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# Passive Filter to Reduce Harmonics in Architecture Building of Samarinda State Polytechnic

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**ABSTRACT:** The use of non-linear loads can cause harmonics in both current and voltage in the electrical system. Non-linear loads are generated from the use of electrical equipment such as computers, air conditioners, semiconductors, and other switching electrical equipment. Harmonics that exceed the standard will have an impact on the quality of the power supplied. The use of Single-Tuned passive filters aims to reduce harmonics both current and voltage in the electrical system of the Samarinda State Polytechnic Architecture Building. This research explains how to calculate the Single-Tuned filter and how to input the calculation results into the ETAP software used to simulate the effect of using a Single Tuned filter to reduce harmonics. In this study, it is known that the use of a 5th-order Single-Tuned filter using ETAP software can reduce the THDi value of phase R from 80.43% to 6.27% where based on IEEE 519-2014 standard THDi value for SCRatio 100-1000A is 15%. The IEEE 519-2014 standard for THDi of 15% is obtained by calculating ISC and IL first.

**KEYWORDS:** ETAP, Harmonic, Non linear load Passive filter

## 1. INTRODUCTION

Energy has a very important role for human life, one of which is electrical energy. In modern times like now electrical energy is one of the basic needs for human life in carrying out activities every day. Almost all fields or sectors of work require electrical energy ranging from industry, offices, government agencies, households, and so on [1]. Along with the times, the use of electrical loads at present is the impact and influence of economic growth [2]. Increasing economic growth causes the need or purchasing power of the community for electrical loads to increase, this can be seen from the increasing use of electrical equipment which is generally a non-linear load. Therefore, it is necessary to pay close attention to the power quality of the distributed electrical energy. This non-linear load can affect the quality of electrical power, because non-linear loads are the main source of harmonic disturbances that affect the power quality of the electrical energy supplied [2], [3], [4], [5], [6]. The type of load, the type and length of the conductor, the type of distribution network, the capacity of the transformer, the power factor, the amount of installed power and the amount of use of inductive loads that cause harmonics affect the quality of the electrical power supplied [7]. Harmonics that are excessive or exceed the permissible standard limits will have a negative impact on the electrical system in the long run. Therefore, harmonics that occur in the electrical system must be controlled so as not to have a long-term negative impact on the electrical system, one of the most widely used ways to reduce harmonics is by installing a harmonic filter. Harmonic filters based on their nature can be divided into 2, namely passive harmonic filters and active harmonic filters. Both types of filters have advantages and disadvantages depending on the conditions of use.

## 2. MATERIAL AND METHODS

### 2.1 Research Conceptual Framework

The research conceptual framework is a flow of thought for researchers related to the scope, material limitations, and results to be achieved in the research stages, explained in the form of a flow chart.

Based on Figure 1, the important thing in this research is the use of passive filters to reduce harmonics in the Samarinda State Polytechnic Architecture Building which is simulated using ETAP software. Things that can affect the use of passive filters based on the flowchart are harmonics caused by the type of load connected to the Samarinda State Polytechnic Architecture Building. The flowchart above shows that when there is a voltage and current frequency disturbance, it will have an impact on the reliability of the power system network work, so that one way that can be used to reduce the impact of these disturbances is to control that the harmonics that occur remain within the limits of the standards set and in this case the standard used is the IEEE 519-2014 standard.

