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ANALYSIS STUDY MODEL OF HARMONIC FILTER OF POWER SYSTEM FOR FL-5 LOAD ON PL-LB / 2 USING ETAP

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ABSTRACT

Current harmonics and harmonic stresses are one of the common problems that occur in a power system that has a constituent component in the form of a non-linear load. Current harmonics and harmonic stresses can affect the stability of the power system itself and provide a bad impact on other electrical components, therefore a step that needs to be done to minimize the adverse effects of the case is one of them is by using a passive filter. In this study, the design of the High Pass Damped Filter model will be carried out using reference from the data obtained from measurements and simulations, so that it can be seen how much influence the high-pass damped filter can reduce the current and voltage harmonics contained in the system with the help of ETAP software to analyze filter design for FL-5 load on PL-LB / 2.

Keywords: harmonic, model, reduce, ETAP.

1. INTRODUCTION

In the electric power system, is it the burden of household electricity, buildings and industry there had to be a linear load and non-linear loads. The Linear load has a perfect sinusoidal waveform while the non-linear load generally has a coil therein and containing semi-conductor materials that make waveform non-linear load into a non-sinusoidal harmonic distortion because it has experienced. Harmonic is a symptom of the formation of the wave with a frequency that is not essentially frequency, so the frequency is formed integer multiplication with a frequency essentially while integer frequency multiplier is essentially a sequence of harmonic numbers [1-3]. One contributor to the harmonic distortion in the electrical system project on Mall at Jakarta are on PL-LB / 1 and PL-LB / 2, where the majority of the load on the panels are non-linear load in the form of lights fluorescent and saving lamps energy [4-5].

These lamps generally have a rectifier circuit and ballast in it, whereas many electronic appliances using semi-conductor materials such as Diodes, Silicon Controlled Rectifier (SCR), transistors, semi-conductors and other equipment where a semiconductor material that causes distortion current and voltage, because the voltage into the system is not proportional to the output voltage or in other words distorted [6-7]. According to [8], fluorescent light is one of the largest sources of harmonics because many uses in the present life and can accumulate. Order of the dominant harmonic currents appear on this fluorescent lamp load is on the order of the third, fifth and seventh if the fluorescent lamp using magnetic ballasts. While the fluorescent lamps that use electronic ballasts, harmonic currents appear dominant on the order of all five [9-12].

Harmonic problems in PL-LB / 2 in a mall affect voltage stability resulting in flicker on basement floor lighting that occurs at certain times and periods. This study will develop a model design and design of the High-Pass Damped Filter model, which is used to reduce harmonic interference in the electrical system. Then the filter design was analyzed for FL-5 load on PL-LB/2.

2. RESEARCH METHOD

Methodology or approach that will be pursued are: Conducting the study of literature and the analysis was based on initial data from previous studies of models of test equipment used to reduce harmonic interference from the electrical system as well as data collection and modeling simulation early stage by ETAP Power Station, see Figure-1.

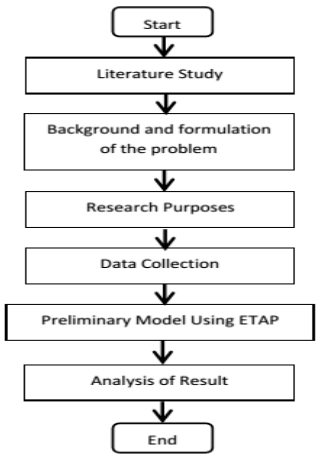

Figure-1. Flowchart of research method.

3. RESULTS AND DISCUSSIONS

3.1 Measurement data of load

Load measurement data retrieval is done when the system is operating as shown in Figure-2 below, the basic principle of the measurement is almost the same as using a Voltmeter or Ampere-meter but the results are to be obtained with this measurement is the current and voltage harmonic components on the specific orders of.

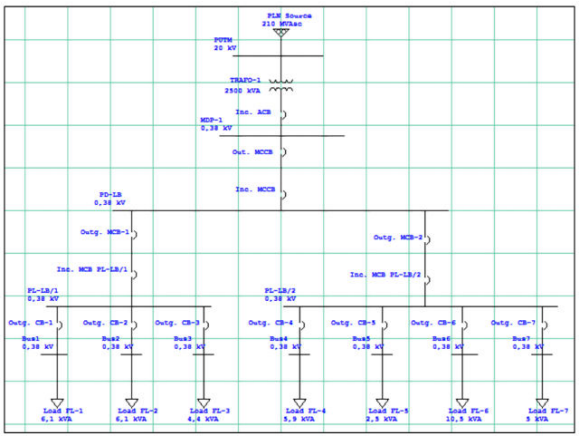

Figure-2. Method of measuring the load.

