ICMSE 2015
INTERNATIONAL CONFERENCE ON MATHEMATICS, SCIENCE, AND EDUCATION

IDENTIFICATION OF METAL ION CONTENTS IN RED CLAY SAMPLES OF GUNUNG PATI : A PART OF CLAY BASED BATTERY RESEARCH

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ABSTRACT

The red clay has characteristics of physical chemistry in which could generate electrical energy with the electrochemical method. Therefore, this research had purposes which were: 1. To Identify the metal ions in the red clay as generator of electrical energy . 2. Measure the voltages that were produced by 1 battery cell of red clay. The sample used was red clay procured from Cepoko village, Sub-district Gunungpati, Semarang. The land will be analyzed by using ICP AES in the Chemical laboratorium of Semarang State University. The results depicted that the red clay contained 22 types of metal ions. The largest consecutive metal ions contents were: aluminum (47.15 mg/L), calcium (18.55 mg/L), manganese (14.54 mg/L), magnesium (6.572 mg/L), sodium (1.329 mg/L), Hg (1.178 mg/L), and ferum (1.042 mg/L). The results of voltage that produced by 1 battery cell of red clay were by 1.03 volts on the first day and 0.75 volts in the day to 17.

Keyword: The red clay, Metal Ion, Electrode Cu and Zn, The electro chemical method.

INTRODUCTION

The population density of Indonesia gets higher per year, so the demand for electrical energy of each year is getting increased. Electrical energy is produced by resource extraction of coal miners and fossil fuels, which are not renewable energy. Coal miners and fossil fuel have existence age which would not be any longer. Before sources of fossils energy are used up, it is needed to be sought for renewable energy which is environment-friendly. Generally, renewable energy sources in the world consist of four basic elements of energy, which are water, wind, heat, and the land.

Three elements of energy has largely been harnessed as a basic foundation of the establishment of a new renewable energy. Those three new renewable energies which were the wind energy, water energy and heat energy. An example of energy that has been applied for instance: wind energy used for electricity in rural areas (Syahrul, 2008). Water energy has also been used for the realization of nano hidro in small discharge (Warsito , et al., 2011). Potential energy of ocean currents for the electricity in the coastal area (Yuningsih and Masduki, 2011). Heat energy was utilized to dry shrimp cracker up by using solar energy (Sumarno and Gatot, 2010), the conversion of electrical energy which comes from solar energy (Goddess and Antonov, 2013) and geothermal energy were utilized as geothermal electric power for example in Gedongsongo (Setyaningsih and Revelation, 2011)

There is an element energy that is not widely known and used which is the land energy. Until now, land energy has never been used as renewable electrical energy, because energy produced is small. The previous research on the red clay, that was about the content of colloids in red clay produces metal ions that has anions, causing cattion are attracted in colloids so that it can generate electricity (Kim, 2011). The red clays have characteristics of physical chemistry in which could produce electrical energy in electrochemistry. Thus, the purposes of this research are: 1. To Identify the metal ions in the red clay as producer of electrical energy . 2. Measure the voltages that were produced by 1 battery cell of red clay.

RESEARCH METHOD

The sample that is used is red clay which is procured from Cepoko village, Sub-district Gunungpati, Semarang. Analysis of the land will be done by using a

tool ICP AES in Chemical laboratory of Semarang State University. Procedures of research were in the month, February-March 2015.

In this study, tools and materials that were used such as: samples of red clay, standard solution of Fe of 1000 ppm, HNO^3 concentrated, HCL concentrated, distilled water. The tools that were used are: spectrophotometer of Absorbed Atoms, Hot plate, oven Fisher, micro Pipette, Pyrex, Pipette volume of pyrex, Pyrex glasses, eye dropper, pulp and filter paper: whatman No. 42, funnels, Bottle of distilled water, Spatula, pH meters, the porcelain cup, Lamps cathode Fe, furnaces, gas Argon HP, gas N_2 HP, HNO_3, distilled water, ICP AES Plasma. A new system ICP-MS made by SCIEX - Perkin Elmer, is equipped with computer system PE 5000, using operating XENIX with software facilities for quantitative analysis: Quantitative Analysis, the Total quantitative, Isotopic Ratio, Isotope Dilution, and facilities of Graphic Software used for qualitative analysis. On testing/measuring the voltage of 1 battery cell of clay, required multitester voltage digital gauges, and materials needed are: plastic containers measuring 1cm in diameter, with a length of 10 cm, electrode Cu and electrode Zn.

