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Electrical Conductivity in Soil

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Abstract: Renewable energy is one of the methods to solve pollution problems. Pollutions leads to greenhouse effects, deforestation and thinner ozone layer. Indeed, the most important renewable sources of energy in Malaysia are biomass, wind, hydro, tidal, geothermal and solar. However, some of the sources are very difficult to be used as the renewable energy sources to produce electricity. Thus, in this project, a different conceptual approach is to be applied in order to generate certain amount of electricity. In this study, the relationship between, the physical of different types of soils, the level of effectiveness of soil moisture and also, the different types of pH values of the selected soils, and the amount of generated voltage level is evaluated. The methods involved in analyzing the relationship are described as follows. Firstly, choosing the types of soils required such are peat soil, clay and sand. Secondly, classified these soils into three conditions that are, dry, nor and wet. Thirdly, choosing copper (Cu) and zinc (Zn) material as an electrode for electrical conductivity. All the components will be connected through crocodile clip wires so that the electric will flow. Lastly, the value for every data needed are recorded by using a digital multimeter. Apart from multimeter, the moisture tester tool also will be used to record the moisture of the soils from time to time. As the conclusion of this project, it is clearly stated that the type of soil used and their textures will influence the amount of current flow and the voltage gained throughout the study. It is also determined that different type of soils has different values of pH level which then produced different amount of electrical conductivity.

Keywords: Electrical Conductivity, Soil Moisture, Ph Value Soil, Acidic

1. Introduction

Electricity is the flow of electrical power and charges, which is a basic needed of human nature. It can be generated through a conversion process of other sources of energy, like coal, natural gas, oil, nuclear power and other natural sources. The energy sources used to generate electricity can be renewable or non-renewable such are solar energy, hydro energy and so forth. In general, the basic

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knowledge of electrical field generation is by the existence of an electric charge motions, which can be positive or negative. Renewable energy particularly, is the energy that derived from a non-depleting source, such as wind or solar electricity. Hence, it is recommended to use renewable sources of energy to produce electricity because it can reduce the pollutions effect which then affected the depletion of the ozone layer, greenhouse effect and deforestation.

In particular, soil is one of the renewable sources that can be used as the source of electricity. In this case study, three different types of soils were tested on the performance of the amount of electrical energy generated. The soils are clay, peat and sandy soils where these soils are easily to find. To obtain the good electrical conductivity, the soil must be sourced from reliable sources. The soil moisture plays an important role in producing best voltage and current values. Acidity and alkalinity are also one of the factors that can be measured to prove that a soil can conduct electricity. Previous study has proven that the higher the soil moisture, the more electric current is produced [1]. Based on the experiment conducted, clay soil with wet conditions has more ions. The reactions occur because zinc easily losses their electrons than copper. Therefore, more free electrons will discharge when the circuit is connected. According to [1], the current flows from the plate that is towards the negative end of the electro potential series.

Soil moisture and soil texture can affect the Electrical Conductivity in Soil (EC). EC can read the data easily when the level of moisture of soil increases. This is because, water will help to free up the ions. Sand and peat soils have low surface contact degree so it has a difficult time retaining moisture but clay have a texture capable of holding a large volume of water [2].

2. Materials and Methods

The study methodology is the design method, technique and analyses the data to obtain evidence that can support a study. The purpose of the methodology is to help understanding more detail the application of the research methods. Besides, it is used to achieve the goals and objectives of the study systematically. This part explains in more details, the materials and method that we use to finish this project. This project is suitable for generating electricity neutrally and can be used many times using nature resources such as soil.

2.1 Materials

Figure 1 shown the several types of components and material used to conduct the project. Three types of soil conditions are to be considered as the main substances such are, peat, clay and sandy soils. These soils are then being analyzed under several conditions in order to obtain the amount of voltage and current produced. Other than that, we need to use copper plate and zinc plate as our electrodes to generate electricity by undergoing an ionization process. Copper plate is set as a negative lead part and the zinc plate is set to be a positive lead part. Next, moisture tool is also used in this project as a measurement instrument for soil moisture, temperature and the pH value of soil. All the required voltage and current values will be recorded by using a multimeter,

Figure 1: List of Project Materials

2.2 Methods

As alternative to save earth from the pollutions, we use natural resources as the main component in generating electrical energy.[3] The study includes on how to design the project of "Electrical Conductivity in Soil", the selection of soil types and other materials, the methods chosen to analyze the parameters needed and lastly, the selection of suitable measurement instrumentation that will enable us to gather an accurate and precise data. To begin with, we start on designing the prototype of the project. We decide to choose zinc plate and copper plate with the same dimension as a constant parameter. The idea of selecting these two types of plates is because they can generate electrical smoothly. After that, the process in choosing the types of soils required such are peat soil, clay and sand. These soils will act as variable parameters, which mean that the texture of the soils will be varied according to the project requirement. After that, classified these soils into three conditions that are, dry, nor and wet. Then, choosing copper (Cu) and zinc (Zn) material as an electrode for electrical conductivity. All the components will be connected through crocodile clip wires so that the electric will flow. Lastly, the value for every data needed are recorded by using a digital multimeter. Apart from multimeter, the moisture tester tool also will be used to record the moisture of the soils from time to time. Figure 2 shows the process flow for the entire project and Figure 3 pictured the layout of the whole project respectively.