In Table-1 below will clarify the characteristics of the technical data of the object that is used as a measurement of the form of each circuit on the panel PL-LB / 2 when the system is operating, this can be done by conducting a simulation study of flow power on ETAP PowerStation.

Table-1. Technical data load PL-LB / 2.

PL-LB/2								
No	Line	Apparent power (kVA)	Active Power (kW)	Voltage (kV)	Reactive power (kVAR)	Current (A)	Frequency (Hz)	Power Factor (%)
1	FL-4	6	5	0.38	3	8.9	50	80.5
2	FL-5	2	2	0.38	1	3.7	50	80.2
3	FL-6	10	8	0.38	6	15.6	50	80.8
4	FL-7	5	4	0.38	3	7.5	50	80.4

While the tables below show the measurement results in the form of harmonics on the value of certain orders of this will be used as a parameter in the analysis on ETAP PowerStation, in Tables 2 to 3.

Table-2. The average value of the magnitude of harmonic voltage on PL-LB / 2.

Harmonic Voltage (%)															
No	Line	Orde of Harmonic													
		2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	FL-4	0.07	5.57	0.09	2.35	0.17	2.15	0.02	1.57	0.05	1.7	0.01	1.23	0.03	2.5
2	FL-5	0.1	5.12	0.12	3.57	0.05	1.5	0.02	1.8	0.15	1.65	0.1	1.35	0.12	1.25
3	FL-6	0.03	5	0.03	3.75	0.07	2.75	0.07	1.65	0.03	1.78	0.03	2.78	0.09	2.25
4	FL-7	0.15	5.29	0.17	3.24	0.12	1.75	0.12	1.95	0.1	1.73	0.18	1.75	0.15	1.45

Table-3. The average value of the magnitude of harmonic currents in the PL-LB / 2.

Harmonic Currents (%)															
No	Line	Orde of Harmonic													
		2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	FL-4	0.32	71.25	0.45	19.15	0.20	11.72	0.75	6.79	0.13	2.35	0.32	3.75	0.35	1.75
2	FL-5	0.10	49.02	0.07	10.25	0.01	5.27	0.03	3.25	0.01	1.25	0.21	1.75	0.08	1.20
3	FL-6	0.38	69.63	0.23	38.72	0.27	23.98	0.25	9.25	0.20	3.87	0.48	5.20	0.72	2.10
4	FL-7	0.20	65.70	0.15	18.25	0.10	12.00	0.15	7.15	0.32	3.75	0.50	5.15	0.17	2.17

3.2 Modeling and mathematical calculations filter specification

The initial step in modeling is preparing a new worksheet or layout, by creating a new project as shown in Figure 3.

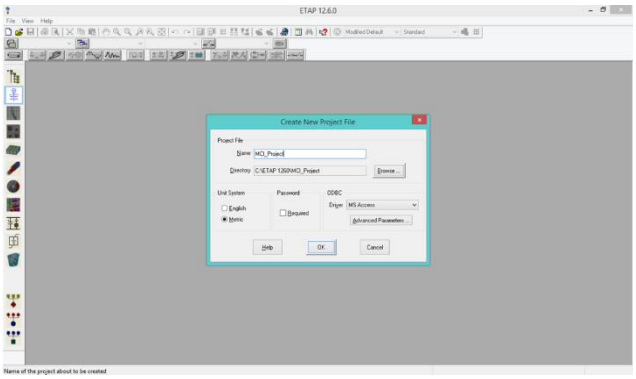

Figure-3. The first step of modeling a new project.

Once the new project name has made it appear the work and project layout editor toolbar along, the next step is to define modeling standards such as the units used, the fundamental frequency and so forth like Figure-4.

