OPTIMIZATION OF ELECTRIC POWER FACTORS BASED ON FUZZY LOGIC CONTROLS: CASE STUDY AT NURUL JADID ISLAMIC BOARDING SCHOOL

Ahmad Muhtadi[1], Bambang Sujanarko[2], Bambang Sri Kaloko[3]
Electro Engineering, University of Jember
[1]muhtadi1703@gmail.com, [2]bbsujanarko@yahoo.co.id, [3]kaloko@unej.ac.id

Abstract

This paper discusses about the optimizing electrical power using bank capacitors that are controlled using fuzzy logic. Bank capacitor is one of the electronic components built from a number of capacitors, where the function and purpose are to repair cos phi or also called the power factor, while fuzzy logic is an orientation of human thinking more flexibly used as a control control system. To prove the flexibility of fuzzy logic in the control system it will be done by applying the fuzzy logic algorithm on bank capacitors to be able to optimize the power factor.

Keywords power factor, fuzzy logic, capasitor bank

INTRODUCTION

Power factor is the ratio between real power (P) and apparent power (S). In electric power systems, the power factor is often also called Cos Phi, power factor correction is used to increase the power factor and to reduce harmonics on the supply side. The power factor, PF, is the ratio of average power (P) to apparent power (S). Low power factor is caused by the number of inductive electrical equipment which results in the amount of losses that occur in the electrical system due to the large amount of current needed for reactive power. According to the previous journal, the power factor [1-2].

Fuzzy logic controllers have been applied to several systems by developing fuzzy logic control algorithms, Fuzzy Logic control systems that are used there are two inputs and one Fuzzy Logic Controller output. Where the two inputs are selected as "Error" and "Delta Error" while the output is "Duty cycle" That the output voltage is felt and compared to the reference voltage or set point. "Error" is the difference between the reference value and the actual value. Likewise "Delta Error" is the difference between the current error and the previous error [3]. The design and calculation of components for inductors has been carried out to ensure the converter operates in continuous conduction mode. Output evaluation is compared to the application of software using the MATLAB application. Fuzzy logic controls are implemented to get the power factor near unity, at reducing higher harmonics in the input current [4-5]. To overcome this problem several converter topologies and control schemes have been proposed in recent years. The previous paper proposed to study control techniques to improve the power factor converter and reduce total harmonic distortion in the input current by regulating the output voltage. This fuzzy logic control strategy is to increase power control factors. The proposed Fuzzy Logic control system is a two input one Fuzzy Logic Controller output [6].

Reactive power compensation in power distribution networks plays an important role in increasing the voltage and stability of the power system. Increased loading of the transmission line can sometimes cause voltage collapse due to lack of reactive power sent at load centers [7]. The conditions in the Nurul Jadid Islamic Boarding School at this time there are quite a lot of inductive loads in the form of electric machines that cause reactive power which will ultimately reduce the value of the power factor. The next result of this was an increase in electricity bills to be paid by Islamic boarding schools. Therefore, based on the problems stated above, it is necessary to improve the electric power factor in installations in Islamic boarding schools with electric power optimization. Besides improving the power factor, it is also hoped that the electricity bill from the State Electricity Enterprise.

RESEARCH METHODS

a. Stages of Research

The study begins with a literature study on the notion of power and power factors and their improvement. From the results of this study, the research objectives were formulated. Then the data needed is taken that is the electric power and the cost of electricity bills in one month. Based on these data it can be calculated the value of the power factor and the value of the capacitance needed for compensation so that the power factor can be corrected. The next step is to test Matlab / Simulink as well as control in optimizing.

b. Research sites

This research was conducted at the Nurul Jadid Islamic Boarding School in Karanganyar Village, Paiton District, Probolinggo Regency, East Java Province.

c. Variable Observation

Based on the variables obtained from previous studies, the variables observed and examined include the effects:

- Output variable:

  Qc : power compensated capacitors (kVAR)

  pf : power factor

- Input variable:

  P : active power (Watt)

  Q : reactive power (VAR)

  S : false power (VA)

  State Electricity Enterprise electricity bill

d. Data Collection and Analysis Techniques

Data collection techniques carried out to obtain the power factor (cos phi) in the form of electricity bills State Electricity Enterprise is using observation techniques. Preliminary data were obtained from the State Electricity Enterprise electricity bill for six months. Further data, after the Matlab / Simulink trial.

