Measurement System for Surface Leakage Current at Epoxy Resin Insulating Materials

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Abstract*—Performance of the insulating material as a new insulator needs to be tested. To determine how well such performance requires testing with data acquisition techniques from analog to digital. Currently Testing is still off line by using oscilloscope. To increase the accuracy of Electrical Tracking measurement required on-line measurements by utilizing current sensors and voltage sensors. To test the accuracy of the voltage sensor and current sensor, it must be tested the sensitivity on the voltage sensor. A measuring device that can simulate the voltage and current conditions in the electrical tracking test was made. If no sensitivity test is conducted, then the results obtained may not match the actual voltage and current in the measurement system. The available current and voltage sensors in the market list the values and parameters in the datasheet. But the conditions in the field at the time of its application is influenced many things, especially mechanical and electrical influences. In this paper, measurement of current and voltage at sample of resin epoxy were carried out. Measurement result in this research show the average LC of rice husk ash is 46 mA. The average voltage during insulation failure in rice husk ash sample is 2,829 volts. The first discharge time on the average rice husk ash sample occurred at the 114 second. The first discharge current of the rice husk ash sample was at 20 mA. The average voltage during the first discharge on the ash of rice husk ash is 3,449 volts. The time of insulation failure on the average rice husk ash sample occurred at 4.661 seconds

***Keywords* — Leakage Current, Epoxy Resin, Data Acquisition, Sensitivity**

I. INTRODUCTION

In transmission line and distribution network systems, a conductor with another conductor is insulated by air, while a conductor with a tower or supporting pole is insulated by a solid insulating material called an insulator[1]. The most common and widely used insulation materials in Indonesia are ceramics and glass. The advantages of ceramic and glass insulating materials are good heat capacity and low thermal conductivity, corrosion resistant, hard and strong, but the ceramic and glass insulation materials have a mechanical weakness that is heavy and water-absorbing (hygroscopic) so that leakage current easily flow on a surface that can cause flashover [1]–[3]

To estimate the things that need to be done with the techniques. Currently experiment test in laboratory is still off line by using oscilloscope. To increase the accuracy of electrical tracking measurements required online by using sensor sensors and voltage sensors[4]. To test the accuracy of the voltage sensor and current sensor, it must be test sensitivity on the voltage sensor. Insulation value material resistance tested can be determined, initial steps can be simulated on multi-sim program. A leakage current flow occurs when a contaminant causes a leakage current from phase to ground. The value of leakage current and the measured voltage can be used to further analyze the relationship between leakage current and voltage and resistance to the insulating material under test[4]–[7]. These values can be further analyzed to determine the energy used during the electrical tracking test of insulating material. Simulation using Proteus can simulate data acquisition on electrical tracking test. This paper present research result on the electrical tracking measurement.

II. EXPERIMENTAL SET UP

A. Material Composition

Material composition of test sample used is an epoxy resin compound with silicone rubber and rice husk. The percentage of the test materials were shown in table I.

TABLE I. TEST MATERIAL COMPOSITION

Test Material Composition (%)	**Massa (gr)**			
	Rice husk	***Silane***	***DGEBA***	***MPDA***
20	10	10	40	40
30	15	15	35	35
40	20	20	30	30

Dimensions of the test material sample made [4] with the size of 120 x 50 x 5 mm can be shown in Figure 1

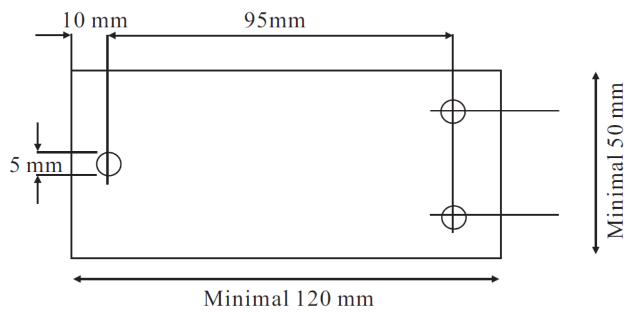

Fig. 1. Size and dimension of test sampel.[8]

TABLE II. SAMPLES MADE BY EACH VARIATION OF FILLER

Test Material Composition Variation	Type of Test Material Rich Husk Ash	Total Amount
20%	3 pieces	3 pieces
30%	3 pieces	3 pieces
40%	3 pieces	3 pieces
TOTAL		9 pieces

B. Leakage Current Measurement

Measurement of leakage current using Incline-Plane Tracking (IPT) method based on standard IEC 587: 1984[9]. The measurement circuit is shown in figure 2. On the measurement is used fixed voltage method with wet conditions. Observation of leakage current using oscilloscope help to record the current wave. The oscilloscope protection and protection device to limit the high voltage by installing the intermediate bisector circuit shown in figure 3.