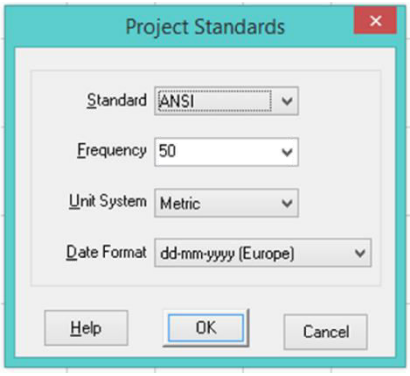

Figure-4. The default settings are used.

Next, to create a single line diagram of the layout work and fill in the parameters of each component based on technical data that already exist, in Figure-5.

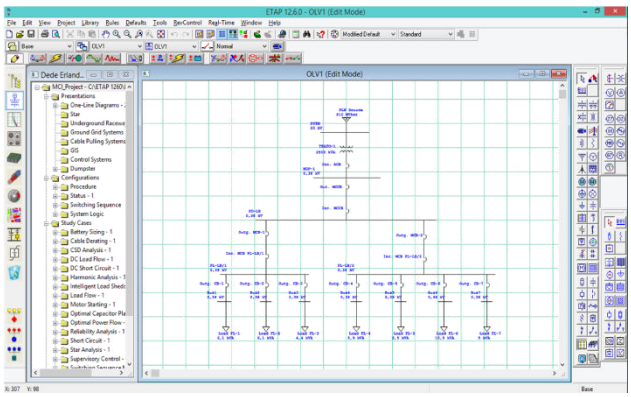

Figure-5. The single line diagram of the layout work ETAP PowerStation.

Once the modeling is finished and technical data have been equipped, the next step is to enter parameter values of harmonic currents and voltages that have been obtained from the results of measurements on each line of PL-LB / 2. Mathematical calculations filter specifications for each load using technical data and measurement results are available. Table-4 below shows the specifications of the load filter FL-5.

Table-4. Specification filter on the load FL-5.

Specification Filter of FL-5					
Q_{var} ($kvar$)	C (μF)	X_L (Ω)	R (Ω)	kV Rated	Q_{Factor}
1.08	71.03	5.328	2.435	0.22	5

3.3 Parameter input filter on ETAP powerstation

From the results of mathematical calculations to filter specs as has been shown in Figure-6.

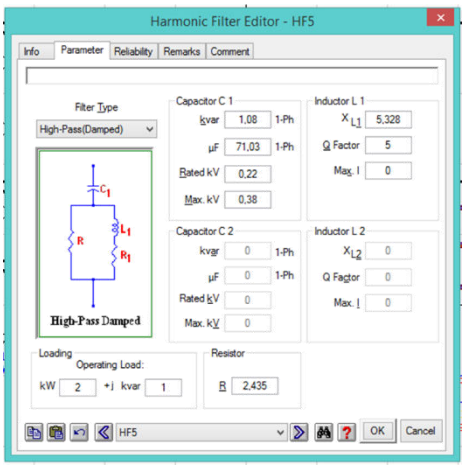

Figure-6. Harmonic filter editor.

Harmonic filter should be placed as close as possible to the source of harmonics, it is to keep the source of distortion remain away from other major electrical system. The next thing is to connect each filter with a bus load as shown in Figure-7.

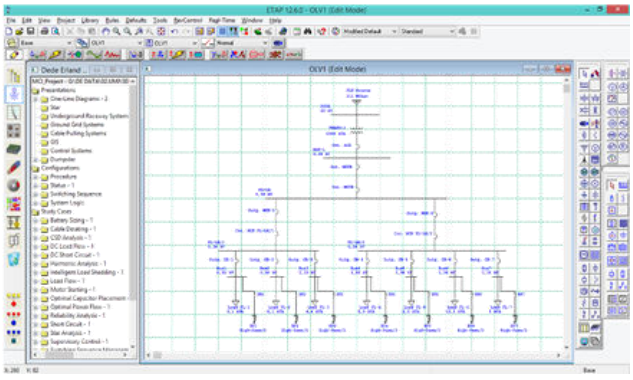

Figure-7. Layout installation of filters on each bus load.

3.4 Running the system at ETAP PowerStation

After the input filter specification parameters have been done then the next step is to determine Harmonic analysis case study in accordance with established procedures, Harmonic analysis case study can be seen in Figure-8.