Data analyzed in the form of active power data, reactive power, apparent power, and nominal electricity bill in the form of fine cover must be paid. Data analysis was carried out by calculating the reactive power compensation needed by using the existing calculation method to obtain the value of the Matlab / Simulink test against the appropriate capacitor bank. All of these controllers are verified by Matlab / Simulink simulation through the use of a continuous time factory model and a discrete time controller [8].

RESULTS AND DISCUSSIONS

In this section we will provide research data and results via simulink on the matlab application. Following below are the research data, simulink images and results.

a. Research data

Power and power factor measurements are performed when the condition does not use a capacitor to determine the reactive power required by the load. Power factor measurements are attempted during peak loads and measurements are made using cos phi meters measured in the distribution panel.

The following data is the measurement of power and power factors :

Table 1. Power & Cos φ Measurement Data

30-31 July 2019				
Time	**kW**	**kVAR**	**kVA**	**Cos ϕ**
03:00-04:00	593,995	370,36	700	0,85
05:00-06:30	340,612	294,08	450	0,76
06:30-07:00	315,313	246,13	400	0,79
08:00-11:00	478,701	361,73	600	0,80
12:00-15:00	440,489	329,35	550	0,80
16:00-17:30	361,431	268,08	450	0,80
18:00-22:00	361,694	345,22	500	0,72

b. Fuzzy Controller Structure

The first important step in the definition of a fuzzy controller is the selection of input variables. To improve operations, we need additional information about the power factor, namely active power and reactive power. This application enables a substantial increase in Simulink performance with gains in optimized power factors. Thus, in the proposed fuzzy controller we use two input variables and one output variable:

