



Application of Eco-Enzyme to Reduce the Grounding Resistance of the Electrical Installation at Pura Luhur Dwijawarsa Malang

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Abstract. As the installations ages, the performance of the grounding system may deteriorate, potentially reducing the overall safety level of the installation. The grounding system is a critical component of electrical installations, serving to protect both personnel and electrical equipment from electric shock hazards, leakage currents, and short-circuit faults. This study aims to evaluate the grounding resistance value of the electrical installation at Pura Luhur Dwijawarsa Malang. The research methodology involved direct measurement of grounding resistance using an Earth Tester and pouring the existing grounding electrode by eco-enzyme in order to reduce soil pH. The measurement results before treatment indicated a grounding resistance value of 12.25 Ω . After the application of eco-enzyme into the grounding electrode, the soil pH dropped from 5.8 to 4.5 and the grounding resistance decreased to 10.69 Ω . These results demonstrate that pouring eco-enzyme effectively reduces grounding resistance. The relatively small decrease in grounding resistance after pouring eco-enzyme was caused by the loose and dry soil type at the location.

Keywords: Eco-enzyme, Grounding Resistance, Soil pH

1 Introduction

A grounding system is a crucial component of an electrical power installation; it functions by diverting fault currents, short-circuit currents, and lightning currents into the earth (Simanullang, 2023), thereby protecting people, equipment, and buildings from the hazards of electric shock and damage caused by system faults. The reliability of the grounding system is heavily dependent on the grounding resistance value; a low resistance value facilitates the rapid dissipation of fault currents into the ground and minimizes the occurrence of dangerous touch and step voltages. Therefore, the grounding system must be maintained to ensure its resistance value remains within the maximum limit of 5 Ohms, in accordance with the General Requirements for Electrical Installations (Badan Standar Nasional, 2020).

Grounding resistance is influenced by various factors, including soil resistivity, moisture content, temperature, mineral content, acidity (pH) levels, electrode dimensions, and the quality of the contact between the electrode and the soil. In long-

standing installations, changes in soil characteristics caused by drying, compaction, mineral leaching, or electrode corrosion—lead to increased soil resistivity, which in turn tends to raise grounding resistance. Such conditions can compromise the effectiveness of electrical protection systems and heighten the risk of equipment failure or electrical accidents.

Various methods have been developed to reduce grounding resistance, including increasing electrode dimensions, adding more grounding rods (Karmiathi & Yoga, 2023), installing electrodes at greater depths, and utilizing Ground Enhancement Materials (GEM) such as bentonite (Utomo & Haryono, 2019), charcoal, salt (Widyaningsih & Teguh, 2016), activated carbon, or other chemical agents (Andhika, 2018). While these methods effectively lower grounding resistance, some materials have drawbacks; they may accelerate electrode corrosion, lose effectiveness due to leaching, or pose potential environmental risks with prolonged use (Lim et al., 2015). Consequently, there is a need for alternative materials that are environmentally friendly, readily available, and effective at improving the soil characteristics surrounding the grounding electrode.

One natural material with potential for use in grounding system maintenance is eco-enzyme; a solution produced by fermenting organic fruit and vegetable waste with sugar and water. Eco-enzymes contain various organic acids, dissolved minerals, enzymes, and microorganisms capable of modifying the physical and chemical properties of the soil. The organic acid content can lower soil pH and enhance ion mobility, thereby increasing soil electrical conductivity while reducing soil resistivity. Furthermore, the use of eco-enzymes supports the concepts of green engineering and zero waste by transforming organic waste into a product that adds value to the engineering field. A study titled "Experimental Investigation of Soil pH Engineering with Eco Enzyme to Improve Grounding Performance" examined the impact of soil pH engineering using eco-enzymes on grounding system performance. The results demonstrated that the application of eco-enzyme reduced grounding resistance from 40 Ω to 9 Ω at an optimal soil pH of 3.8 (Jondra et al., 2026). Several soil factors that influence grounding resistance (Arifin, 2021) include:

- a. Water content: wet soil tends to have low resistance because water facilitates electrical conduction.
- b. Soil type: clay and loamy soil generally have lower resistance compared to sand.
- c. Grounding electrode depth: the deeper the electrode is buried, the better, due to the presence of moist soil conditions.

This study aims to analyze the effect of applying eco-enzyme on reducing grounding resistance in electrical grounding systems and to evaluate its effectiveness as an eco-friendly maintenance method. The findings are expected to contribute scientifically to the development of grounding system maintenance technology and serve as a reference for the application of eco-enzyme as an alternative ground enhancement material that supports the reliability and safety of electrical installations.