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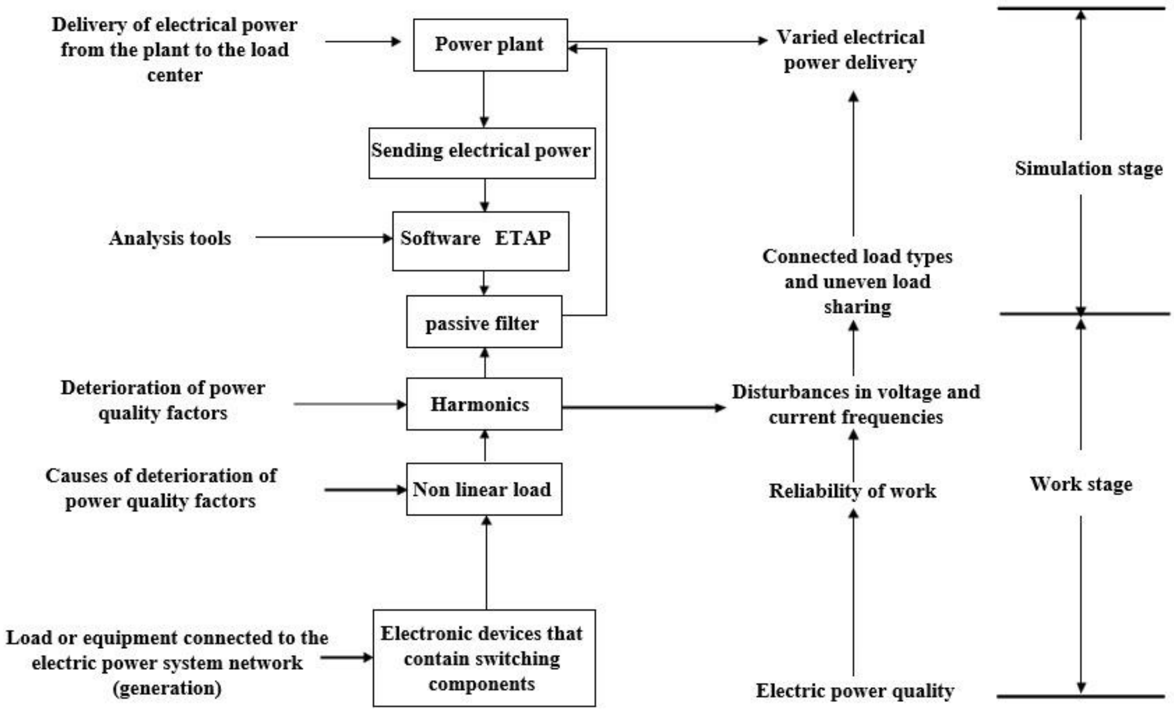


**Figure 1. Research conceptual framework**

The types of loads connected or used by each consumer vary and are generally non-linear loads such as the use of electronic equipment (televisions, refrigerators, air conditioners, laptops, etc.) as well as driving motors in small, medium and large industries. This causes harmonics to arise in the network system which has an impact on the electric power received by consumers due to a decrease in power quality.

Based on the description above, the research conceptual framework is divided into 2 stages as follows.

1. Simulation stage to simulate the electrical system in the Samarinda State Polytechnic Architecture Building in the form of a simple single line diagram so that it can be simulated using ETAP software.
2. The work stage is an analysis of harmonics channeled through simulation results that have been obtained and then compared with the results of measurements that have been made at the Samarinda State Polytechnic Architecture Building.

### 2.2 Research Operational Framework

Figure II shows the flow chart of the research operational framework. The initial stage of research by conducting a literature study consisting of literature studies and case studies then obtained the results of literature studies in the form of load types and harmonics. In addition to the results of the literature study, reference data was also obtained in the form of data derived from literature studies and field data in the form of technical data on the Samarinda State Polytechnic Architecture Building.

After the literature study and data are obtained, then process the data using PQ ONE software. PQ ONE is software used to read parameter data from measurements on the Samarinda State Polytechnic Architecture Building and then exported in excel. To be able to see the parameter data measured at the Samarinda State Polytechnic Architecture Building in the form of an excel file, Microsoft Excel software is needed. Then the data is input into ETAP software for further analysis. ETAP is software used to analyze field data so that the data generated is in the form of harmonic data on electric current and voltage which affects the quality of the power supplied to the Samarinda State Polytechnic Architecture Building then the results of field data analysis with ETAP software in the form of simulation test results in the form of graphs, tables and images that are converted into docx or pdf files using Microsoft Word 2019. After the field data analysis is successful, it is continued with writing the results and discussion in accordance with the limitations of the problem used so that the research objectives can be achieved.

