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Performance Analysis Of Electrical System Postgraduate University Of Lancang Kuning

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Abstract: The use of electrical energy generally shows an increase, because electricity is a very beneficial form of energy and helps humans in carrying out their lives. The need for electrical energy comes from generating electrical energy to the user, required network systems and distribution substations. The addition of the construction of the new Postgraduate Program Building is a factor due to the increase in the number of students who will study and study at Lancang Kuning University. Research Objectives to Analyze and determine the current load on the three phases of the electrical system, Calculate power consumption, Calculate power losses in the electrical system, Evaluating the Grounding System in the Unilak Postgraduate Program Building. Based on the calculation results obtained an average current size at a voltage of 3 phase 380 volts of 23.3 amperes, a large power capacity of 98 kW, a voltage drop of 14.4 volts, a large power loss of 328.45 watts and a large earth resistance value of 22.15 ohms. Whereas the measurement of earth resisting at the wire point is 66 ohms and at the neutral point of the measurement of 52 ohms, it means that the value of earth resistors in the Unilak postgraduate building exceeds the calculated value in the analysis of the discussion of earth resistance by 22.15 ohms.

Keywords: Electrical Energy, Power Capacity, Electrical Systems

1. Introduction

Channels of electrical energy are the main needs in daily life and for industrial needs. Because electrical energy channels are easy to send and convert into other forms of energy. The supply of stable and continuous electrical energy is an absolute requirement that must be met in meeting the electricity needs. The use of electrical energy generally shows an increase, because electricity is a very beneficial form of energy and helps humans in carrying out their lives. The need for electrical energy comes from generating electrical energy to the user, required network systems and distribution substations. [4]. The addition of the construction of the new Postgraduate Program Building is a factor due to the increasing number of students who will study and study at Lancang Kuning University. The addition of the building will also result in an increased burden on the use of electrical energy in Unilak. This is due to the implementation of teaching and learning activities that will use electrical equipment and supplies.

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Channeling electricity after being generated by generators and then channeled to consumers through a long and branched conductor and through forests, trees and high rise buildings, this can cause disruption will occur if the distribution is not reliable. The use of electrical energy is now a basic human need in daily life. The use of electrical energy in Indonesia is supplied by state-owned companies and other private companies using electric energy generating machines. To obtain a good reliability system, efforts are made to repair, maintain regularly and reduce the number of disturbances and minimize blackouts, in order to increase continuity of service to consumers.

The need for electricity usage is high, causing an increase in power in the lecture room, leadership room and laboratory. As a result of the addition of the load resulted in an imbalance of load, this is because the installation and addition of the load does not comply with the rules and standards that apply in this case electrical standards and regulations. Because of these problems, it is necessary to do research on the electrical system of the Postgraduate Program to be able to overcome the disturbances that occur and be able to secure equipment, buildings and people. Conduct calculation analysis on the grounding system in the Postgraduate Program building and neutral point, whether it still matches the amount of ground resistance with the SPLN or IEC standard of $< 5\ \Omega$. Electrical energy is dangerous to humans and the environment, so the electrical quality of a building must be safe. Safe in the sense that individuals who use electrical energy in their activities are far from the danger of being touched by electrical voltage and buildings are also safe from fire hazards in the event of electrical disruptions such as short circuit currents. So that the use of electrical energy and the quality of electricity in buildings in accordance with applicable regulations and meet the minimum standards specified.
Research Objectives for:

1. Analyze and determine the current load on all three phases in the electrical system of the Lancang Kuning University Postgraduate Program.
2. Calculating power consumption in the Unilak Postgraduate Program building
3. Calculating power losses in the electrical system of the Unilak Postgraduate Program.
4. Evaluating the Grounding System in the Unilak Postgraduate Program Building

2. Literature Review

The use of load current in building I is large load current 8.22 amperes, building II 10.24 amperes and building III 1.57 amperes. While the power loss in building I was 35.61 Watt, building II 55.26 Watt and building III 1.31 watt [1]. For a large containment system the value of earth resistivity in building I 59, 5 ohms, building II 178 ohms and building III 119 ohms. To balance the load, it is necessary to increase the load on phase R by 690 watts of large safety 3.92 A. At phase S a decrease in power of 690 Watts, safety amount of 3.92 A. At phase T the power decrease of 800 Watts, safety amount of 4.54 A. The need maximum of each phase is, phase R = 33.35 A, phase S = 37.92 A, phase T = 36.47 A [2]. 2.1 Materials

2.1 Electric Power Distribution in Buildings

2.1.1. PLN Medium Voltage Substation

Electric power from the State Electricity Company (PLN) is distributed to customers through a distribution substation. Distribution substations deliver electricity from PLN through medium voltage main panels (MVMDP) to supply electricity needs in a building.

