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Overcoming Power Loss in Hospital Electricity in Tangerang Regency with the Matlab Method

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Abstract

Efforts to save on the use of electric power are absolutely necessary in industries, institutions, and households. As the demand for electricity increases, there must be steps to overcome it. Inductive load with low power factor, the load current is getting bigger so it needs improvement in power factor. PLN imposes kVARh fines on customers. The purpose of this study is to overcome power losses at a hospital in Tangerang Regency as an effort to save electricity usage costs by installing capacitor banks. This tool serves as an electricity saver to reduce reactive power in electric loads. From the results of the comparative study of the power factor before repair cos φ1 0.67 and the power factor after repair, namely cos φ2 0.96 greatly affects the value of the reactive power, if before the installation of the reactive power bank capacitor is Q1 which is 130.50 kVAR then after installing the capacitor bank or improvement in the power factor, the value of the reactive power decreased by 93.58 kVAR to Q2, namely 36.92 kVAR.

Keywords: *Inductive Load, Power Loss, Capacitor Bank, Power Factor.*

1. Introduction

In the world of electricity in industry, it is often found that inductive loads with a low power factor cause the load current to increase so that improvements in the power factor are needed. PLN imposes kVARh fines on industrial customers, if the power factor (cos φ) is less than 0.85. With this fine from PLN, PLN will benefit if the power factor is not improved in each industry. One way to improve the power factor of an inductive load is by installing a capacitor according to the required value. Capacitor installation can be done in parallel or in series to the power source so that losses due to kVARh fines can be overcome [1] [2].

Today's PLN consumers are advised to use bank capacitors, because many industries use motors that are included in the inductive load or non-linear load. This will cause the value of power efficiency or power factor cos φ on the network to decrease, causing losses to industry players [3] [4]. Industrial consumers who use a lot of motorbikes will be fined for reactive power or kVARh from PLN. To get rid of the losses caused by kVARh fines, it is better if consumers in the industry use bank capacitor panels to increase the facto value of their power beyond that determined by PLN which is valued at 0.85 [5]. Apart from the above problems, the reasons for using bank capacitors also exist on the inductive load side, this is what makes the power factor less than 1 [6]. Examples of equipment that have inductive loads are air conditioners, refrigerators, fans, water pumps, washing machines, and equipment that uses both 1-phase and 3-phase motors or also commonly referred to as components that have windings. In AC current, all loads connected to the type of inductive load will cause lagging, namely the current lagging against the voltage and the problem is that most of the electric load is inductive. Therefore, capacitor banks play an important role in maximizing the power factor [7] [2].

2. Method

This research starts from collecting previous research journals that can be used as research references. In this study, an analysis will be carried out on the effect of installing capacitor banks in the Tangerang District

Hospital. The results of this study were taken to determine the benefits and impacts of using bank capacitors on power, voltage, and current [8].

2.1 Tools and Materials

Tools

In its implementation, this research requires several tools for research, some of the tools that will be used to support this research, including the following:

1. Laptop
2. *Megger*
3. *Multimeter*
4. Matlab R2013a
5. *Microsoft Word* 2010
6. *Microsoft Visio* 2013

Materials

Some of the ingredients needed for the success of this study are as follows:

1. Capacitor bank
2. *Power Meter Digital*
3. *Power Factor Regulator*

2.2 Research stages

Broadly speaking, the stages of this research consist of literature studies, data collection, manual calculations, making simulink matlab simulations, data analysis and comparing results. The stages of making in this study can be seen in Figure 1.

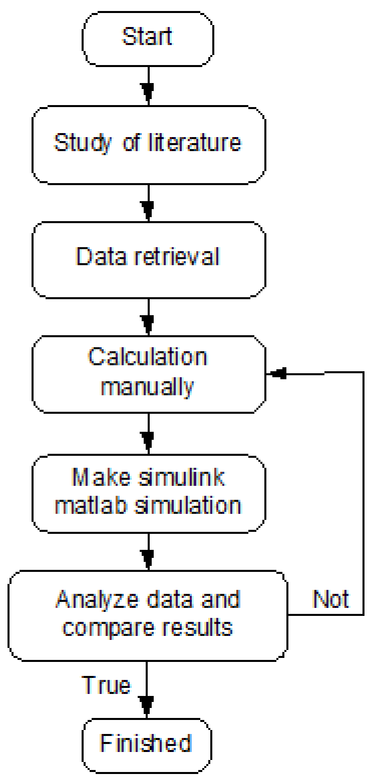

Figure 1. Research stages

2.3 System planning

In designing this system, it begins with data collection on the power meter contained in the LVMDP panel by looking at the current and voltage in the R S T phase. The next step is to process the data that has been obtained

and create a simulation from the data. Then the calculation results are analyzed with graphs and simulations that have been made are tested and get the results [9].