The way to determine the metal ions in the samples of red clay was acquired by destroying or destructing the land at the first time. The usual procedure was known as wet digestion. It needed about 5 grams of sample to be weighed then it can be evaporated in the oven with the temperature 105-110°C for 45 minutes. After that, samples got ashing in an oven for 8 hours at high temperature of 450°C to sample dried up. Then it continued to the process of wet destruction by dissolving samples in 20 milliliters of mixed HNO3- H2SO4 (3 : 1) on the temperature 100°C for 10 minutes. After it was done, samples were cooled for 10 minutes and added 2 milliliters of H202 30% dropwise. The heating process was continued slowly at a temperature of 200°C until a clear solution resulted. Dry destruction carried out by cremating the sample at a temperature of 400°C for 3 hours. Ashes obtained dissolved in 20 milliliters of HNO3 concentrated. Dissolution process was accelerated by heating on the temperature of 200°C to obtain a clear solution. Analysis of the metal ion content of the soil was done by flame atomic absorption spectroscopy (AES) after the results of soil destruction was completely produce sample solution of red clay.

The working process of ICP tool as follows: the sample solution was sucked and fed through the capilarry tube to the Nebulizer. Nebulizer changed the sample solution to the form of aerosol which was then injected into the ICP. In the plasma temperatures (around 6000-8000° C), samples will be atomized and excited. The excited atoms will return to its initial state (ground state) while emitting radiation. The radiation beam was dispersed by the optical components. The dispersed rays appeared sequentially at each wavelength elements and converted in the form of an electrical signal in proportion to the amount of light emitted by the element concentrations. This electrical signal was then processed by a data processing system (Amini, 1997). Limitations of these measurements was shown with a detection limit value obtained (Nugroho, et al., 2005).

One battery cell of the red clay was produced by making a plastic container with a plastic straw which had a diameter of 1 cm were cut into 10 cm. On one side of plastic straws were given plastic glue and on the other side were given glue when completed given an electrode and soil. Hereinafter, copper plate and zinc plate were cut with the size of each width 0.5cm and length of 12 cm. The battery cell was given electrode of Cu as a positive pole and the electrode of Zn as a negative pole, then filled in the soil into a plastic container. To be noted was ensured when put it that the electrodes did not intersect with one another in order to avoid short circuit. Each of one battery cell was filled of 5 grams of dried red clay, and given distilled water as the electrolyte of 2.5 ml. The procedure was accomplished by injected into the battery cell, and then measured with a digital multitester, as well as its development was observed every day for 17 days.

RESULTS AND DISCUSSION

ICP tool can detect 30 types of metals. there were 22 metal ions got involved in the content of metal ions in the red clay (Table 1). There were 8 metal ions that were not identified in the red clay which were lithium (Li), potassium (K), cesium (Cs), barium (Ba), zinc (Zn), arsenic (As), lead (Pb), and titanium (Ti). The highest metal ion content in a row on red clay as follows: aluminum (47.15 mg / L), calcium (18.55 mg / L), manganese (14.54 mg / L), magnesium (6.572 mg / L) , sodium (1,329 mg / L), Hg (1.178 mg / L), and ferum (1.042 mg / L). The data of content analysis from metal ion measurement by ICP tool is shown in Table 1.

Table 1. The content of metal ions contained in the red clay.

No	Metal Ion	Content (mg/L	No	Metal Ion	Content (mg/L
1	Li	0	16	Bi	0,013
2	Na	1,329	17	Cd	0,009
3	K	0	18	Co	0,241
4	Rb	0,607	19	Cr	0,026
5	Cs	0	20	Fe	1,042
6	Be	0,016	21	Ga	0,039
7	Mg	6,572	22	Hg	1,178
8	Ca	18,55	23	In	0,755
9	Sr	0,243	24	Mn	14,54
10	Ba	0	25	Ni	0,02
11	Al	47,15	26	Pb	0
12	Cu	0,113	27	Se	0,288
13	Zn	0	28	Ti	0
14	Ag	0,019	29	U	0,398
15	As	0	30	V	0,012

Inductively Coupled Plasma - Atomic Emission Spectrometer (ICP AES) Plasma 40 was a tool for analyzing metal elements in a material. The material which will be analyzed must be tangible homogeneous solution. There were about 30 elements can be analyzed using this tool. The advantages of this tool was very selective and can be used to measure multiple elements at once in sequence in each measurement (Nugroho, 2007). The general principle in this measurement was to measure the intensity of the energy / radiation emitted by elements that are changing the energy levels of atomic excitation or ionization (Phillips, 1989).