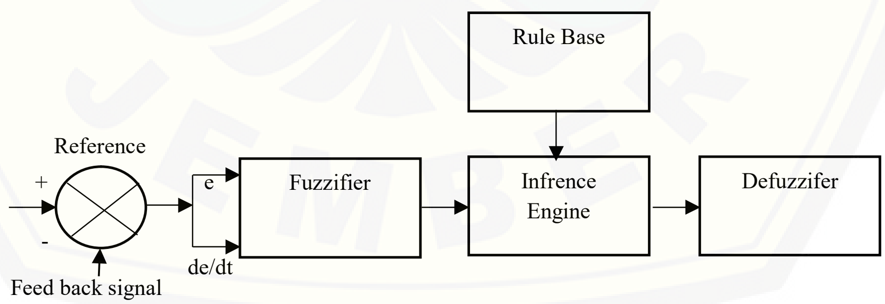

Fig. 1 Block diagram of typical fuzzy logic controller

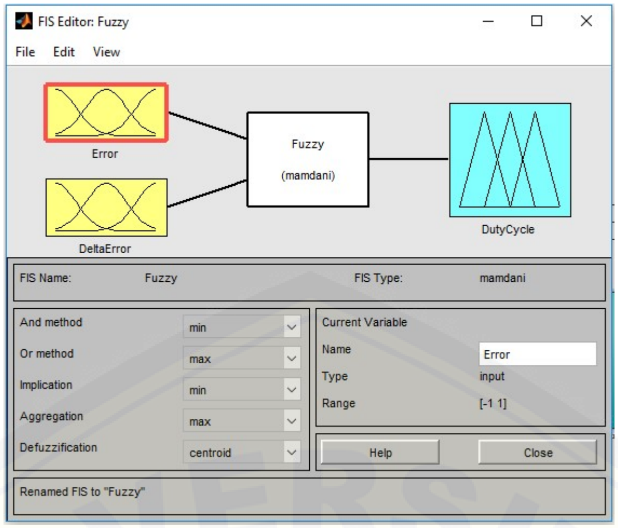

Fig. 2 FIS Editor

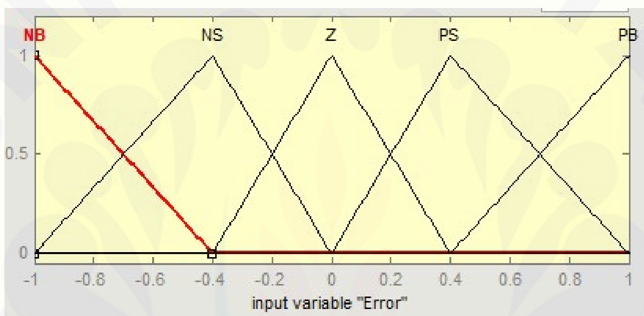

Fig. 3 Membership functions shapes for Eror

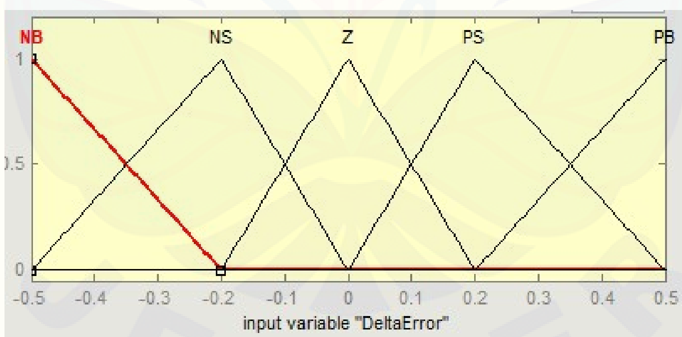

Fig. 4 Membership functions shapes for DeltaEror

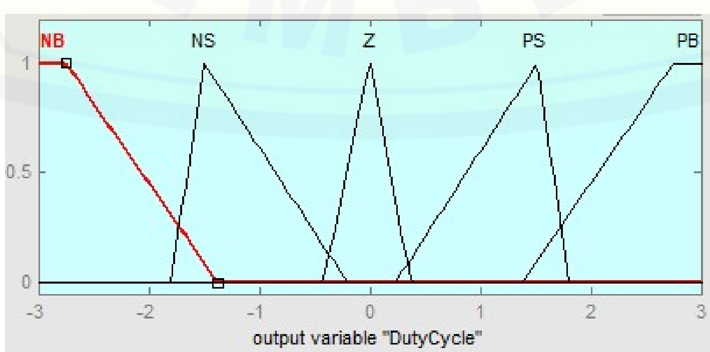

Fig. 5 Membership functions shapes for DutyCycle