3. Result and Discussion

Based on the data in Table 1, the average values of apparent power, active power, and reactive power after power factor improvement can be seen in Table 1 below.

Table 1: Average apparent power, active power, and reactive power after power factor improvement

Day	Apparent Power(kVA)	Active Pwer (kW)	Reactive Power (kVAR)
Monday	343,5	328	39,8
Tuesday	346,16	337,33	35,33
Wednesday	342,33	332,66	37,83
Thursday	350,66	340,16	36,83
Friday	338,66	331,33	34,83
Mean	344,26	333,89	36,92

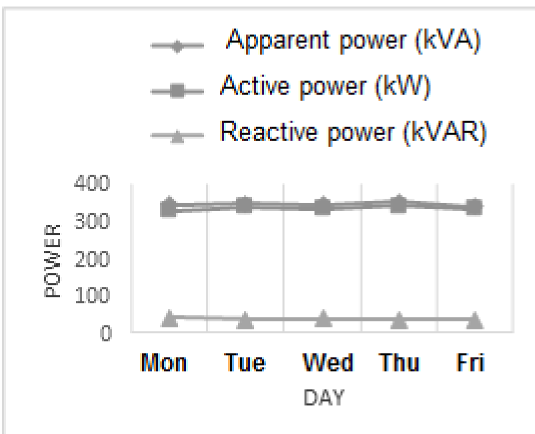

Fig. 2 Graph of average apparent power, active power, and reactive power after power factor improvement

Based on Figure 1, it can be seen that the highest apparent power value occurs on Thursday at 350.66 kVA and the lowest occurs on Friday, which is 338.66 kVA. The highest active power occurred on Thursday, which was 340.16 kW and the lowest active power occurred on Monday, which was 328 kW. The highest reactive power occurred on Monday, namely 39.8 kVAR and the lowest reactive power occurred on Friday, namely 34.83 kVAR. The average values for the 5 days of the study were apparent power of 344.26 kVA, active power of 333.89 kW, and reactive power of 36.92 kVAR.

Table 2: Average voltage rating after power factor improvement

Day	Voltage (V)		
	R	S	T
Monday	236,13	235,95	235,79
Tuesday	229,89	229,71	229,60
Wednesday	216,49	216,30	216,22
Thursday	230,49	230,47	227,12
Friday	227,20	226,35	226,82
Mean	228,04	227,756	227,11

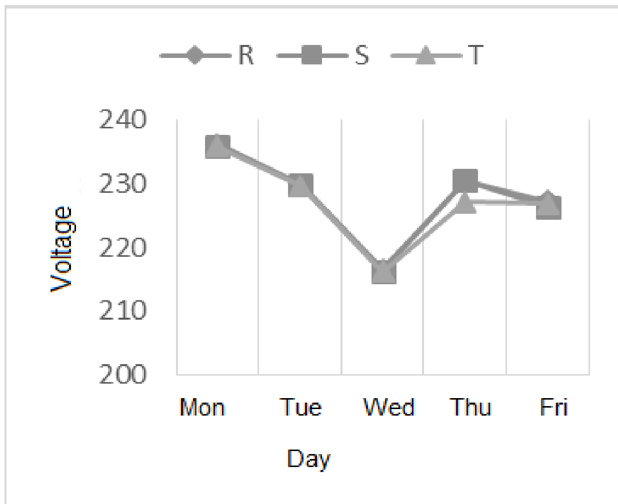

Fig. 3 Voltage graph after power factor improvement

Based on Figure 2, it can be seen that the highest value in the R phase occurs on Monday at 236.13 V and the lowest occurs on Wednesday, which is 216.49 V. For the S phase the highest value occurs on Monday, which is 235.95 V and The lowest value of the S phase occurs on Wednesday, which is 216.30 V. The highest T phase occurs on Monday, which is 235.79 V and the lowest T phase occurs on Wednesday, namely 216.22 V. The 5 days of research, namely the R phase of 228.04 V, the S phase of 227.756 V, and the T phase of 227.11 V. The comparison of active power, apparent power, and reactive power before and after power factor improvement can be seen in Figure 3.