2 Methodology

This study aims to determine the effect of applying eco-enzyme on the grounding resistance of existing electrical installations. It builds upon previous fundamental research regarding the use of eco-enzyme to reduce grounding resistance. As a natural substance, eco-enzyme offers a potential eco-friendly solution for improving grounding values. The study seeks to establish an empirical method applicable to electrical installations in public buildings and places of worship, particularly those utilizing outdoor systems. The research involved measuring grounding resistance levels both before and after the application of the eco-enzyme. Consistent with prior findings, achieving maximum reduction in grounding resistance required pouring a mixture of eco-enzyme and water—in a ratio of two parts eco-enzyme to three parts water—onto the grounding rod. In addition, soil pH measurements were taken around the grounding rod before and after the application of eco-enzyme to determine the soil acidity level. Grounding resistance was measured using a Kyoritsu Earth Tester 4105A, while soil pH was measured using a pH meter. The grounding resistance measurement employed the three-point method, as illustrated in Figure 1. The second probe (C2) was inserted into the ground at a distance D from the first probe (C1), which was connected to the earth electrode, while the third probe (P2) was positioned at a distance of 62% of D . For instance, if the distance between the first and second probes was 10 m, the third probe would be placed 6.2 m from the first probe. All probes had to be aligned in a straight line. During the procedure, measurements could be repeated with the first probe connected to the second probe. If feasible, the positions of the second and third probes could be adjusted to obtain the optimal resistance value (Pratama & Wijaya, 2022; Utomo & Haryono, 2019).

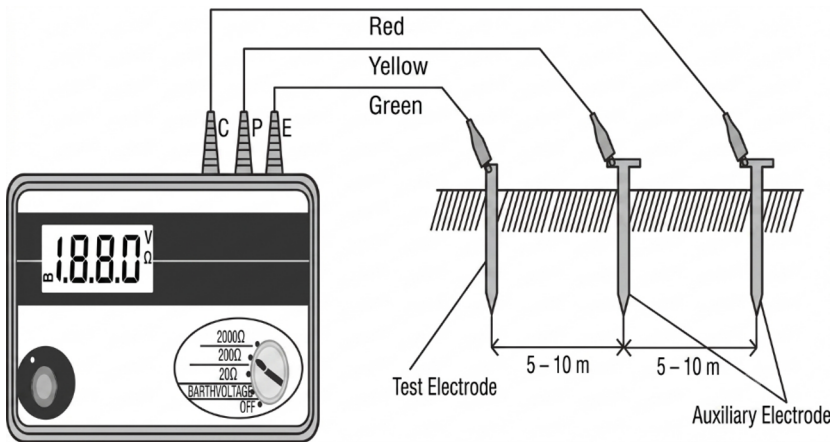


Figure 1. Grounding Resistance Measurement Method using an Earth Tester



Figure 2. Eco-Enzyme Liquid

3 Result and Discussion

3.1 Result

Initial soil pH measurements showed a value of 5.8, indicating that the soil tends to be acidic. The addition of eco-enzyme is expected to further reduce soil acidity. The soil resistance measurement results under those conditions show a value of 12.25 ohms as shown in the Figure 3.



Figure 3. pH and Grounding Resistance before Eco-Enzyme Treatment

After the application of eco-enzyme, the soil pH value decreased to 4.5, while the grounding resistance value dropped to 10.69 ohms, as shown in Figure 4.



Figure 4. pH and Grounding Resistance after Eco-Enzyme

The measurement results for grounding resistance and soil pH before and after the application of eco-enzyme are presented in Table 1.

Table 1. Results of Soil pH and Grounding Resistance Measurements before and after Eco-Enzyme Application.

Condition	Soil pH	Grounding Resistance (Ω)
Before eco-enzyme application	5.8	12.25
After eco-enzyme application	4.5	10.69

3.2 Discussion

The measurement results in Table 1 indicate that the application of Eco-enzyme led to a decrease in soil pH and grounding resistance compared to the initial state. The pH value dropped from 5.8 to 4.5 while resistance indicated a decrease from an initial value of 12.25 ohms to 10.69 ohms. The results show that applying 3 liters of Eco-enzyme at a 2:3 ratio caused the soil pH to drop by 1.3 (from 5.8 to 4.5) and the grounding resistance to decrease by 1.56 ohms (from 12.25 to 10.69 ohms). In percentage terms, the reduction in grounding resistance was:

$$\frac{(10.69 - 12.25)}{12.25} \times 100\% = -12.73\%$$

This reduction indicates an increase in soil conductivity around the grounding electrode. Eco-enzyme, which contains various organic compounds, dissolved minerals, and microorganisms has been proven capable of increasing ion levels in the soil conductivity around the grounding electrode, thereby lowering soil resistivity. Reducing grounding resistance facilitates the flow of electrical fault currents into the ground, thereby enhancing the safety of the electrical installation. This indicates that

the Eco-enzyme application method described above was significantly successful in reducing the grounding resistance.

This study also demonstrates the specific influence of soil type and condition on grounding resistance. Research shows that although there is a decrease in grounding resistance, the value still does not reach the required value. References regarding grounding resistance indicate that low resistance values are determined by soil type and condition. Wet, clayey soil tends to yield low grounding resistance values, whereas it is difficult to achieve low resistance values in dry, loose soil. Pura Luhur Dwijawarsa is located in a hilly area characterized by loose, dry soil. This condition makes it difficult to achieve a low resistance value.

4 Conclusion

Based on the results of this study, the application of eco-enzyme successfully reduced the grounding resistance of the electrical installation at Pura Luhur Dwijawarsa Malang from 12.25 ohms to 10.69 ohms, representing a 12.73% improvement in grounding performance alongside a decrease in soil pH from 5.8 to 4.5. However, the moderate reduction in grounding resistance is primarily attributed to the dry, loose, and highly porous soil conditions at the temple's hilly location, which limits moisture and ion retention around the grounding electrode.

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