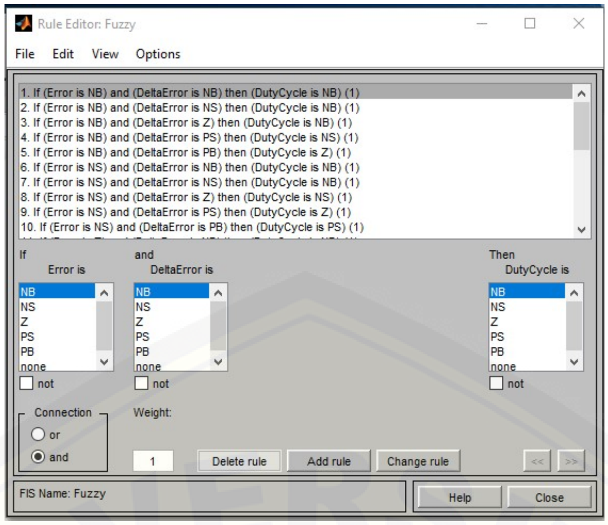

Fig. 6 Rule Editor

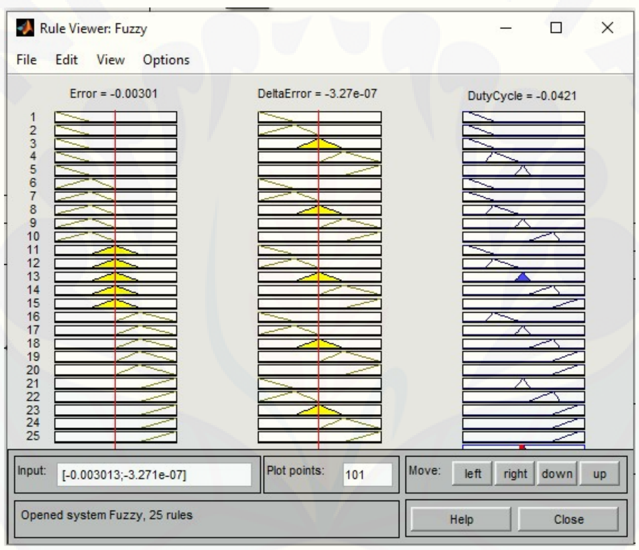

Fig. 7 Rule Viewer

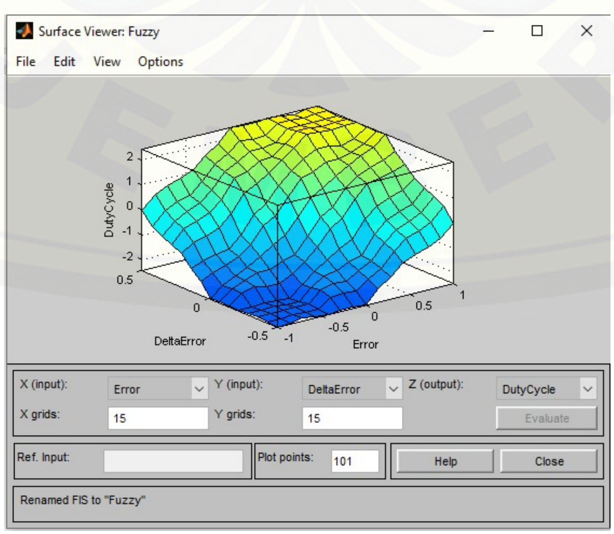

Fig. 8 Surface Viewer

c. Simulation Model and Results

Optimization power factor with fuzzy logic controls discussed in the previous session was validated using MATLAB / SIMULINK Software as shown in figures 9, 10 and 11.

