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RECHARGEABLE ALLUMUNIUM ION (Al-ion) BATTERY WITH BASIC MATERIAL ACTIVATED COCONUT SHELL CHARCOAL

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Abstract

This study aims to know the tecnique of making of rechargeable Al-ion battery with basic material activated coconut shell charcoal and to know the best composition of materials to produce optimum potential (V) and current (mA). The working principle of battery using electrochemical process to produce potential (V) and electric current (mA). In wich principle is indeed involves only the transport of elecrtons beetween two electodes separated by a conductive medium (electrolyte). There are two electrodes used in which aluminum as anode undergoes oxidation reaction and graphite as cathode undergoes reduction reaction. The optimum composition in the production of Al-ion batteries with basic marerial activated coconut shell charcoal is 7,5 grams activated coconut shell charcoal, 2,5 grams polypyrol catalyst (MnO2), and NaCl 4,5 %. This composition produce 2,05 mA at the first hours as optimum current capacity the first hour of 45 mA because the remaining wet condition of electrolyte at this point allows the electrons to move easily. For the value of the optimum voltage in the last hours is a discharge voltage of 2,05 volts and superfast charging time is only one minute.

Keywords: *Rechargeable aluminum-ion battery, activated coconut shell charcoal, potential, electric current*

1. Introduction

Energy have important role in every aspec of life. Supply demand energy always rice make the decrease of fossil energi source. In 2012 the demand of electricity in Indonesia up to 174 Twh, increase 10,1 % compare the needs of last years demand. In one side, Indonesia is a country that have a lot of natural resaurce, but unfortunetely that source have not explort much as renewable energy source (Ministry of Energy and Mineral Resources, 2013).

Long time scientist try to develop renewable energy source, one of them is battery. Therefore in reality conventional battery that we usw this time contain of hazarous material like mercury, nitrat, cadmium, and nickel that can effect environtmen contamination. Furthermore the development of battery technology is continue to produce for better quality product. Li-ion battery that many use on phone battery only give power about 2 until 4 hours on laptop. This situation uncompareable to advances of technology that develop so fast. Beside of that Li-ion less save because flammeable or end explode.

To overcome that problems researche is needed to develop nature friendly battery, savety, and fast charging. So this research we try to develop an rechargeable Al-ion battery with basic material coconut shell charcoal. The speciality of Al-ion battery is on superfast charging, low flammability, and for a new inovation we use the coconut shell as base material because it natural friendly and Indonesia having the most coconut plantation in the world with about 2.920.665 ton in 2015 (Directorate General Estate Corps, 2016).

Al-ion battery are composed of two electrodes (anode and cathode) connected by an ionically conductive material called an electrolyte (Armand, 2008). The working principle using electrochemical process to produce electrical energy. The aluminum metal in this battery system will experience anoxidizing reaction by generating $Al_2Cl_7^-$ and electron. The movement of electrons to the cathode will produce electrical energy (Modesto

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&Julie, 2007). In this research aluminum metal serve as anode on this battery, so this battery is name as an alumninum ion battery. Teoritically, voltage value outcome by each kind of battery will be defferent according to the type of metal used as anode. This different is based on the standart potential energy value of each metal (Vicenzo & Benedetto, 2014). Rechargeable batteries based on aluminum are attractive alternatives to those based on conventioal chemistries because of the high charge storage capacity, relatively low cost of aluminum, and Al is the most abundant metal in the earth's crust (Hudak, 2013).

In this research composed to develop Al-ion battery is aluminum as anode, graphite as cathode, and mixing activated coconut shell charcoal with polypyrrole catalyst (MnO2) and salt solution (NaCl) as electrolyte pasted. The testing of electrical energy from rechargeable Al-ion battery is potential (V) and electric current for 5 hours in a row. The result is the best composition Al-ion battery is 7.5 grams activated coconut shell charcoal, 2.5 grams polypyrole catalyst (MnO2), and NaCl 4.5 %. This composition produce 45 mA at the first hours as optimum because the remaining wet condition of electrolyte at this point allows the electrons to move easily. For the value of optimum voltage is a discharge voltage of 2.05 V and superfast charging time is only one minute.

2. METHOD

2. 1. Material

Material is used in this research is aluminum foil, graphite, activated coconut shell charcoal, polypyrrole catalyst (MnO2), Natrium Clorida (NaCl), aquadest, LED light, cable, electric switch, tissu, pipe, box acrylic.

The research title depeloving rechargeable of Al-ion battery with basic material coconut shell charcoal using electrochemical process to produce potential (V) and electric current (mA), used to electrodes include aluminum as anoode undergoes oxidation reaction and graphite as cathode undergoes a reduction reaction. The methode used in this research begins with preparing materials and equipments which will be used in this research. The research use activated coconut shell as basic material to make Al-ion battery. Activated coconut shell pounded until smoot, than do to making rechargeable Al-ion battery.