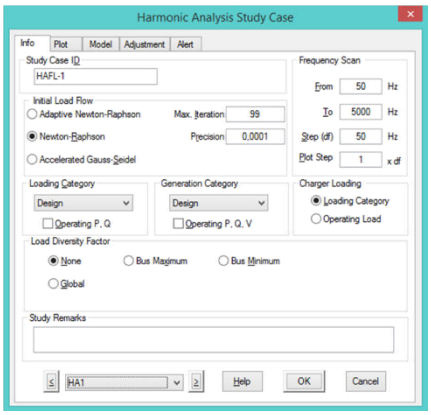

Figure-8. Harmonic analysis case study.

The next step is to run a simulation system to determine the value THDv and THDi. Below is a display of harmonic currents and voltages at one bus-line FL-5 both before and after the installation of filters, Figure 9-10.

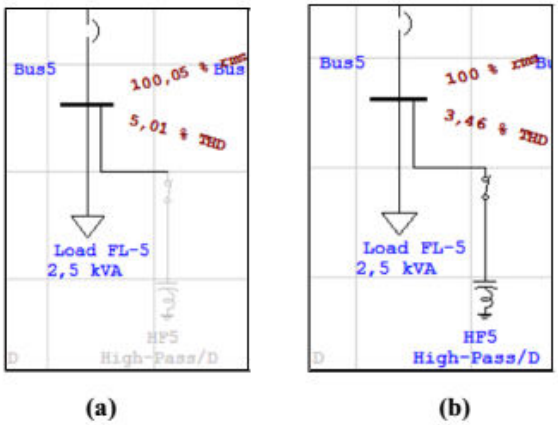

Figure-9. (a) THDv views on the load FL-5 before the installation of filters; (b) THDv views on the load FL-5 after installation of filters.

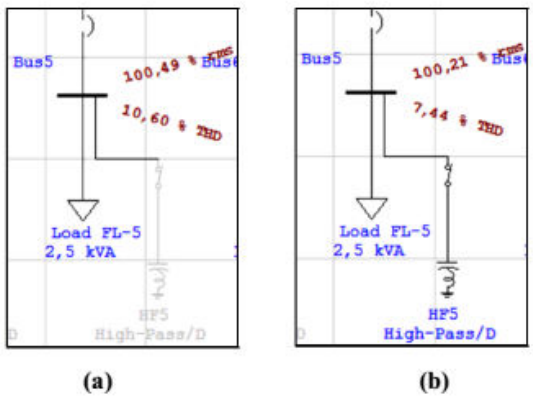

Figure-10. (a) THDi views on the load FL-5 before the installation of filters; (b) THDi views on the load FL-5 after installation of filters filter.

Here is one of the results plot the waveform harmonic currents and voltages, before installation and after installation of filters on line FL-5, Figures 11-12.

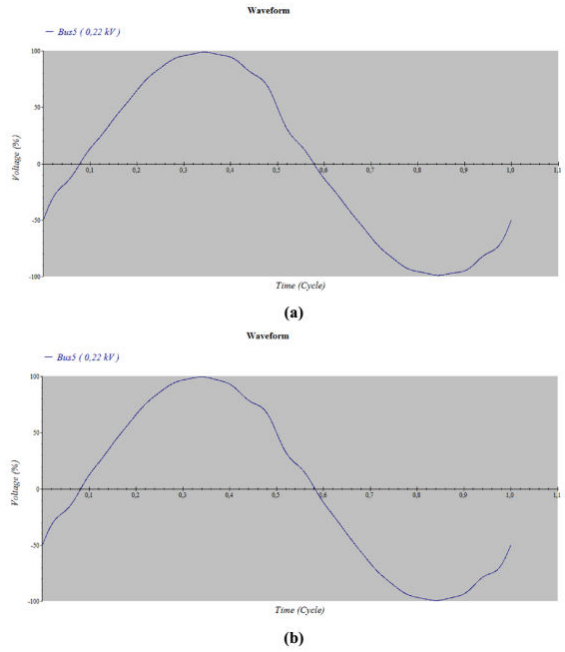

Figure-11. (a) Harmonic voltage waveform FL-5 before the installation of filters; (b) Harmonic voltage waveform FL-5 after installation of filters.