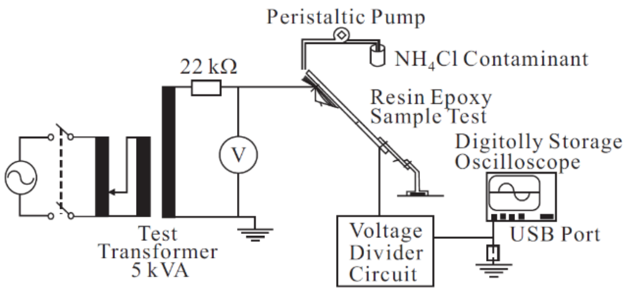

Fig. 2. Leakage current measuring system .[8]

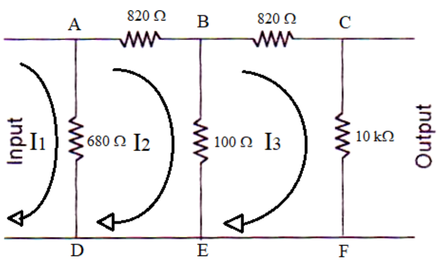

Fig. 3. Voltage divider circuit

Measurements were made by limiting the occurrence of surface tracking as far as 25 mm from the bottom electrode or with a maximum measurement time of 1 hour.
This standard uses two test methods to evaluate electrical insulation test materials for use under several conditions, with power frequencies (48 Hz to 62 Hz) for measurement of tracking and erosion barriers. This method is done by steps :

1. Make the circuit in accordance with IEC 587: 1986 standard[10]
2. Laying the top and bottom electrodes on the sample. At the top electrode before it is mounted on the sample it is given 8-ply filter paper. Then place the sample on a buffer so that the sample surface portion facing downward with a 45 ° angle to the horizontal axis is shown in Figure 3.36.
3. Set the pollutant flow rate at 0.3 ml / min, then drain into the sample through the filter paper. The function of using this filter paper is to have a uniform flow of contaminants from the top electrode to the bottom electrode before the applied voltage.
4. Provides the resistance of the series IEC 587: 1984 series resistors for the 3.5 kilovolt test voltage with series resistor is 22KΩ.
5. Inspect to ensure that the pollutant flows directly on the surface of the test material through the small opening of the top electrode tip toward the bottom electrode.
6. Applying a 3.5-kilovolt voltage on the sample, obtained from a high-voltage generator through the top electrode, while the bottom electrode is connected to a ground-level measuring device.
7. Measure the LC using the data acquisition software by pressing the initialization key to enter the comport value and the baud rate value used in the test. Then to start measuring press start menu, then data acquisition will start. To stop the measurement, press the Stop menu.
8. Wait until the insulator test material forms a fire path and finally burns as far as 25 mm. That means it has failed to isolate the voltage.

Fig. 4. Sample has been tracked as far as 25 mm

9. Saving the LC measurement results by pressing the save button on the automated data software will be stored on the laptop with the same folder with the folder where the data acquisition program is stored.
10. Measurement was complete, then copy paste in microsoft excel to see the graph.

III. Results and Discussion

Data of measurement results were obtained. Data to be used for analysis of leakage current above surface insulator. The first discharge rate table and LC then insulation failure and discharge current during insulation failure are shown in Table 3.

Table 3 Average first discharge time and isolation failure as well as the amount of leaking current occurring in rice husk ash samples.

TABLE III. TIME TO DISCHARGE

	Firts Discharge				**Failure Insulation**			
	Second (t_o)	**Second (t)**	**Current (mA)**	**Voltage (V)**	**Second to**	**Second (t)**	**Current (mA)**	**Voltage (V)**
1	257	128,5	19,93	3451,57	9543	4771,5	49,228	2884.38
2	211	105,5	19,931	3419,93	8107	4053,5	49,228	2842,19
3	214	107	19,31	3474,61	10318	5159	39,462	2814,85
Av	**227,3**	**114**	**20**	**3449**	**9323**	**4661**	**46**	**2829**

A. Sample 1

The relationship between voltage and current in test sample 1 is shown in Figure 5.