2. 1. Designing Battery

This step contais all procedures in designing rechargeable aluminum-ion battery based activated coconut shell charcoal which are as follow :

1. Making salt solution (NaCl) with composition 2,5 grams, 3,5 grams and 4,5 grams in 0,1 L aquadest, then they are dissolved to form 2,5 %, 3,5 % and 4,5 % of NaCl
2. Making electrolyte for battery use activated coconut shell charcoal with composition:

a. 7,5 grams activated coconut shell charcoal, 2,5 grams polypyrrole catalyst (MnO2), and NaCl with concentration 2,5 %
b. 7,5 grams activated coconut shell charcoal, 2,5 grams polypyrrole catalyst (MnO2), and NaCl with concentration 3,5 %
c. 7,5 grams activated coconut shell charcoal, 2,5 grams polypyrrole catalyst (MnO2), and NaCl with concentration 4,5 %

3. Each composition of the above electrolyte mixture is then mixed becoming homogeneous to a concentration of 25%.
4. After all tools and materials have been prepared, the next step is designing rechargarbe aluminium batteries in which aluminium foil as anode and graphite as cathode with tissue as separator of both electrodes.

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2. 2. Tecnique to Making Rechargeable Al-ion Battery

Figure 1. Making the electolyte of battery

Figure 2. Put electrolyte and positive electrode (graphite) on separator (tissue)

Figure 3. Rolled up to form cylinder

Figure 4. Aluminum foil coating

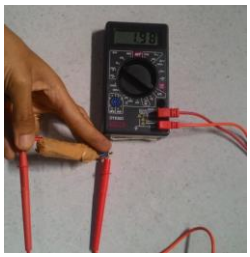

Figure 5. Measuring potential (V)

Figure 6. Measuring current (mA)

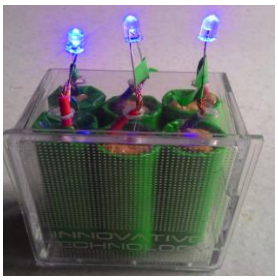

Figure 7. Perform test of battery

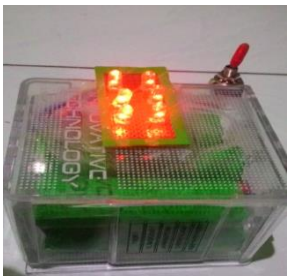

Figure 8. Final product of battery applying for LED light

2. 3. Function Test

Function test is testing stage using digital multimeter to know potentian (V) and current electricity (mA) at rechargeable Al-ion battery with basic material coconut shell charcoal.

2. 4. Performance Test and Collecting Data

Performance test is testing stage using loads with adjustable voltage and current to determine whether the reahargeable Al-ion battery is capable of working or not. Performance test used LED light which loads 3 V. An Al-ion prototype battery have potencial 1,52-2,05 V bigger than an AA conventional battery that we use. Two pieces of Al-ion batteries assembly as series to light up an LED lamp. Furthermore to produce brighter light 6 alluminioum ion batteries assembly as series to light up 6 LED lamp wich pararelly assmbly. Next phase Al-ion battery charge. The gattering potential data and current Al-ion battery must be done for every electrolite variation and potencial test and current generated for 5 hours in row.

2. 5. Data Analysis

The step for data is to analyze the data from examination and measurement in making this product. The data in the nexy step is connected to literature study and theories related to the phenomenon in the potential and current chart that the produced by rechargeable Al-ion battery.

3. Results and Discussion

The research of developing rechargeable Al-ion battery with basic material activated coconut shell charcoal is use three electrolyte sample were use where the first electrolyte consisted of mixture of 7.5 grams activated coconut shell charcoal, 2.5 grams polypyrrole catalyst (MnO2), and 2.5 % NaCl. The second electrolyte comprises a mixture of 7,5 grams activated coconut shell

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charcoal, 2.5 grams polypyrrole catalyst (MnO2), and 3,5 % NaCl consentration. The third electrolyte a mixture of 7,5 grams activated coconut shell charcoal, 2.5 grams polypyrrole catalyst (MnO2), and 4,5 % NaCl consentration.

The result is the best composition to produce optimum potential and current was obtained in third electrolyte sample as shown in Table 1

Table 1. The avarege value for potential and current at rechargeable Al-ion battery

Electrolyte	Potential (V)	Current (mA)	Optimum value	
			Potential (V)	Current (mA)
I	1.72	25	2.05	45
II	1.98	32		
III	2.05	45		

In third elecrolyte sample, the optimum potential value reaches 2,05 V with a current is 45 mA. The main condition to produce voltage is on potential difference on both electroda. According Armand et,all (2008) The storage energy content of a battery be maximize by having a large chemical potential difference between the two electrodes. Potential differences happen because the differences number of electron produce from electrochemistry proscess. Electric current from the number of capacity caused by electron movement which produce from electrochemistry proscess.

