



PRELIMINARY STUDY DESIGN MODEL FOR HARMONIC FILTER OF POWER SYSTEM STABILITY USING ETAP POWERSTATION

Erwin Dermawan¹, Deni Almada¹, Dede Erland Ramadhan¹, Ery Diniardi², Syawaluddin²
and Anwar Ilmar Ramadhan²

¹Department of Electrical Engineering, Faculty of Engineering, University of Muhammadiyah Jakarta, Jakarta, Indonesia

²Department of Mechanical Engineering, Faculty of Engineering, University of Muhammadiyah Jakarta, Jakarta, Indonesia

E-Mail: anwar.ilmar@umj.ac.id

ABSTRACT

Harmonic current and voltage harmonic are one of the problems that commonly occur in a power system which has a constituent component in the form of non-linear loads. Harmonic currents and harmonic voltage can affect the stability of the power system itself and have a negative effect on electrical components others, therefore we need a step that needs to be done to minimize the adverse impacts of the case one of them is to use passive filters. The method used is to use measurement data acquisition is then carried through a simulation calculation for the initial model designs using ETAP Power Station. Results obtained are: The average value of the magnitude of harmonic currents and harmonic voltage varies with the largest value occurs on the order of 3, therefore, the design of the filter is set on the order of 3. And the value of THDi and THDv before and after the filter mounted on the initial design models using ETAP Power Station is the value of THDi and THDv before installed are 18.87% and 5.33%, whereas once it's installed and the values THDi and THDv are 13.24 % and 3.46%.

Keywords: harmonic, model, filter, 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 Cipinang Indah 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 [9-10].

Problems harmonics on PL-LB / 1 and PL-LB / 2 in Cipinang Indah Mall project affect the stability of the

voltage, resulting in flicker on the Basement floor illumination that occurs at the time and a certain period. Thus, in this research conducted a preliminary study Harmonics Filter model design, which is used to reduce harmonic disturbances in the electrical system.

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.

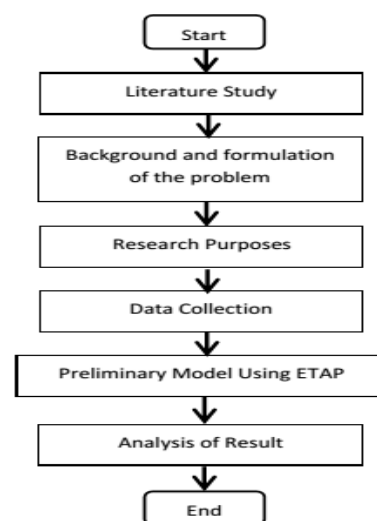


Figure-1. Flowchart of research method.



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.

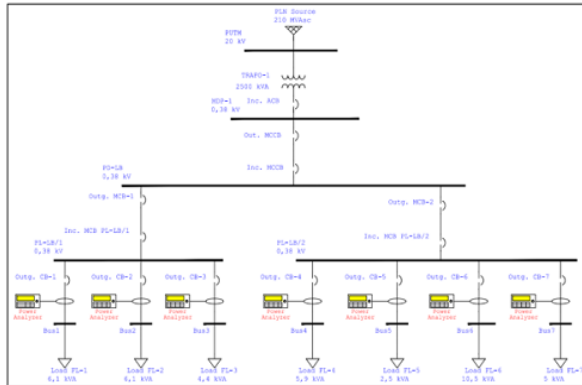


Figure-2. Method of measuring the load.

In Tables 1 and 2 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 / 1 and 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 / 1.

PL-LB/1								
No	Line	Apparent power (kVA)	Active Power (kW)	Voltage (kV)	Reactive power (kVAR)	Current (A)	Frequency (Hz)	Power Factor (%)
1	FL-1	6	5	0.38	4	9.1	50	80.5
2	FL-2	6	5	0.38	4	9.1	50	80.5
3	FL-3	4	3	0.38	3	6.6	50	80.3

Table-2. 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 3 to 6.

Table-3. The average value of the magnitude of harmonic voltage on PL-LB / 1.

Harmonic Voltage (%)																
No	Line	Order of Harmonic														
		2	3	4	5	6	7	8	9	10	11	12	13	14	15	
1	FL-1	0.03	5.32	0.07	2.87	0.07	1.15	0.03	1.75	0.17	2.1	0.13	2.3	0.07	2.73	
2	FL-2	0.13	4.85	0.01	3.57	0.01	2	0.03	1.23	0.12	2.75	0.01	1.8	0.07	2.3	
3	FL-3	0.1	5.27	0.09	3.78	0.12	1.5	0.03	1.5	0.03	1.23	0.09	1.43	0.15	1.25	

Table-4. The average value of the magnitude of harmonic voltage on PL-LB / 2.

