Identification resistivity value of soil: alternative substitute resistance material on resistor

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Abstract. This study utilized soil as a raw material for making resistor. The type of soil use is latosol soil, organosol soil, and clay. The method used is an experiment. These soils are very densely compressed into a tube with a surface area \( A = 6.3 \times 10^{-4} \) m\(^2\). Each of the tube have a length \( l = 1.5 \times 10^{-2} \) m and diameter \( d = 1 \times 10^{-2} \) m. The results of resistance value can be observed through measurement using a multi-meter on the artificial resistor. Found the resistance value from latosol soil, organosol soil, and clay in a row is at 66.3 kΩ; 58.6 kΩ; 47.1 kΩ. The results are used to determine the value of resistivity through a formula. The results showed that latosol soil, organosol soil, and clay respectively have a value of resistivity of 2.78 kΩm; 2.46 kΩm; 1.98 kΩm. This study shows that soil can be used as an alternative to resistance on the resistor material. These results also indicate that resistivity value of latosol soil higher than organosol soil and clay.

1. Introduction
The soil has resistivity and conductivity values [1-6], while resistor containing carbon as constituent components also have two values [7]. This equation reveals that the soil can be used as an alternative material on resistor. Resistivity is an important parameter to identify characteristic of soil ant its content [8]. Soil resistance values can be measured [9-11] through a variety of experiments. It was found that the soil resistance values vary depending on the type or texture of the soil [9,12]. The soil used in this study is latosol soil, organosol soil, and clay. This soil selected as the study sample because these soils are found in Kalimantan, Indonesia. It is explained [13] Latosol soil is formed from the weathering of sedimentary and metamorphic rocks, while organosol soil formed from the weathering of organic matter such as plants, peat and swamp. There are in an area that has a wet climate and high rainfall. As for the clay is the type of soil consist of a mixture of aluminum and silicate which has a diameter of not more than four micrometers. Clay formed from the weathering of silica process conducted by carbonic acid and some of them produced from geothermal activity. Latosol soil, organosol soil, and clay in this study are packaged in a specific container to determine the resistivity of the material. Thus, if the resistivity is known, can facilitate and be a consideration for further research to produce a resistor made from latosol soil, organosol soil, and clay having regard to the standard specification resistance material on resistor to safety when assembled with other electrical components. Resistors are used to limit or impede the flow of electricity through a series resistor [14-15]. This is made clear by [16] the resistor in a circuit has a function as a flow divider, voltage divider, lowering the voltage, overcurrent safety, inhibiting the
flow of electricity, and so on (depending on the design of components of different types of resistor). Resistors have diverse types, one of which is resistors carbon film. Resistor carbon film made of carbon materials that consist of a tubular resistive element with a wire or metal lids on both ends [17]. In this soils are an option to be change component substitution on resistor.

2. Numerical Methods
This research method using an experimental method, while the method of measurement in this study using a length measuring tools (ruler), and measuring barriers (multi-meter). Resistivity soil of value determined by calculations using the formula $R = \rho \frac{l}{A}$. The ruler is used to set the control variables, namely the size of the radius and height of the pipette used. Multi meter is used to measure the resistance value which becomes the dependent variable. The soil used as independent variables in this study.

In this study, begins with soil to compressed slowly using blunt spikes and rubber mallet into a tube. The tube is made from a pipette with both ends covered with aluminum foil adhesive. Length ($l$) or high ($t$) pipette of $1.5 \times 10^{-2}$ m and a diameter of $1 \times 10^{-2}$ m, so that the surface area ($A$) of the tube amounted to $6.3 \times 10^{-4}$ m$^2$. The calculation is as follows:

$$A = 2 \pi r (r + t)$$
$$= 2 \frac{22}{7} (0.5 \times 10^{-2}) [(0.5 \times 10^{-2}) + (1.5 \times 10^{-2})]$$
$$= 6.285 \times 10^{-4} \text{m}^2$$
$$\approx 6.3 \times 10^{-4} \text{m}^2$$

The last, giving the wire on each side of the tube. Wire each side should not be a fused, and the aluminum foil should not exceed big tear wire that is attached to it. Then resistance has measured using a multi meter and a calculation of the resistivity soil. To determine the value of resistivity, it is necessary to first know the value of resistance. The relationship between resistance ($R$), the cross-sectional area ($A$), length ($l$), and resistivity of materials ($\rho$) shown in the equation:

$$R = \rho \frac{l}{A}$$

The equation for calculating the value of the resistivity material is as follows:

$$\rho = \frac{RA}{l}$$

As for the procedure scheme of making resistor from soil is as follows.