The results of potential data and current Al-ion battery must be done for every electrolite variation and potencial test and current generated for 5 hours in row shows in figure 1 and figure 2.

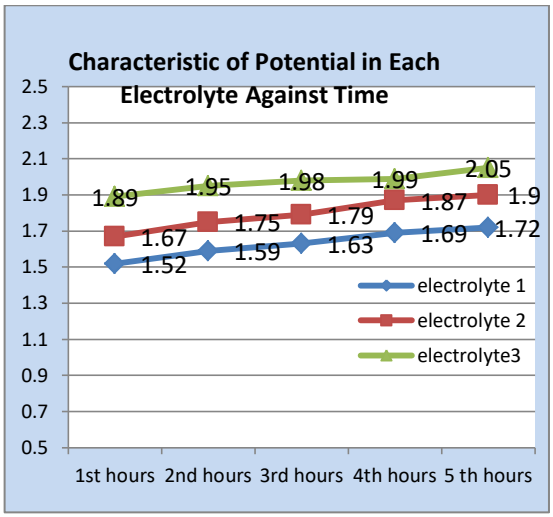

Figure 1. Chart Characteristic of Potential in Each Electrolyte Againts Time

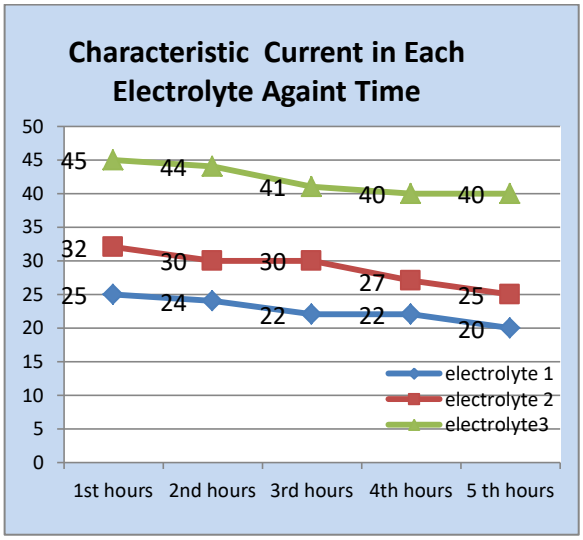

Figure 10. Chart Characteristic of Current in Each Electrolyte Againts Time

From the result of potential and current data Al-ion battery (see figure 9 and 10) it is found the optimum average is volt is last hours , while the average current in the first hour of the third electrolyte sampel with composition 7,5 grams activated coconut shell charcoal, 2.5 grams polypyrrole catalyst (MnO2), and 4,5 % NaCl consentration. Generally voltage phenomenon that happened every hour tend increase, but current value that

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produce tend to decrease because to produce stable voltage need some time in order electrochemistry balance work properly. Meanwhile the reason the decrease of current value tend to decrease cause by corrotion on anoda with electolyte so the ion production to produce electron decrease every huor. The other problem is the decrease of liquid electric composition used because already consumed to produce current on early proscess electrochemistry.

Electrolyte is important part in electrochemistry cell, but aluminum foil as anode is corroded by reaction between the electrolyte and the surface of the A-ion battery, and will also form a metal hydroxide coating. This causes the process of migration of metal ions to the catide will be inhibited and this causes decrease energy density battery life to be short (Mohammad, 2008, Gelman et all., 2015, Vicenzo et all., 2014).

To solve above the problem can use pure aluminum (99.99 %0 as anode material with a combination of metal Mg, Sn, In,and Ga. This metal can prevent corrosion and can also break the passive hydroxide layer aluminum. However, considering that pure aluminum is relatively expensive then the alternative that can be used is to add inhibitor or direct additive to the electrolyte or alternative solvents such as alcohol and ionic liquids (Egan et all, 2013)

4. Conclusion

Based on the result of the research and the description of the discussion that have been presented, it can be concluded that the best composition of materials to produce optimum potential and current of Al-ion rechargeable battery with basic material activated coconut shell charcoal is 7,5 grams activated coconut shell, 2,5 grams catalys (MnO2) and NaCl 4,5 % with the optimum current capacity in the first hour of 45 mA. This is mainly because at this point the electrolyte is still wet which allows the electrons to move. While the value of the optimum voltage in the last hours with a discharge voltage is 2,05 volts, and superfast charging time is only one minute.

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