The use of physically activated and soil composed bentonite as environment friendly for grounding resistance

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The use of physically activated and soil composed bentonite as environment friendly for grounding resistance

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Abstract. Grounding resistance of the earthing system is affected by soil resistivity. Soil resistivity should have a high-water content (moisture) inside the ground. Soil moisture can be made and maintained by substance addictive that can absorb water in vicinity. This research uses bentonite as an additive. It has undergone the heating process in different temperature and duration before used, thenbentonite is mixed into the soil with the different composition. Those treatments are categorized as physics-activated. The aim of this research is to analyze the effect of bentonite in order to reduce soil resistance. The grounding resistance is observed with and without bentonite. The earthing system with bentonite as addictive has the smaller grounding resistance than that without bentonite. The biggest percentage of reduction in grounding resistance are 74% due to bentonite which is activated at temperature 2000C. Non-activated bentonite can achieve 68% reduction in grounding resistance. In contrast, the composition of 50% non-activated bentonite and 25% soil can reduce the grounding resistance by 69%.

1. Introduction

Grounding system is being used for protecting devices that use electricity as their power source. Grounding system is also an important part that has to be concerned to guarantee safety and reliability of a electrical system. One good grounding system can reduce or even completely eradicate the loss that may occur by interferences [1].

Factors that are affecting soil resistance are kinds of soil, salt concentration, soil temperature, and soil humidity [2]. Soil humidity affects soil resistivity; the more humid the soil, the less it's grounding resistance. Soil humidity can be made by adding additive substances that absorb liquid and gas. The substances could be either gypsum, charcoal powder, salt, zeolyte, or bentonite [3].

In this research, additive substance that is being used is bentonite. Bentonite is one additive substance that may absorb water and hold it in long time [4]. Bentonite also has electrolyte substance. This research is being done by physically activating the bentonite. Physical activation is meant to enhance some special properties of bentonite by eradicating pollutants and evaporating water that is trapped in bentonite's pores. Bentonite that has been activated is being used for 1 driven rod method of grounding system to be examined in the soil. To measure the value of soil resistance, method that is being used is using earth tester with "3-points" method. Measurement is being done 3 times a day.

Physically activated and soil composed bentonite is expected to be able to reduce grounding resistance. It can used as a guide to design a better Grounding system.

2. Research Methods

2.1. Bentonite

Bentonite is basically a kind of clay that mostly consisted of montmorillonite with minerals such as quartz, calcite, dolomite, feldspars, and other minerals. Montmorillonite is a part of smectite, known as Al2O3.4SiO2.H2O. this is how bentonite looks like.

Figure 1. Bentonite

Bentonite can absorb water and hold it in its structure, because in montmorrilonite thera are several layers; they are clays that consist of tetrahedral and octahedral and also interlayers where water absorbtion happens. Inside this interlayers, there are water molecules and cations [5].

This research uses Na-Bentonite type, that can expand up to 8 times of its original size when sank to water and still being dispersed while in water. When it is dry, it is white andcream colored, but it turns glossy when it is wet. Comparison between Na+ cation and Ca+ cation is relatively high, and its coloidal suspension has 8,5-9,8 of pH [6].

2.2..Experimental setup

Bentonite has to be activated and processed before being implemented. Activation is one of treatment upon chemical substance that is meant for enlarging pores by preventing hydrocarbon bond or oxidating surface molecule so that the substance is physically changed.

Physical activation process that is being used in this research is by heating the substance or usually called calcination. Calcination is a process which heating until reaching predetermined temperature, but is still below its melting point in order to eliminates the volatile content. The activation process in bentonite will affect the physical properties of bentonite, the increased surface area of bentonite contact caused by the opening of bentonite pores covered with impurities in the form of water, air, and acid. This proves that dehydration has resulted in cations on the surface of unprotected bentonite and released so that bentonite physically becomes more active [7].