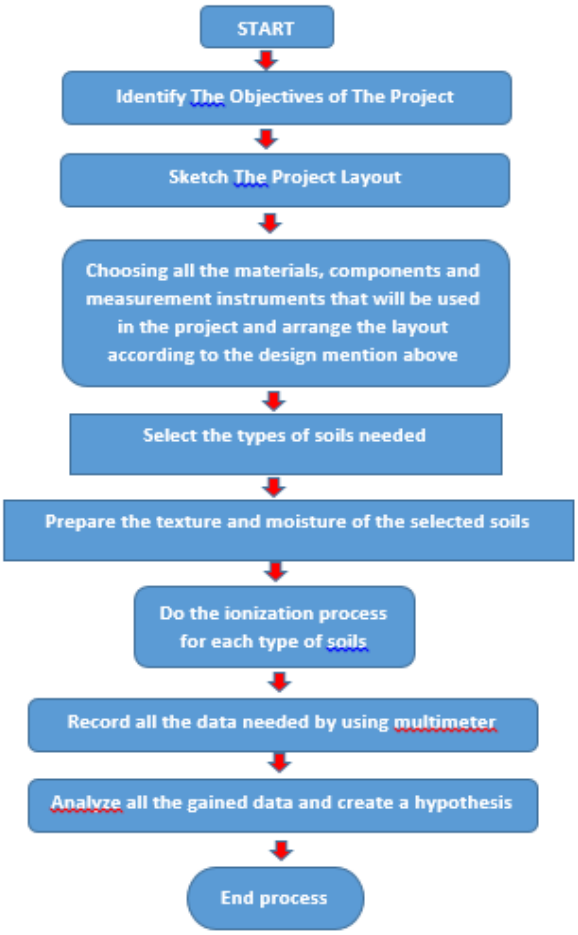

Figure 2: The Process Flow of the Entire Project

Figure 3: The Layout of the Whole Project

3. Results and Discussions

In this project, each type of soil will be prepared into three different level of moisture conditions such are dry, nor and wet conditions. Then, the pH value of every condition will be recorded. Finally, by using a multimeter, the value of voltage level and the amount of current flow will be observed and tabulated in Table 1 for Clay soil, Table 2 for Peat soil and Table 3 for Sand soil respectively.

Table 1: Clay Soil Results in three conditions

Parameter	First Condition	Second Condition	Third Condition
Moisture	Dry	Nor	Wet
pH	7.0	6.2	5.2
Voltage	0.51 (V)	0.97 (V)	1.00 (V)
Current	0.00 (A)	0.54 (A)	1.72 (A)

According to Table 1, there are three types of clay soil conditions that produced different values of pH values, voltage level and the amount of current flow. It is shown that, the dry type has the highest pH value. This indicates that the soil is in a neutral state between alkali and acid. Meanwhile, both Nor and Wet types are more acidic. Table 1 also indicates that the wet type has the highest voltage value of 1.00V and the highest current flow of 1.72A.

Table 2.0: Peat Soil Results in three conditions

Parameter	First Condition	Second Condition	Third Condition
Moisture	Dry	Nor	Wet
pH	7.0	6.3	5.2
Voltage	0.34 (V)	0.92 (V)	1.03 (V)
Current	0.00 (A)	0.32 (A)	1.81 (A)

According to Table 2, the three types of peat soil conditions also produced various values of pH, voltage level and the amount of current flow. This indicates that the soil category was acidic, with a pH value of 6.3. Although the dry type has the highest pH value, the voltage and current flow are inadequate. The wet type of peat soil is the best condition for supplying electricity. Among the three conditions, it has the highest voltage of 1.03 (V) and current of 1.81 (A).

Table 3.0: Sand Soil Results in three conditions

Parameter	First Condition	Second Condition	Third Condition
Moisture	Dry	Nor	Wet
pH	7.0	5.0	5.0
Voltage	0.02 (V)	0.99 (V)	0.90 (V)
Current	0.00 (A)	0.53 (A)	0.90 (A)

By referring to Table 3, it shown that the two types of sand soil conditions can be used to supply electricity, which are the Nor and the Wet conditions. Furthermore, the current for the Nor type is 0.53A, which is lower than the current for the wet type. Both conditions indicated almost the same value of the voltage level. The findings of this project also can be summarized as shown in the following graphical figures. These figures indicate the comparison between each types of soil with different level of moisture conditions. Figure 4, Figure 5 and Figure 6 show the required data gained for the Dry, Nor and Wet condition for each type of soil respectively.