2.1.2. Step-down transformer

Step-down transformers are transformers that have an output voltage on the secondary coil lower than the input voltage on the primary coil. The number of secondary turns on this transformer is smaller than the number of primary turns.

2.1.3. Distribution Panel

In the distribution of electricity to a multi-storey building, electrical panels are needed in each zone to facilitate maintenance and control.

2.2 Distribution Channels

Power distribution channel is a channel connecting substations with consumers, primary distribution channel with Medium Voltage and secondary distribution channel with Low Voltage. Third is the channel called the installation of utilization, which is a channel that connects the source of electric power with electricity utilization equipment [9].

2.2.1 Radial Distribution Channels

This radial channel has shortcomings, sending electrical energy to the distribution substation obtained from a power plant. So if the substation experiences interference, then all feeders sent by the substation will experience outages. Another weakness is the quality and the quality of the voltage at the very end of the distribution substation is not good, due to the greatest voltage drop at the end of the channel. Figure 1 shows the medium voltage distribution network in the form of a radial configuration [9]. Interconnecting radial channels between distribution substations, several connected distribution substations in series supplied by a Substation busbar. This channel consists of several feeders coming out of the GI and a one-way voltage source. On the feeder there are distribution booths equipped with a voltage reducing transformer. This configuration is a simple configuration in its operation.

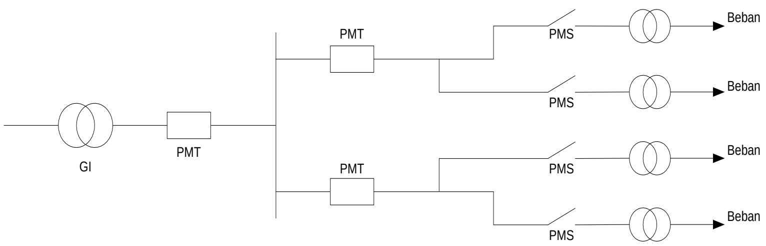

Figure 1: Diagram of One Line Radial Distribution System

2.2.2 Loop Configuration Distribution Channels

Loop channel is an interconnection between distribution substations that form a closed loop (loop). In the configuration there is more than one busbar substation, and each feeder forms a closed circuit with the substation. The advantage of loop configuration is that the delivery of electric power from the substation is safer and more secure. Because if one substation experiences interference, the feeder will continue to get supplies from the other substation without interference. and substations that experience interference can be repaired without fear of disrupting the power supply to the distribution substation [9].

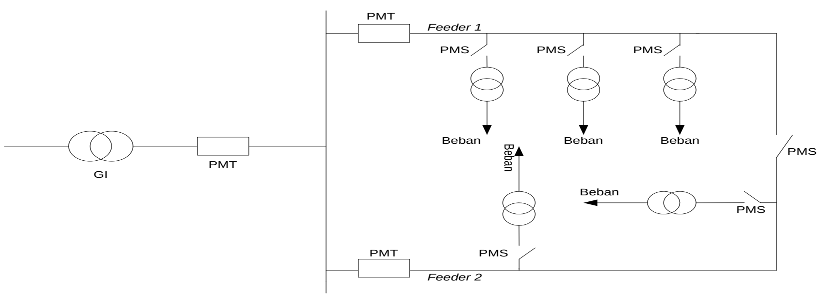

Figure 2: Diagram Of One Line Loop Distribution System

2.2.3 Spindle Configuration Distribution Channels

Spindle configuration channel is a series connection between distribution substation which both ends are connected by busbar substation and substation connecting. Express feeder functions as a backup feeder that will supply the electrical power when the feeder is disturbed. In this spindle network there are several feeders that are supplied by GI and end at a relay substation. Figure 2.5 is a form of spindle configuration distribution channel [9].