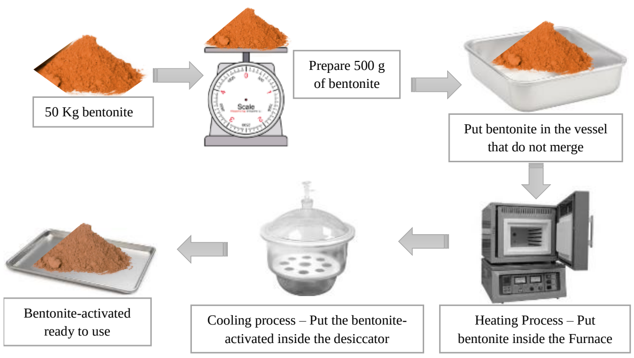

Figure 2. Physics-Activation Process

3. Result and Discussion

This research begins with the creation of a hole and continued by activating the bentonite. Total holes for this research are 9 holes with a depth of each hole 1 m and a diameter of 10 cm, which can be seen in Figures 3 and 4 with the function of each hole.

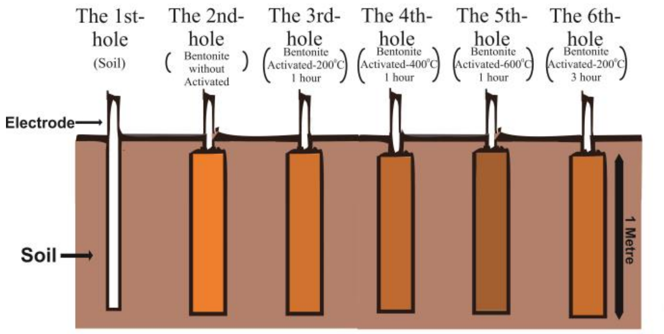

Figure 3. Visualization for Grounding Testing 1

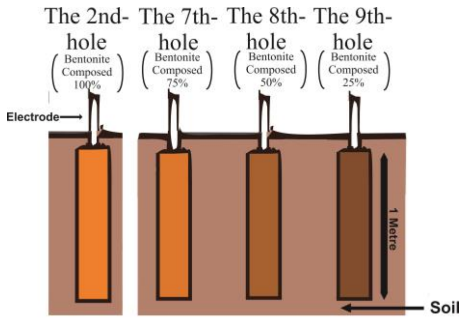

Figure 4. Visualization for Grounding Testing 2

3.1. Grounding Measurement Result

1. Testing 1
   a. Activation with Temperature Variation

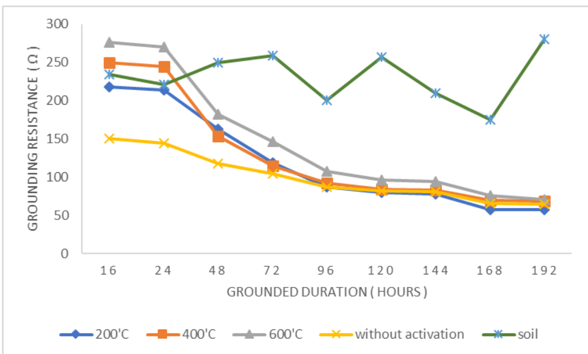

Figure 5. Temperature-Variation Graphic based on Measurement Result

In Figure 5 shows the difference between the grounding resistance before given by bentonite, after given bentonite without activation and after activation. The grounding resistance prior to bentonite has a very fluctuating value as shown in the graph, whereas the value after and before activated has a fairly stable degradation value, but no significant difference in grounding resistance between bentonite without activation and after activation.

b. Activation with Heating Duration-Variation

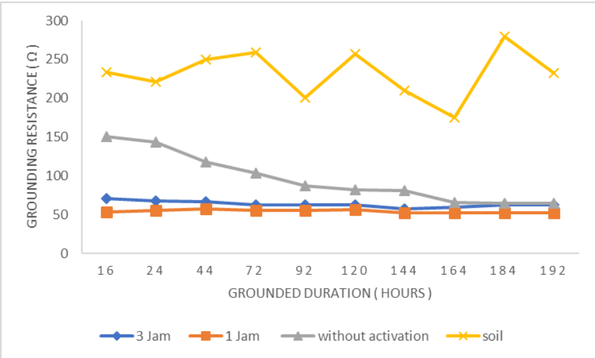

Figure 6. Heating Duration-Variation Graphic based on Measurement Result

The grounding resistance prior to bentonite has a very fluctuating value, while that value after activated and without activated has a fairly stable degradation value, but no significant difference in grounding resistance value between bentonite without activation and after activation.