Harmonic Voltage (%)																
No	Line	Order 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-5. The average value of the magnitude of harmonic currents in the PL-LB / 1.

Harmonic Currents (%)																
No	Line	Order of Harmonic														
		2	3	4	5	6	7	8	9	10	11	12	13	14	15	
1	FL-1	0.42	79.31	0.17	27.54	0.37	17.25	0.37	7.23	0.15	2.97	0.35	4.90	0.53	1.72	
2	FL-2	0.27	78.21	0.23	25.57	0.27	16.50	0.25	7.75	0.20	2.65	0.52	4.97	0.25	1.73	
3	FL-3	0.12	65.27	0.20	17.85	0.08	10.25	0.12	5.62	0.15	2.15	0.47	3.98	0.21	1.52	

Table-6. The average value of the magnitude of harmonic currents in the PL-LB / 2.

Harmonic Currents (%)																
No	Line	Order 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.

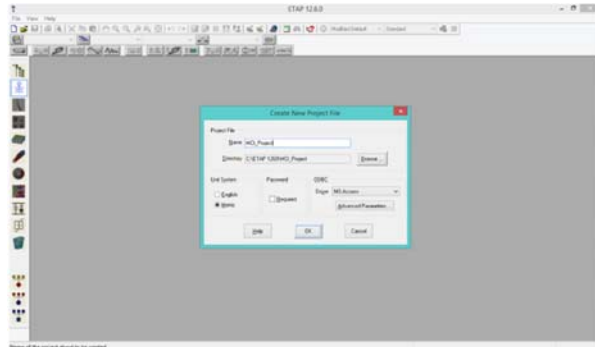


Figure-3. The first step of modeling a new project.

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.

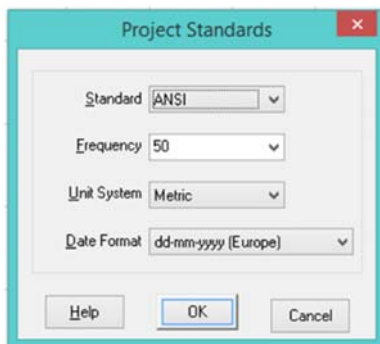


Figure-4. The default settings are used.

Next is 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.

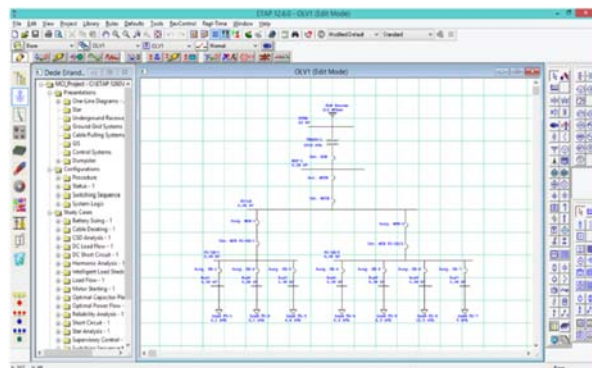


Figure-5. The single line diagram of the layout work ETAP powerstation.

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 / 1 and PL-LB / 2. Mathematical calculations filter specifications for each load using technical data and measurement results are available. Table-7 below shows the specifications of the load filter FL-1.

Table-7. Specification filter on the load FL-1.

Specification Filter of FL-1					
Q_{var} (kvar)	C (μF)	X_L (Ω)	R (Ω)	kV Rated	Q_{Factor}
2.67	175.6	2.155	0.985	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.

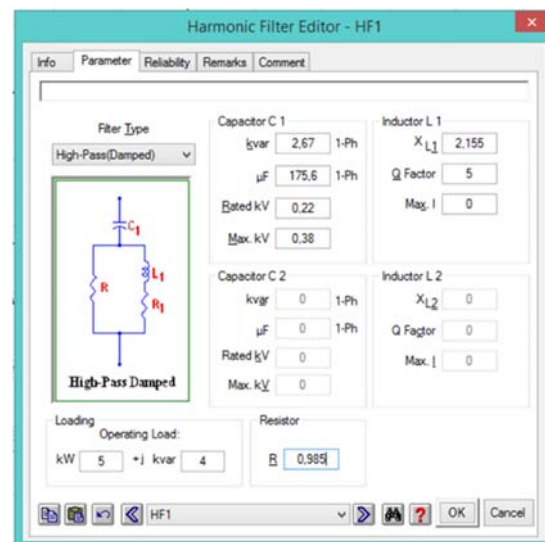


Figure-6. Harmonic filter editor.

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.