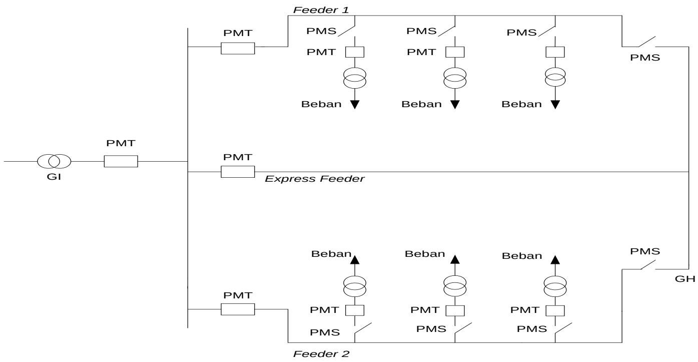

Figure 3: Diagram Of One Spindle Distribution System Line

2.3 Voltage Drop

Voltage drop is the voltage generated by an electric current that flows through the resistance wire conductor. The voltage falling on the conductor is greater if the current I in the conductor is greater and the resistance of conductor Rℓ is also greater. Voltage drop is the amount of voltage lost in an electrical conductive conductor. The voltage drop on an electric power line is generally directly proportional to the length of the line and the load and inversely proportional to the conductor cross-sectional area. The voltage drop equation is determined from the power transmission phasor diagram in Figure 4.

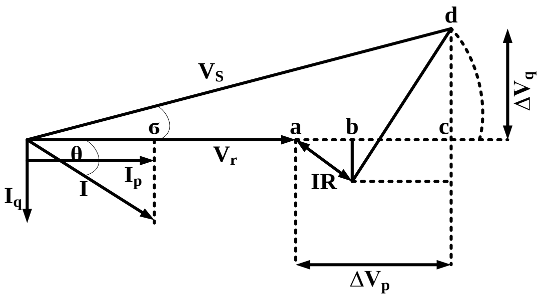

Figure 4: Diagram Of Power Load Transmission Phasor Series

The load contained in electric power has a resistive-inductive nature. The load absorbs the active and reactive power generated by the generator. Absorption of reactive power due to inductive loads causes voltage drops on the voltage sent by the generator. Causes the receiver side voltage value is different from the sending side voltage value. The voltage drop equation can be seen in equation 1.

$$\Delta V = I \times Z \quad (1)$$

Information:

ΔV = voltage drop (volt)

I = current (Ampere)

Z = impedance (ohms)

Voltage drop (ΔV) is the difference between the sending voltage (VS) and the receiving voltage (VR), then it is defined in equation 2.

$$\Delta V = VS \times VR \quad (2)$$

Information:

ΔV = voltage drop (volt)

VS = send voltage

VR = receiving voltage

2.4 Power Losses

The choice of the type of conductive cable used in the distribution network is an important factor to consider in the planning of an electric power system. Type of conductive cable with a small resistance value can reduce power losses. Power losses are the amount of electrical power lost in a channel, the amount of which is equal to the power supplied from the source minus the amount of power received. The amount of power losses in the distribution network can be written as follows:

$$\Delta P = I2.R \text{ (watt)} \quad (3)$$

Information:

ΔP = network power loss (wattage)
I = Load current on the network (ampere)
R = pure resistance (ohms)

For power losses in a three phase network expressed by the equation:

$$\Delta P = \sqrt{3}.\ I^2.R \text{ (watts)} \quad (4)$$

The current along the wire can be considered the same and the magnitude is the same as the current at the receiving end.

$$I = \frac{P}{\sqrt{3}V\ I\cos\ \varphi} \quad \text{amperes} \quad (5)$$

The amount of power in the three phase channel is:

$$P = \sqrt{3}\ V\ I\ Cos\ \varphi \quad \text{watts} \quad (6)$$

Information:

P = load power at the receiving end of the channel (watts)
V = phase voltage (volts)
Cos φ = load power factor

Voltage is also very influential on power losses, the greater the voltage on a channel, the smaller the current on the channel. While the current is one factor that affects the size of the power losses in a channel.

2.5 Ground Safety System

Requirements for an effective ground system :

a. Make a low impedance line to the ground for safety and equipment by using an effective circuit.
b. Can resolve and spread repetitive interference and currents due to the solar circuit.
c. Use corrosion-resistant material against various soil chemical conditions, to ensure continuity in appearance throughout the life of the equipment being protected.
d. Use mechanical materials that are strong but easy to care for and repair when damage occurs.