2. Testing 2

Testing 2 is an examination with the addition of bentonite composed with soil to see the impairment of earthen resistance values. In Testing 2, bentonite that is being used is un-activated bentonite.

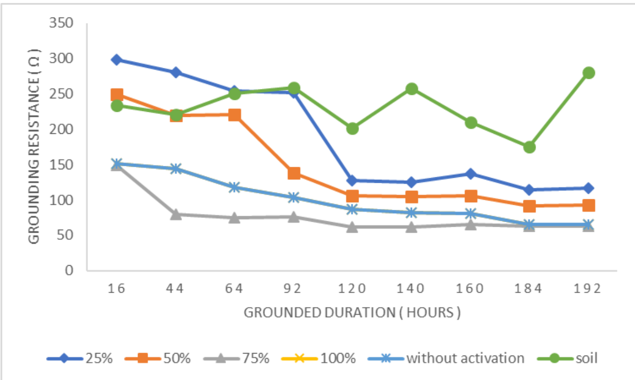

Figure 7. Soil Composition with Bentonite-Variation Graphic based on Measurement Result

In Figure 7 shows the difference in the value of grounding resistance after being given bentonite composed with soil and ground only. The value of grounding resistance prior to the grounded soil-bentonite has a fluctuating value as shown in Figure. 7, while after given 25% and 50% soil-

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bentonite is shown to be stable after 112 hours of planting time and the 75% ground-based bentonite represents a Stable value after 40 hours of planting time, then for 100% bentonite has a fairly stable value.

3.2. Percentage Grounding Resistance Improvement

Measuring the value of grounding resistance for about 1 week for each treatment of bentonite, then calculate the percentage change of earth resistance with the equation.

$$R = \frac{R_X - R_Y}{R_X} x\ 100\% \qquad (1)^{[8]}$$

Where,

R_X = grounding resistance without bentonite
R_Y = grounding resistance with bentonite

The value of the grounding resistance used in the percentage calculation of change is the final measurement value because the value of the grounding resistance is stabilized.

Table 1. Percentage Grounding Resistance Improvemen for Testing 1

	Grounding Resistance (Ω)	Percentage Grounding Resistance Improvement (%)
Soil	206	-
Bentonite without activation	65	68%
Bentonite activated-200'C	53	74%
Bentonite activated-400'C	68	67%
Bentonite activated-600'C	76	63%
Bentonite activated-200'C (3 hour)	63	69%
Soil composed with Bentonite- 25%	130	37%
Soil composed with Bentonite- 50%	97	53%
Soil composed with Bentonite- 75%	63	69%

Based on the calculation result from Equation 1, the percentage variance of the highest value of grounding resistance obtained by ground with activated bentonite with the heating temperature of 200^0C equal to 74%, when compared with the ground without activation of percentage value of the variance of earth resistance there is no significant difference. Thisoccurred because the impurities on the pores of bentonite do not all undergo evaporationafter they are heated. The bentonite used in this research has a very small powder size, because of that and the overheating temperature makes a lot of bentonites damaged and unable to absorb minerals around the soil when planted on the ground after being activated.

Variance percentage of the highest grounding resistance value for Testing 2 obtained by ground with 75% soil composition bentonite equal to 69%, if compared with bentonite 100% composition. it has a variance percentage value of grounding resistance which is not much different, but better than ground given Bentonite composed 50% and 25% with soil. This occurred because both processes still have a large enough soil combination that affects the deterioration of the grounding resistance and also the ability of bentonite to absorb water and retain water in its structure.

3.3. Scanning Electron Microscope (SEM) Analysis

SEM is an electron microscope used to investigate the surface of a solid object directly. The results obtained are bentonite powders having a non-homogeneous structure with each other. The sampled bentonite in the SEM test has a diameter range of 9.381 μm to 26.80 μm.