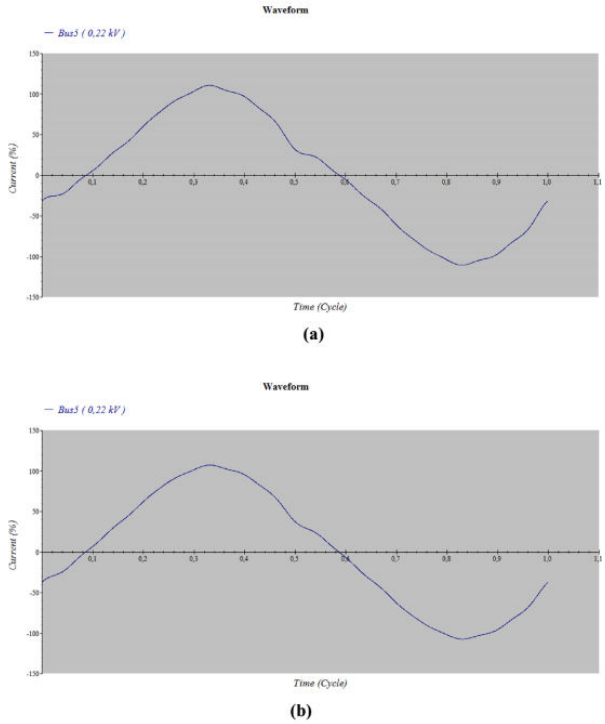

Figure-12. (a) Waveform harmonic currents FL-5 prior to the installation of filters; (b) Waveform harmonic currents FL-5 after installation of filters.

Table-5 below shows the comparison of improvement of THD current and voltage values at the time before and after installation of the filter.

Table-5. Value of THDi and THDv FL-5 before and after the installation of filters.

PL-LB/1				
Line	Before		After	
	THDi (%)	THDv (%)	THDi (%)	THDv (%)
FL-1	18.87	5.33	13.24	3.46

4. CONCLUSIONS

Based on the results of the research, the conclusions are as follows: THDi and THDv FL-5 values before and after installation of filters using ETAP Powerstation are 18.87; 5.33 (%) and there after obtained 13.24, 3.46 (%).

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REFERENCES

[1] IEEE Std 519-1992, Recommendation Practice and Requirement for Harmonics Control in Electrical Power System, Revision of IEEE Std 519-1981.

[2] Srivastava KK, Saquib S, Anand VP. 2013. Harmonics and its mitigation technique by Passive Shunt Filter, IJSCE. 3(2).

[3] Tomar Apurva. 2015. Reduction in Total Harmonic Distortion by Multilevel Inverters and Passive Filter, IJERR. 3(1).

[4] Pertiwi, Velayati Puspa. Perancangan second order damped filter untuk mereduksi masalah harmonik pada beban non-linear menggunakan ETAP Powerstation 7.0.0, Skripsi, Program Sarjana FTUI, Depok, pp. 39-42 (in Indonesian).

[5] Dugan Roger C., McGranaghan Mark F., Santoso Surya and Beaty H. Wayne. 2004. Electrical Power System Quality, Second Edition, McGraw-Hill

[6] De La Rosa, Francisco. 2006. Harmonics and Power Systems, CRC Press.

[7] Das J C. 2015. Power System Harmonics and Passive Filter Designs, IEEE Press.

[8] Arrillaga J. and Watson N. R. 2003. Power System Harmonics. Wiley Press.

[9] Masri Syafrudin. 2004. Analisis Kualitas Daya Sistem Distribusi Perumahan Modern, Vol-3 (in Indonesian).

[10] Baggini Angelo. 2008. Handbook of Power Quality, John Wiley & Sons Ltd.

[11] Almanda D., Dermawan E., Ramadhan D. E., Diniardi E., Syawaluddin Ramadhan A. I. 2018. Analisis Perancangan Filter Untuk Beban FL-1 Pada PL-LB/1 Dengan Menggunakan ETAP Powerstation, Jurnal Teknologi, 10(1): 19-24, DOI: 10.24853/jurtek.10.1.19-24.

[12] Dermawan E., Almanda D., Ramadhan D. E., Diniardi E. and Syawaluddin Ramadhan A. I. 2017. Preliminary Study Design Model for Harmonic Filter of Power System Stability Using ETAP Power Station. ARPN Journal of Engineering and Applied Sciences. 12(16): 4684-4688.