e- + Cu2+(aq). At the anode (aluminum) 2 chloride ions (Cl-) will each surrender an electron to the anode (which likes electrons because it is positively charged) to form a molecule of chlorine gas: 2Cl-(aq) -> Cl2(g) + 2e-. At the negative electode (cathode) hydrogen ions (H+) from water pick up electrons to form hydrogen :2H+(aq) + 2e- -> H2(g) and the copper ions (Cu2+) which were mobilised from the anode also pick up electrons to form metallic copper which is deposited on the cathode, Cu2+(aq) + 2e- -> Cu(s). These electrons movement produced current. For further explanation of electron movement in salt water, see [6].

In the previous study [5], we have introduced our preliminary results research on the feasibility of salt to generate electricity. In this paper, we investigate the effect of electrode size on the correlation between salinity and

generated voltage. Based on the results, we have found that the generated voltage is linearly correlated with the salt density in the water and will reach a constant voltage at some level of salinity with all evaluated sizes. From [6], the current does not depend strongly on the concentration of salt, despite the increased conductivity for stronger salt solutions. The conductivity of saltwater is at a maximum for a 12% solution by weight. Increasing the amount of salt increases the conductivity, but the rate of reaction is limited by the amount of oxygen in the solution.

With respect to the size of electrodes, in particular between the electrolysis setup with 5x5 cm^2, 7x7 cm^2 and 9x9 cm^2 electrodes, the correlation between salinity and voltage was not different significantly. Therefore, it has no effects to the voltage produced. However, the value of voltage with 3x3 cm^2 electrode was less than the other electrodes. This could suggest that the relationship between electrode size and the produced voltage is not linear or exponentially increased. Nevertheless, more experiment need to be done (by reducing the size of electrode) to verify this suggestion.

This study has documented that salinity_voltage has linear relationship and up to some value of salinity, the produced voltage will reach saturation point. In addition, the size of electrodes could affect the produced voltage. These findings could be used as a foundation to develop the salt electric power and as well as a sensor system for salinity in sea water or liquid.

For future study, we will investigate other types of salt and other size range of electrodes.

ACKNOWLEDMENT

The author would like to thank to Ministry of Science, Technology and Innovation for the financial support under research grant (SCIENCEFUND/06-01-14-SF00090 L00017). Special thanks to the Universiti Teknikal Malaysia Melaka students and staff for their participation in this study.

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