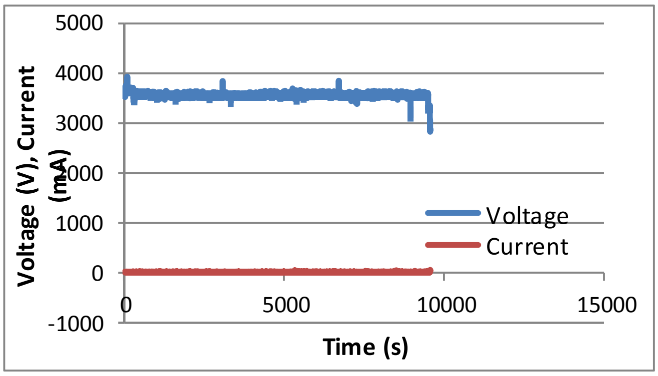

Fig. 5. Relatioship between voltage and current in sample 1

From the graph it can be concluded that the first discharge current occurs in the data to 257, seconds to 128.5 with the magnitude of 19.93 mA current, 3451.57 volt. And this continues to be marked by changing discharge currents. So in the data to 9,543, seconds to 4771,5 failure occurs in isolation marked by the magnitude 49,228 mA current, voltage 2884.38 volts.

B. Sample 2

The relationship between voltage and current in test sample 2 is shown in Figure 6.

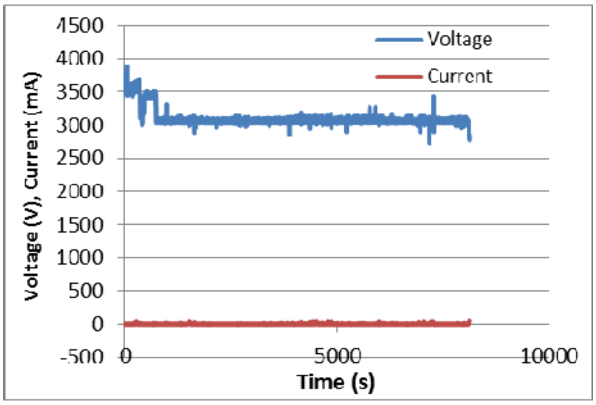

Fig. 6. Relatioship between voltage and current in sample 2

From the graph it can be concluded that the first discharge current occurs in the data to 211, seconds to 105.5 with the magnitude of 19.93 mA current, voltage 3419.93 volts. And this continues to be marked by changing discharge currents. So in the data to 8.107, seconds to 4053.5 failure occurs in isolation marked by the magnitude of 49.228 mA current, voltage 2842.19 volts.

C. Sample 3

The relationship between the voltage and current in the test of sample 3 is shown in Figure 7.

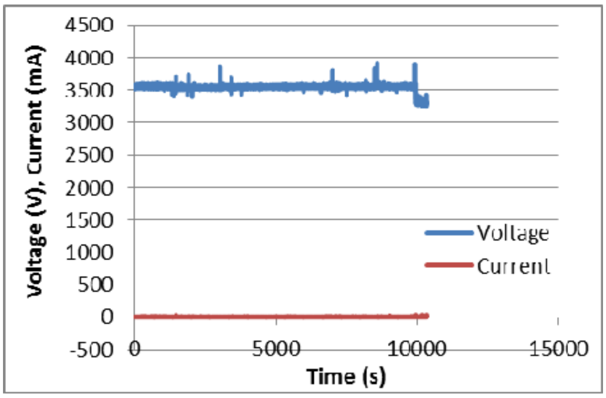

Fig. 7. Relatioship between voltage and current in sample 3

From the graph it can be concluded that the first discharge current occurs in the data to 214, 107 seconds with the magnitude of 19.31 mA current, voltage 3474.61 volts. And this continues to be marked by changing discharge currents. So in the data to 10138, 5159 seconds to the failure of isolation marked by the magnitude of 39.462 mA current, voltage 2814.85 volts.

IV. Conclussion

Measurement system for surface leakage current and voltage can be done in this testing the samples of rice husk ash. Measurement result in this project show the average LC of rice husk ash is 46 mA. The average voltage during insulation failure in rice husk ash sample is 2,829 volts. The first discharge time on the average rice husk ash sample occurred at the 114 second. The first discharge current of the rice husk ash sample was at 20 mA. The average voltage during the first discharge on the ash of rice husk ash is 3,449 volts. The time of insulation failure on the average rice husk ash sample occurred at 4.661 seconds.

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