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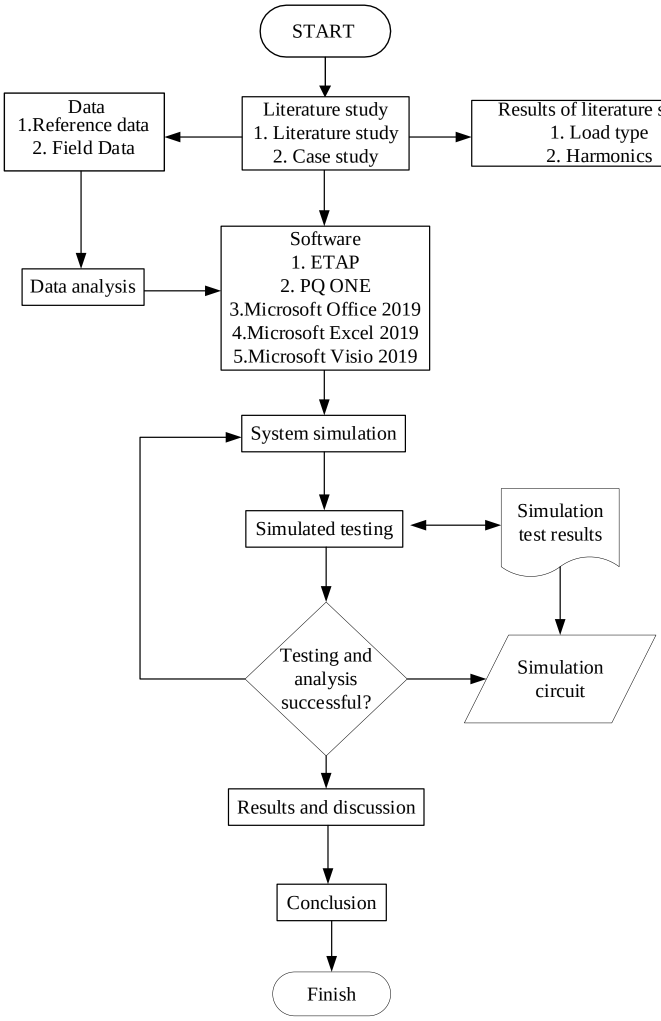


**Figure II. Flowchart of the Operational Framework**

## 3. RESULTS AND DISCUSSION

### 3.1 Data Analysis and Discussion

Based on the measurement data that has been carried out at the Samarinda State Polytechnic Architecture Building for 8 days, it is found that the connected load is in an unbalanced condition. This is characterized by the difference in current values between phases as in the measurement data that has been done. Table 1 is the data from the measurement of the current value for each phase for 8 days.

**Table 1. Smallest and largest current values for each phase**

| | Current | | | | | |
|---|---|---|---|---|---|---|
| | **Smallest** | **Date** | **Time** | **Greatest** | **Date** | **Time** |
| **R** | 0,05A | April 4, 2023 | 06.57 | 18,6A | March 31, 2023 | 14.42 |
| **S** | 0A | April 1, 2023 | 18.37-23.42 | 49,2A | April 3, 2023 | 10.52 |
| **T** | 0A | April 1, 2023 | 18.37-23.42 | 30,6A | April 3,2023 | 11.52 |

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The current value of 0A occurs because on April 1, 2023 the activities in the Architecture Building are on holiday both lectures and other administrative activities so that not all loads in the Architecture Building are used. Based on the measurement data obtained, the average current value in phase S has a greater value than phase R and T within 8 days measured. However, within 8 days only phase R is always loaded characterized by the presence of a measurable current value even though it is <1A. This proves that there is unbalanced loading between phases in the Samarinda State Polytechnic Architecture Building. Table 2 is the measurement data of the 1 phase voltage value for each phase for 8 days.

**Table 2: Smallest and largest voltage values of 1 phase**

| | Voltage | | | | | |
|---|---|---|---|---|---|---|
| | **Smallest** | **Date** | **Time** | **Greatest** | **Date** | **Time** |
| **R** | 235V | April 5,2023 | 09.17 | 245V | April 4,2023 | 06.57 |
| **S** | 225V | April 3,2023 | 10.52 | 240V | April 3,2023 | 07.17 |
| **T** | 221V | April 3,2023 | 11.42 | 241V | April 4,2023 | 07.12 |

Based on the measurement data obtained, the average voltage value in phase R has a greater value than phase S and T within 8 days measured. The difference in voltage values between phases is not too impactful for 1 phase loads or electrical equipment, however, for loads or electrical equipment with a 3 phase system the difference in voltage values between phases can cause damage. The difference in voltage values between phases is often caused by the type and variety of loads connected in the electrical system. When the load of 1 phase with another phase has a different impedance value, type of load, and number of loads, it will cause a difference in voltage value between phases. Table 3 is the data from the measurement of the 3-phase power value for 8 days.

**Table 3. Smallest and largest power values for 3 phase**

| | Power | | | | | |
|---|---|---|---|---|---|---|
| | **Smallest** | **Date** | **Time** | **Greatest** | **Date** | **Time** |
| **P** | 0,04kW | April 1,2023 | 22.07 | 20,4 | March 31,2023 | 14.47 |
| **S** | 0,04kVA | April 1,2023 | 22.07 | 20,6kVA | March 31, 2023 | 14.47 |
| **Q** | 3,73kVAr | March 30,2023 | 11.42 | 3,31kVAr | March 30, 2023 | 12.52 |

Table 4 is the THDv measurement data for each phase for 8 days.