Dry Condition

Parameters	Clay	Peat	Sand
pH value	7	7	7
Voltage (V)	0.51	0.34	0.02
Current (A)	0	0	0

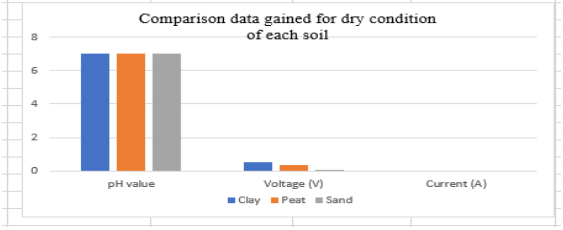

Figure 4.0: Data gained for the Dry condition

Nor Condition

Parameters	Clay	Peat	Sand
pH value	6.2	6.3	5
Voltage (V)	0.97	0.92	0.99
Current (A)	0.54	0.32	0.53

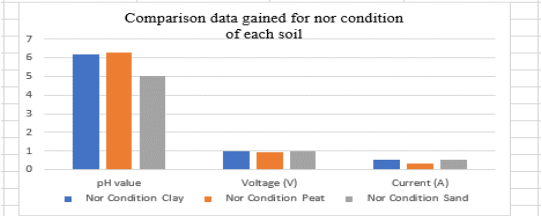

Figure 5.0: Data gained for the Nor condition

Wet Condition

Parameters	Clay	Peat	Sand
pH value	5.2	5.2	5
Voltage (V)	1	1.03	0.9
Current (A)	1.72	1.81	0.9

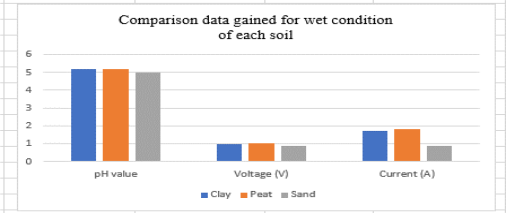

Figure 6.0: Data gained for the Wet condition

From these figures, it is clearly stated that for each type of soil, the potential of producing electricity is the greatest under wet condition. This is because, water will help to free up the ions for ionization process.

4. Conclusion

As the conclusion of this project, it is clearly stated that the type of soil used and their textures will influence the amount of current flow and the voltage gained throughout the study. It is also determined that different type of soils has different values of pH level which then produced different amount of electrical conductivity. Overall, it can be concluded that the peat soil under wet condition is the best

soil to be used for generating electrical conductivity. The pH level is 5.2, the voltage value produced by peat soil is 1.03V, and the current can flow up to 1.81A. Meanwhile, the dry soil was unsuitable for allowing electrical conductivity. There is no current flow through the dry soil because ionization process could not occur under this condition. For future work recommendation, we shall use renewable energy because it brings so many benefits to human kind environmentally and economically. The advantages of using renewable energy, which is created energy from fossil fuels, not only to prevent greenhouse gases effects, but also to reduce some types of air pollution. Another benefit is diversifying energy supplies and decreasing reliance on imported fuels.

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References

[1] G. Rabenberg, "Electrical Conductivity : The Pulse of The Soil," Acres U.S.A, 2019. [Online]. Available: https://www.ecofarmingdaily.com/build-soil/electrical-conductivity-the-pulse-of-the-soil/. [Accessed 6 May 2021]

[2] Energy Information Administration, "EIA.gov," U.S. Energy Information Administration , 9 December 2020. [Online]. Available: https://www.eia.gov/energyexplained/electricity/electricity-and-the-environment.php. [Accessed 6 May 2021]

[3] B. Mary, "The Basics: An Introduction to Electricity and Electronics." ThoughtCo, 26 August 2020. [Online]. Available: https://www.thoughtco.com/electricity-and-electronics-4072563 . [Accessed 6 May 2021].

[4] F. Visconti and J. M. Paz, "Electrical Conductivity Measurements in Agriculture: The Assessment of Soil Salinity", New Trends and Developments in Metrology, Luigi Cocco, IntechOpen, DOI: 10.5772/62741, 20 July 2016. [Online]. Available: https://www.intechopen.com/books/new-trends-and-developments-in-metrology/electrical-conductivity-measurements-in-agriculture-the-assessment-of-soil-salinity

[5] L. Calderone, "Using the Earth as a Battery" Energy storage and grid, 29 October 2019. [Online]. Available: https://www.altenergymag.com/article/2019/10/using-the-earth-as-a-battery/32056. [Accessed 6 May 2021].

[6] N. Othaman, et al., ". Factors that affect soil electrical conductivity (EC) based system for smart farming application", 2020. [Online]. Available: https://aip.scitation.org/doi/pdf/10.1063/1.5142147. [Accessed 6 May 2021].

[7] K. Nasrullah, S. Zahid and A. Naeem, "Experimental study of earth batteries", 2nd International Conference on Electrical Engineering, ICEE. 1-4. 10.1109/ICEE.2008.4553917. (2008). [Online]. Available: https://www.researchgate.net/publication/4347039_Experimental_study_of_earth_batteries. [Accessed 6 May 2021].