The result of mineral measurements in the red clay was shown that it was composed by such kinds of cations, those are Al 3+ = 47.15 mg / L, Mg 2+ = 6.572 mg / L, Fe = 1.042 mg / L, and Ca2 + = 18.55 mg / L (Table 1). This red clay minerals that can be substituted by isomorphous can produce electricity because the clay-containing colloidal particles which are very fine generally negatively charged. The mineral metal ion of this clay consisted of cations composition of Al 3+, Mg 2+, Fe 2+, Fe 3+, and Ca2 + are also contained in the clay by (Sugahara, 1988) and (Kim, 2011).

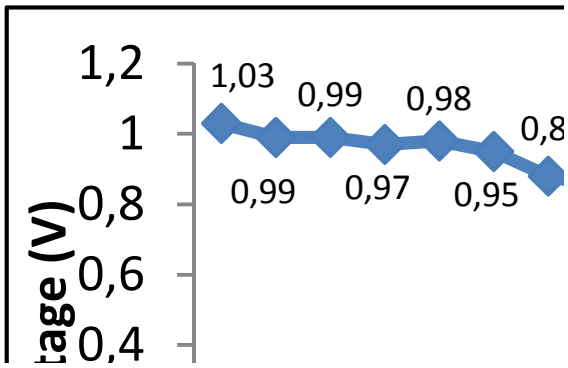
On the red clay soil as the ICP analysis results was containing metal ions which have electrical conductivity, namely Fe (1.042 mg / L) and Mn (14.54 mg / L) (Table 1), in the soil. Research by (Sujuan, et al. 2014) said that the metal ions in soil have electrical conductivity in metals Fe and Mn.

Fe 2+ ion of 1,042 mg / L had low ionic conductivity caused a decrease in electrical conductivity in the soil. This means that if the content of Fe 2+ ions was low, then it will affect the electricity generated to be low. The Fe content of metal ions was including the largest value from the other metal ions which are Al, Ca, Mn, Mg, Na, and Hg (Table 1). Then the ionic conductivity in the red clay was not so low that can generate electricity. The research by (Dong et al, 2014) also assumed that if the Fe 2+ ions affect the ionic conductivity that can cause a decrease in the electrical conductivity of the soil, so that the electricity generated was low.

According to information from various references (Sugahara, 1988), (Kim, 2011), (Sujuan, et al. 2014), (Dong, et al. 2014), (Mendez, et al., 2011) stated that the metal ions which play a role in generating electricity on land, namely: Al, Mg, Fe, Ca, Mn, Na, Hg, Ni, K, and Pb. Eight of the 10 metal ions were mentioned in the references contained in the red clay which has been investigated. There were two metal ions that were not contained in the red clay that were K and Pb. Therefore, the metal ion content in the content of red clay that can generate electricity were Al, Mg, Fe, Ca, Mn, Na, Hg, and Ni.

The result of the experiments came from 1 battery cell of red clay, obtained large voltage tended to decrease. The following measurement data from 1 battery cell of red clay without any burden, the result of measurement voltage was measured for 17 days, can survive with a large voltage which was generated was shown in Graph 1.

Graph 1. The measure of voltage generated by one battery cell of red clay.



In the first day, it generated electricity of 1.03 volts. It didn't happen in the second day decreased by 0.044 volts (0.99 V). The third day was the same in voltage 0,99V until the sixth day the range of 0.95 V, up and down just a difference of 0.01 V. Then decreased on day 7 of 0.07 V to 0.88 V ie up to day 10 by 0.82 V. It decreased by 0.79 V in day eleven. However, on day 12 increased by 0.16 V is 0.95 V. In day 13 decreased again by 0.12 V is 0.83 V . The graph tended increasingly lowering at day 14 of 0.67 V, and rose again on day 15 of 0.09 V is 0.76 V. However, it declined 0.02 V is 0,74V in day-16, then the voltage ie an increase of 0.01 V to 0.75 V. This means proved that the red clay can produce electricity. Mains voltage on red clay has decreased due to one battery cell reaction occurs that shows loss of electrons or electron reaction showed gains.

Oxydaton $Zn\ (s)$: $Zn^{2+}\ (aq) + 2\ e^-$
Reduction Cu^{2+} : $Cu^{2+}\ (aq) + 2\ e^-$ x $Cu\ (s)$

The chemical reaction that occurred in these lands battery cells occurred spontaneously generate voltage DC power.

CONCLUSION

Based on the analysis results of ICP, there were 22 types of metal ions as the content of metal ions in the red clay. Metal Ions that can produce power those were Al, Mg, Fe, Ca, Mn, Na, Hg, and Ni. The measures of voltage that produced by 1 battery cell of red clay were by 1.03 volts on the first day and 0.75 volts in the day to 17.

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