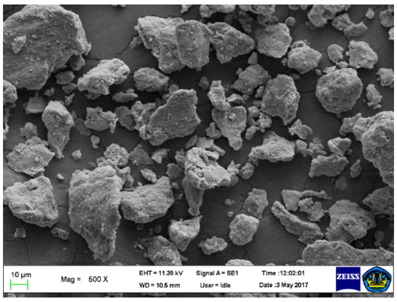

Figure 8. SEM Testing Result with 500 Magnificaton

Figure 8 shows clearly the size of the diameter and extent of the pores of one of the measured particle powders and such pores as forming a fairly symmetrical pattern. The magnitude of the pores of bentonite has a diameter that varies with a range of values of 574.3 nm to 670 nm. Figure 9 is the result of SEM test with 2 μm resolution and magnification 7,000 times with work distance which is still equal to 10,5 mm.

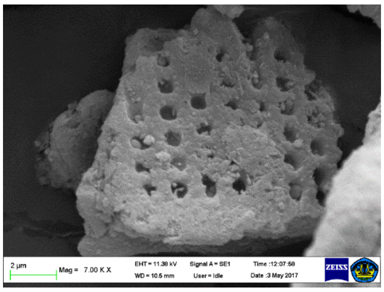

Figure 9. SEM Testing Result with 7.000 Magnificaton

Figure 10 shows the results of a SEM test of one of the other particulate powders measured and no pores in the bentonite powder. Figure 10 is a SEM test result with a resolution of 2 μm and magnification of 2,000 times with a work distance of 10.5 mm.

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Based on the previous analysis, the physical activation process has no significant effect on the impairment of earth earthing values. This is clarified by the results of testing bentonite samples with SEM. Based on Figures 9 and 10, there are bentonite particles that do not have pores so that although the bentonite is physically activated, it is unable to absorb water in the absence of pores. The more bentonite particles that do not have pores then the process of physics activation on bentonite does not bring a significant effect on the impairment of grounding resistance.

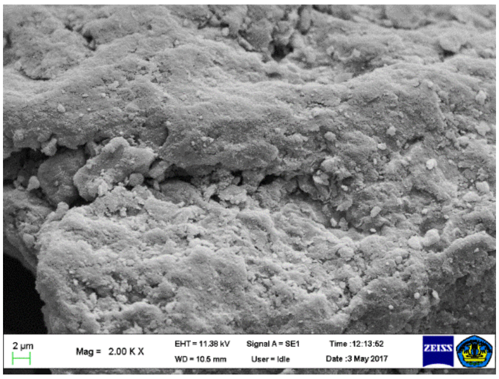

Figure 10. SEM Testing Result with 2.000 Magnificaton

4. Conclusion

Based on the measurement of the value of grounding resistance with activated and composition ground-based bentonite, it can be obtained some conclusions as follows :

1. Activated bentonite with 200^0C heating temperature is able to lower the earth resistance value better than the activated bentonite with a heating temperature of 400^0C and 600^0C with each stable grounding resistance value rated 53 ohms for temperature 200^0C, 68 ohms for temperature 400^0C and 76 ohms for temperature 600^0C.
2. The duration of the heating activation process does not affect the decline in the value of the grounding resistance. The value of grounding resistance using activated bentonite for 3 hours has a value of 63 ohms while for earth-activated bentonite for 1 hour has a smaller earth earthing value of 53 ohms.
3. 75% bentonite with soil is able to lower the grounding resistance better than the 50% and 25% bentonite grounding with each stable grounding resistance value rated 63 ohms for 75% bentonite, 97 ohms and 130 ohms respectively for soil composition with Bentonite 50% and 25%. While the 100% bentonite composition yields a grounding resistance value of 65 ohms.
4. Some bentonite particles do not have pores to absorb water, so for this type of bentonite, the physics activation process does not significantly influence the effort to decrease the value of grounding resistance.

5. Acknowledgment

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