![Procedure scheme of making resistor from soil materials](image)

Caption:

= Next

**Figure 1.** Procedure scheme of making resistor from soil materials

As for the schematic diagram illustrating the measurements resistance and resistivity shown is as follows. The same step to some different soil type.
3. Results and Discussion

This study aims to determine the resistivity value latosol soil, organosol soil, and clay as alternative substance resistance material on resistor. It is expected to make a significant contribution in the world of technology through the utilization of soil. Components of the resistor in the form of resistance material which has been put into focus as a core material in the manufacture of carbon film resistor can be changed. In this research material soil must be packed solid very tightly into the container. The density of the material is very important, because the resistance value can only be read when the material is really tight. The amount of container or surface area also determines the value of resistivity material. The container used in this study is a tubular pipette with a height \( t = 1.5 \times 10^{-2} \) m, and a diameter of \( 1 \times 10^{-2} \) m. By the equation: \( A = 2\pi r(r + t) \), it was found that the surface area was \( 6.3 \times 10^{-4} \) m\(^2\). The surface area of a cylindrical tube made of materials similar to latosol soil, organosol soil, and clay intended to do the comparison value of resistance and resistivity between the three soil materials. It value constraints can only be read when the player scale digital multi meter showed limit the scale of 200 kilo ohm (200 kΩ), so that the values read on-screen digital multi meter also has the same unit that kilo ohm (kΩ or \( 10^3 \) Ω). This shows that the resistor is made using these three ingredients can only be used to produce a resistor with a large resistance value. The value of constraints for latosol soil, organosol soil, and clay, shown in Table 1 as follows.

| Soil Material     | Resistance Value (Ω) |
|-------------------|-----------------------|
| Latosol Soil      | \( 66.3 \times 10^3 \) |
| Organosol Soil    | \( 58.6 \times 10^3 \) |
| Clay              | \( 47.1 \times 10^3 \) |

It was found that the value of resistance can determined by using a digital multi meter. The third ingredient is soil can be used as an alternative substitute resistance material in resistor. It found that latosol soil at higher than organosol soil and clay. For simple illustration, the chart resistance values organosol soil, latosol soil, and clay in this study are shown in Figure 2 as follows.
After being found by measuring the resistance value, the value of resistivity material searchable through the calculation of the data obtained. The calculation is performed using equation (3). The resistivity value of latosol soil, organosol soil, and clay, shown in Table 2 below.

**Table 2. Resistivity value of soil**

| Type Soil        | Resistivity (Ωm) |
|------------------|------------------|
| Latosol Soil     | $2.78 \times 10^3$ |
| Organosol Soil   | $2.46 \times 10^3$ |
| Clay             | $1.98 \times 10^3$ |

Calculation of resistivity material on latosol soil, organosol soil, and clay in this study showed that the latosol soil has a higher resistivity than organosol soil and clay. This is because latosol soil is formed from the weathering of sedimentary and metamorphic rocks [13], it contains iron and aluminum. This metal material has high resistivity values [17]. Resistivity comparison latosol soil, organosol soil, and clay, shown in Figure 3 as follow.

In conclusion, soil in this study can be used as an alternative substitute resistance material on resistor. Found resistance values with measurements on latosol soil at 66.3 kΩ, organosol soil at 58.6 kΩ, and clay at 47.1 kΩ. Cross-sectional area of each of the materials used at $6.3 \times 10^{-4}$ m$^2$ and a length of $1.5 \times 10^{-2}$ m. Based on calculations using the equations $\rho = \frac{RA}{l}$ can be identified that the resistivity for latosol soil by 2.78 kΩm, organosol soil 2.46 kΩm, and clay 1.98 kΩm. Resistance value and resistivity materials have a proportional relationship. The greater the value of its resistance, the greater the value of resistivity, otherwise the smaller the resistance value is smaller the resistivity.
4. References

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