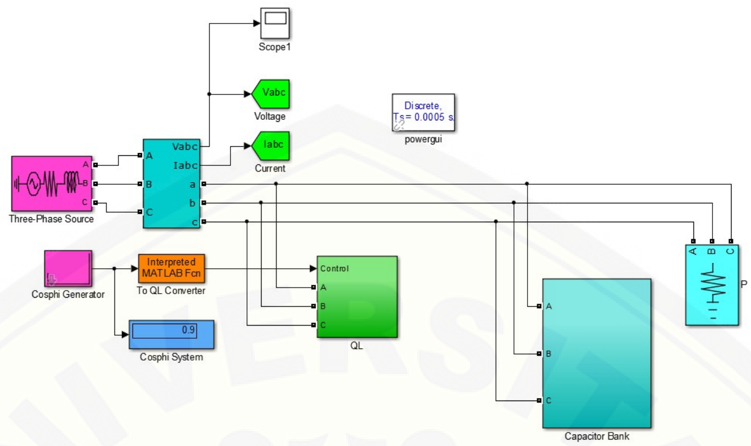

Fig. 9 Power Factor Optimization Simulation Circuit

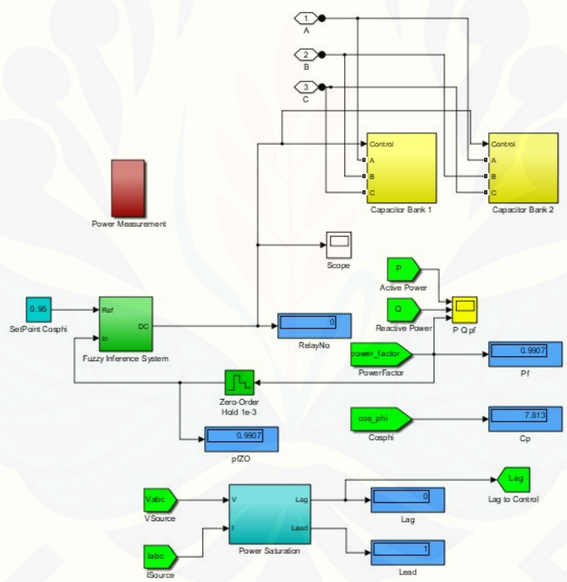

Fig. 10 Capacitor Bank Simulation Circuit

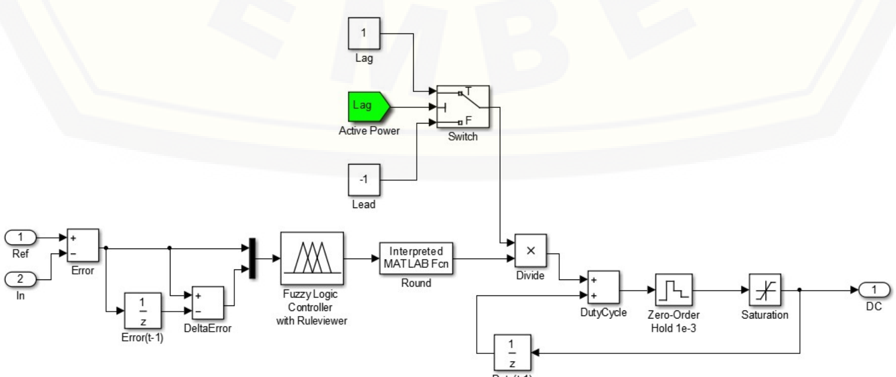

Fig. 11 Circuit Fuzzy logic controller simulation

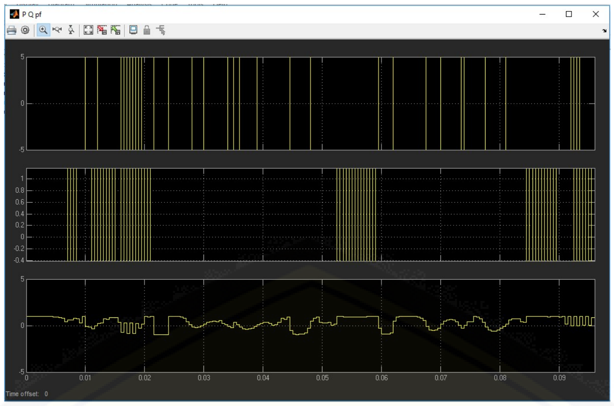

Fig. 12 Graph of simulation results

Table 2. Comparison of results before and after using Fuzzy Logic Controls

Research Measurement Data						Results Data	
Time	**kW**	**kVAR**	**kVA**	**Cos ϕ**	**QC**	**pf**	**Cos ϕ**
03:00-04:00	593,995	370,36	700	0,85	82,68	0,9907	0,95
05:00-06:30	340,612	294,08	450	0,76	129,11	0,9356	0,95
06:30-07:00	315,313	246,13	400	0,79	93,41	0,9601	0,95
08:00-11:00	478,701	361,73	600	0,80	129,88	0,9648	0,95
12:00-15:00	440,489	329,35	550	0,80	116,01	0,9677	0,95
16:00-17:30	361,431	268,08	450	0,80	93,03	0,968	0,95
18:00-22:00	361,694	345,22	500	0,72	170,04	0,907	0,95

CONCLUSION

Based on the results of the discussions and trials conducted, the following conclusions can be drawn:

1. At 03: 00-04: 00 the peak load of the power factor value is 0.9907 and at the lowest peak at 18: 00-22: 00 the power factor is 0.907
2. After the system power factor is improved by using fuzzy logic controls, the system's power factor has increased to 0.95. In all conditions
3. The application of the fuzzy logic control method to the optimization of power factors is more efficient and optimal in the use of electric power.

REFRENCE

[1] Zeynep Bala Duranay, Hanifi Guldemir, Servet Tuncer (2018). Fuzzy Logic Controlled Unity Power Factor Converter. *International Journal of Scientific & Engineering Research (IJSER), 9 (4).*

[2] A. Kessal, L. R. (2012). Power Factor Correction based on Fuzzy Logic Controller with Fixed Switching Frequency. *International Standard Serial Number (ISSN 1392 – 1215)*, 118.

[3] G. Bhanumanjari, O. Ranjitkumar (2015) A Fuzzy Logical Controlled New Power Factor Correction Technique Using Pfc Boost Converter. *International Journal Of Professional Engineering Studies (IJPRES) 4 (5),* 3.

[4] Moh Moh Myint Aung, Y. A. (2016). A Fuzzy Logic Approach for Improvement of Power Quality Using FC-TCR. *American Scientific Research Journal for Engineering, Technology, and Sciences (ASRJETS) , 26* (2), 239.

[5] VS Prasadarao K, Menikanta Sai Yarra, Sai Pramod Kumar Maddi. (2017). Comrative Analysis of Fuzzy and PI Controller Based Two Switch Buck-Boost Converter for Power Factor Correction. *International Journal of Applied Engineering Research (ISSN 0973-4562) 12 (1),* 297.

[6] P.Kripakaran, J. R. (2014). Power Factor Correction Using Fuzzy Logic Control. *IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE) , 9* (1), 11.

[7] Periyasamy, K. (2012). Power Factor Correction Based On Fuzzy Logic Controller With Average Current-Mode For DC-DC Boost Converter. *International Journal of Engineering Research and Applications (IJERA) , 2* (5), 771.

[8] Pranali V. Narayane, D. H. (2018). Power Factor Correction of a Single Phase AC to DC Interleaved Boost Converter using Fuzzy Logic Controller. *International Journal of Trend in Scientific Research and Development (IJTSRD) , 2* (4), 1884.