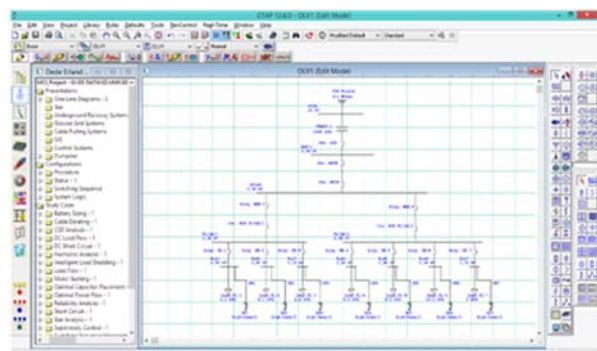


Figure-7. Layout installation of filters on each bus load.



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.

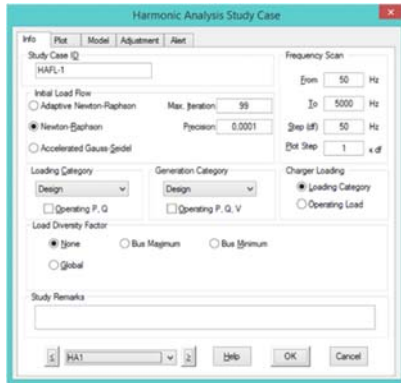


Figure-8. Harmonic analysis case study.

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-1 both before and after the installation of filters, Figures 9-10.

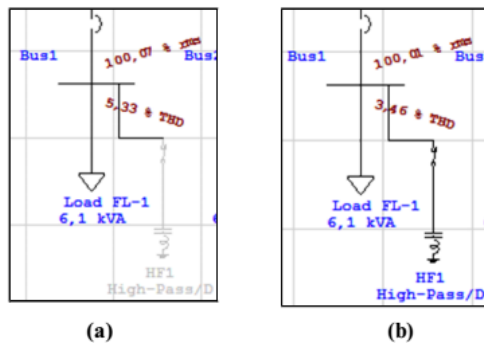


Figure-9. (a) THDv views on the load FL-1 before the installation of filters; (b) THDv views on the load FL-1 after installation of filters.

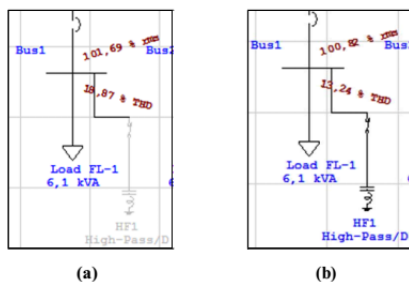


Figure-10. (a) THDi views on the load FL-1 before the installation of filters; (b) THDi views on the load FL-1 after installation of filters filter.

Here is one of the results plot the waveform harmonic currents and voltages, before installation and after installation of filters on line FL-1, Figures 11-12.

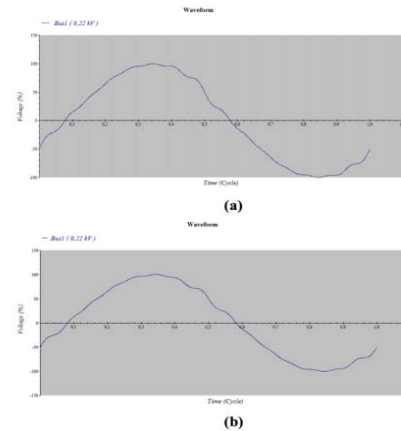


Figure-11. (a) Harmonic voltage waveform FL-1 before the installation of filters; (b) Harmonic voltage waveform FL-1 after installation of filters.

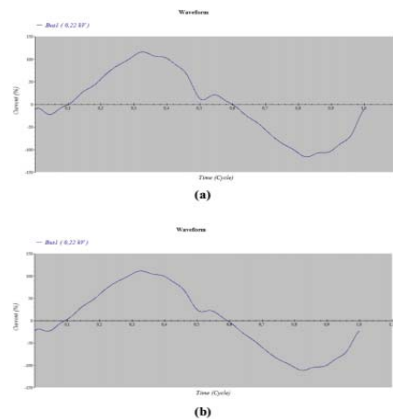


Figure-12. (a) Waveform harmonic currents FL-1 prior to the installation of filters; (b) Waveform harmonic currents FL-1 after installation of filters.

Table-8 below shows the comparison of improvement of THD current and voltage values at the time before and after installation of the filter.

Table-8. Value of THDi and THDv FL-1 before and after the installation of filters.

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

CONCLUSIONS

Based on the results of research and testing, then the conclusion is as follows: The average value of the magnitude of harmonic currents and harmonic voltage varies with the largest value occurs on the order of 3,



therefore, the design of the filter is set on the order of 3. And value of THDi and THDv before and after the filter mounted on the initial design models using ETAP Power Station is the value of THDi and THDv before installed are: 18.87% and 5.33%, whereas once it's installed and the values THDi and THDv are 13.24 % and 3.46%.

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