The balanced current load equation for 380 volt voltage is shown in equation 7 below:

$$I\ Rata-rata = \frac{I_{RT} + I_{TS} + I_{TR}}{3} \quad (7)$$

To determine the earth ground resistivity using the equation below:

$$R = \frac{\rho}{4}\sqrt{\frac{\pi}{4}} \quad (8)$$

Information :

R: Grounding Resistors (ohms)
ρ: soil resistivity (ohm-meter)

The smaller the resistance value of the earth system, the better it is especially for personal security and equipment. The agreed standard is that the substation transmission line must be planned in such a way that the ground resistance value does not exceed 1 Ω for earth resistance in the system / data communication and the maximum allowable prisoner price 5 Ω for the building / building [6].

3. Methodology

Data that has been processed to obtain the value of power and electrical energy is then analyzed as follows:

a. Calculate the voltage drop using the equation $\Delta V = I \text{ x } Z$

b. Calculate the power loss of 1 phase by using the equation $\Delta P = I2.R$ (watt) and 3 phases $\Delta P = \sqrt{3}.\ I2.R$ (watts)

c. Calculate a balanced current load for a voltage of 380 volts using the equation

d. Calculate the value of earth using the equation

Based on the phases above, a research implementation framework can be arranged. The research begins with preparations in the form of personal preparation, preparation of determining work steps and preparation of equipment to be used. Each person has their own tasks and is assisted by outside staff to conduct field surveys. Subsequently determined work steps compiled in a research flow chart (Fishbone Diagram) as illustrated below.

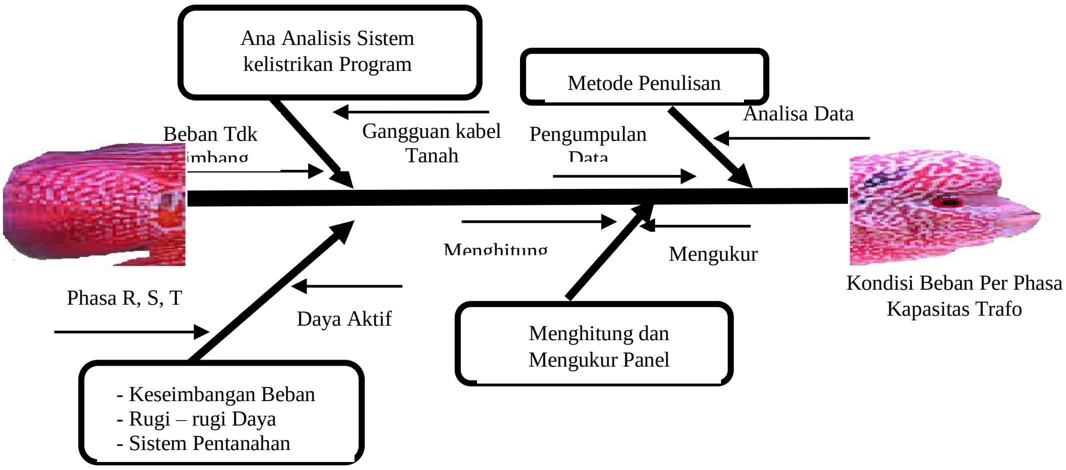

Figure 5: Research Flow Chart (Fishbone Diagram)

4. Result and Discussion

4.1. Calculation of load usage at the Lancang Kuning University Postgraduate Building uses with a load of R = 25 amperes, load S = 22 amperes and load T = 24 amperes. Calculation of 3 phase load usage can be calculated as follows:

4.2. The total power consumption with a maximum power factor of 0.98 with a transformer capacity of 100 kVA is as follows:

$P = KVA \text{ x } \cos \varphi$

$= 100 \text{ x } 0.98$

$P = 98 \text{ kW}$

Assuming that the initial cos φ ($\varphi 1$) is 0.95, it can be found using the following equation:

$Q1$ = P x tan $\varphi 1$

= 98 x tan (cos-1 0.95)

= 98 x 0.32

= 31.36 kVAr

Assuming that the initial cos φ ($Q2$) is 0.99 (cos φ at best 1 or 0.99), it can be found using the following equation:

$Q2$ = P x tan $\varphi 2$

= 98 x tan (cos-1 0.99)

= 98 x 0.14

= 13.72 kVAr

From the above calculation, it is known that the large capacitors needed to improve the power factor can be calculated as follows:

$Qc = P\ x$ (tan $Q1$ - $tan\ Q2$)

= 98 x (0.32 - 0.14)

= 98 x 0.18

= 17.64 kVAr

From the calculations above, the Lancang Kuning University Postgraduate Building can be installed with capacitors with a capacity of 17.64 kVAr or 18 kVAr

4.3. The voltage drop that occurred at the Lancang Kuning University Postgraduate Building was with a wire impedance of 95 mm2 = 0.3396 + j 0.3449

ΔV = I x Z

Then the voltage drop is as follows:

ΔV = I x Z

= 23.3 x 0.605

ΔV = 14.4 volts

Meanwhile, to determine the calculation of the power loss with the value of resistance (R) twistead cable size 95 mm2 = 0.605 ohm-meter, then obtained:

□P = I2 x R

= (23.3) 2 x 0.605

= 542.89 x 0.605 watts

= 339.8 watts

□P = 0.340 kW

4.4. To calculate the earth ground resistance of a building using the equation below :

Based on the calculation results obtained an average current size at a voltage of 3 phase 380 volts of 23.3 amperes, a large power capacity of 98 kW, a voltage drop of 14.4 volts, a power loss of 339.8 watts and a large earth resistance value of 22.15 ohms. While the measurement of earth resistance at the wire point is 66 ohms, the measurement value exceeds the calculated value and the value of the earth resistance at the neutral point of the measurement is 52 ohms, meaning that the large value of the ground resistance of the neutral point exceeds the calculation results. This means that the measurement value of the wire point resistance is 66 ohms and the earth resistance at the neutral point is 52 ohms.

5. Conclusion

Based on the results of the discussion, the conclusions obtained at the Lancang Kuning University Postgraduate building are as follows:

1. The average current size at a voltage of 380 volts is 23.7 amperes,

2. Large power capacity of 98 kW,

3. Large voltage drop of 14.4 volts,

4. The amount of power loss is 339.8 watts or 0.340 kW

5. The value of the earth resisting results of the discussion and calculation is 22,15 ohms, while the measurement of earth resistance at the earth wire point is 66 ohms and the earth resistance at the neutral point is 52 ohms, then the measurement value of the earth resistance exceeds the value of the discussion and calculation of 22.15 ohms.

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References

[1] Abrar Tanjung, Arlenny, 2015, Analisis Kinerja Sistem Kelistrikan Fakultas Hukum Universitas Lancang Kuning Pekanbaru, Jurnal Teknologi, Vol. 8 No. 1 Fakultas Teknologi Industri Institut Sains & Teknologi Apkrind Yogyakarta. ISSN 1979-3405

[2] Abrar Tanjung, 2015, Analisis Sistem Pentanahan Transformator Distribusi Di Universitas Lancang Kuning Pekanbaru, Jurnal SITEKIN UIN Susqa, Vol. 12 No. 2, Pekanbaru, ISSN 2407-0939 (On Line)

[3] Abrar Tanjung, 2019, Analisis Kinerja Sistem Kelistrikan Akibat Penambahan Gedung Fakultas Keguruan Ilmu Pendidikan Universitas Lancang Kuning, UNITEX Vol 12 No.2 Juli-Desember 2019, STT Dumai

[4] As Pabla, 1994, Sistem Distribusi Daya Listrik, Erlangga, Cetakan Pertama.

[5] Budi Setyo, 2014, Korsleting Listrik Penyebab Kebakaran Pada Rumah Tinggal Atau Gedung, Edu Elektrika Journal, EDUEL 3 (2) (2014), Universitas Negeri Semarang

[6] Hutaruruk, 1991, “Pengetanahan Netral Sistem Tenaga”, Erlangga, Jakarta

[7] Ikrul Sadi, 2014, Keseimbangan Beban Pada Instalasi Listrik Di Gedung Riset Tsunami, Universitas Syiah Kuala Banda Aceh.

[8] Surya Darma , 2012, Analisis Pengaruh Ketidakseimbangan Beban Terhadap Arus Netral Dan Losses Pada Trafo Distribusi 200 KVA, Jurnal Teknik Elektro, vol 1 nomor 2 februari 2012, ISSN 2089-2942

[9] Zuhal, 1991, “ Dasar Tenaga Listrik “, Penerbit ITB Bandung