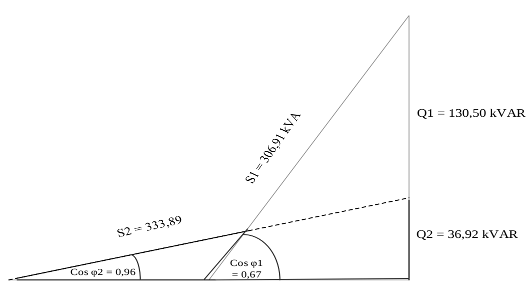

Fig. 4 Voltage graph after power factor improvement

It can be seen that the power factor ratio before repair is cos φ1 0.67 and the power factor after repair is cos φ2 0.96 greatly affects the value of the reactive power if before installation the reactive power bank capacitor is Q1 which is 130.50 kVAR then after installing the capacitor bank or improvement in the power factor, the value of the reactive power decreased by 93.58 kVAR to Q2, namely 36.92 kVAR. For active power, the comparison before repairing active power or P1 was 207.006 kW and after repairs using a capacitor bank the active power increased from 137.254 kW to P2, namely 344.26 kW. Meanwhile, the pseudo power comparison before the installation of bank capacitors is S1, namely 306.91 kVA and after installing the capacitor bank to S2, which is 333.89 kVA, the difference is only 26.98 kVA which is not too significant because pseudo power is the power provided by PLN as an electricity supplier

Table 3: Comparison value before and after power factor improvement

Day	Post Voltage (V)			Pre Voltage (V)		
	R	S	T	R	S	T
Monday	236,13	235,95	235,79	146,40	146,28	146,18
Tuesday	229,89	229,71	229,60	142,53	142,42	142,35
Wednesday	216,49	216,30	216,22	134,22	134,10	134,05
Thursday	230,49	230,47	227,12	142,90	142,89	140,81
Friday	227,20	226,35	226,82	140,86	140,33	140,62
Mean	228,04	227,756	227,11	142,33	142,17	142,07

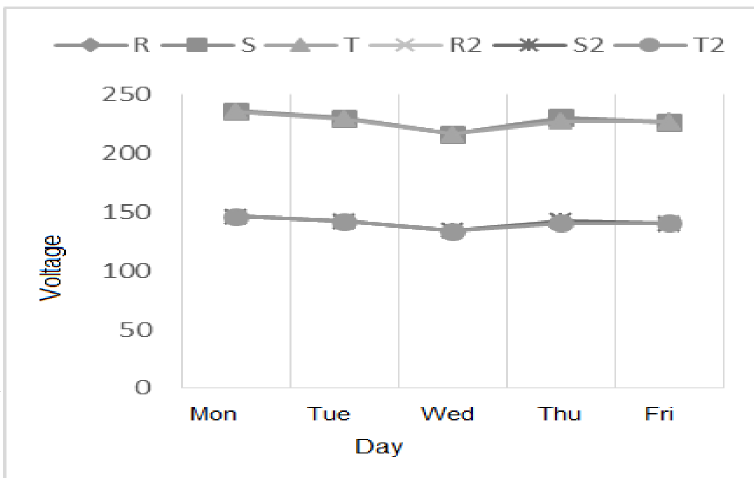

Fig. 5 Voltage comparison graph before and after power factor improvement

Based on Figure 4, it can be seen that the effect of installing capacitor banks to improve the power factor affects the amount of voltage flowing in the R, S, and T phases. As on Monday, the difference in voltage between the R phases before and after the power factor repair is 89.73 V , the S phase before and after the power factor improvement was 89.67 V, and the T phase before and after the power factor improvement was 89.61 V. On Tuesday the difference in voltage between the R phase before and after the power factor improvement was 87, 36 V, the S phase before and after the power factor improvement was 87.29 V, and the T phase before and after the power factor improvement was 87.25 V. On Wednesday, the difference in voltage between the R phase before and after the power factor improvement was equal to 87.27 V, the S phase before and after the power factor improvement was 82.2 V, and the T phase before and after the power factor improvement was 82.17 V. eg the difference in voltage between the R phase before and after the power factor improvement is 87.59 V, the

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4. Conclusions

Based on the research that has been confirmed, it can be seen that the power factor ratio before repair is cos φ1 0.67 and the power factor after repair is cos φ2 0.96 greatly affects the value of the reactive power if before the installation of the reactive power bank capacitor is Q1 which is 130.50 kVAR Then after installing the capacitor bank or improving the power factor the value of the reactive power decreased by 93.58 kVAR to Q2, namely 36.92 kVAR.

Based on the research that has been done, it can be seen that the effect of installing capacitor banks for power factor improvement affects the amount of voltage flowing in the R phase of 85.71 V, the S phase of 85.586 V, and the T phase of 85.26

Based on the ETAP experiment that was carried out by making a power factor before the repair, namely 0.67, the results obtained in the load flow report that the load on bus 1 is 204 kW with a passing current of 26.8 A. The results obtained from the load flow report are that the load contained in bus 1 is 320 kW with the current passing is 29.2 A. Then the ratio obtained by the load with the power factor before and after repair is 116 kW while the current ratio is not too away at 2.4 A.

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