**Table 4. Smallest and largest THDv values for each phase**

| | THDv | | | | | |
|---|---|---|---|---|---|---|
| | **Smallest** | **Date** | **Time** | **Greatest** | **Date** | **Time** |
| **R** | 1,5% | March 30, 2023 | 16.32 | 2,46% | March 30, 2023 | 11.47 |
| **S** | 1,29% | April 4,2023 | 15.32 | 2,26% | April 1, 2023 | 21.07 |
| **T** | 1,38% | March 29, 2023 | 16.17 | 2,31% | April 3, 2023 | 11.42 |

Based on the THDv data from the measurement results within 8 days in the Architecture Building, the THDv values for the three phases are within the standard limits permitted by IEEE 519-2014 for working voltages <1kV of 5%. Table 5 is the THDi measurement data for each phase for 8 days.

**Table 5. Smallest and largest THDi values for each phase**

| | THDi | | | | | |
|---|---|---|---|---|---|---|
| | **Smallest** | **Date** | **Time** | **Greatest** | **Date** | **Time** |
| **R** | 12,3% | March 31, 2023 | 14.42 | 81,2% | April 5, 2023 | 15.41 |
| **S** | 0% | April 1, 2023 | 18.37-23.42 | 20,6% | April 3, 2023 | 07.17 |
| **T** | 0% | April 1, 2023 | 18.37-23.42 | 65,9% | April 5, 2023 | 15.37 |

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The smallest THDi value for phase S and T is 0 because there is no measurable current due to the absence of loads connected to phase S and T at that hour. The largest THDi contributor based on the results of measurements that have been taken is from odd orders such as 3rd order, 5th order, 7th order, and 9th order and so on. To determine whether the THDi value in the electrical system in the Architecture Building meets the IEEE 519-2014 standard, the SCRatio calculation must be done first. Based on the data in Table 5, one data sample is taken with the largest measurement THDi value within 8 days in the Architecture Building to plan the installation of a passive filter as a harmonic reducer of the electrical network system.

### 3.2 Determining the Short Circuit Ratio

**Table 6. SCRatio values for each day in the architecture building**

| Day | Hour | ISC (A) | IL (A) | SCRatio |
|---|---|---|---|---|
| Day One | 11.47 | 7216,88 | 24,30 | 296,99 |
| Day Two | 12.07 | 7216,88 | 23,99 | 300,82 |
| Day Three | 15.02 | 7216,88 | 24,07 | 299,82 |
| Day Four | 19.47 | 7216,88 | 0,19 | 37983,57 |
| Day Five | 07.17 | 7216,88 | 6,47 | 1115,43 |
| Day Six | 06.57 | 7216,88 | 6,54 | 1103,49 |
| Day Seven | 15.07 | 7216,88 | 17,74 | 406,81 |
| Day Eight | 15.41 | 7216,88 | 12,44 | 580,13 |

Based on the results of the SCRatio calculation that has been carried out, the THDi value limit in accordance with the IEEE 519-2014 standard is 15% for SCRatio between 100-1000 and 20% for SCRatio> 1000. By knowing the SCRatio value every day in the electrical system in the Architecture Building, the THDi standard allowed can be seen in Table 7 below.

**Table 7. THDi maximum limit**

| Day | Hour | SCRatio | | THDi Max |
|---|---|---|---|---|
| | | Calculations | IEEE Standard 519-2014 | |
| Day One | 11.47 | 296,99 | 100-1000 | 15% |
| Day Two | 12.07 | 300,82 | 100-1000 | 15% |
| Day three | 15.02 | 299,82 | 100-1000 | 15% |
| Day Four | 19.47 | 37983,57 | >1000 | 20% |
| Day Five | 07.17 | 1115,43 | >1000 | 20% |
| Day Six | 06.57 | 1103,49 | >1000 | 20% |
| Day Seven | 15.07 | 406,81 | 100-1000 | 20% |
| Day Eight | 15.41 | 580,13 | 100-1000 | 15% |

### 3.3 Calculation of THDi Value

To calculate the THDi value can use Equation 2. 15, the calculation of THDi value is done to see the difference between the calculation results and the measurement results that have been done. Table 8 is the amount of harmonic current for 50 orders of phase R. The data used as a calculation sample is the measurement data for phase R, phase S, and phase T on April 5, 2023 at 15:41 PM.

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**Table 8. Harmonic current values of 50th order phase R**

| Orde | Ih (A) | Orde | Ih (A) |
|---|---|---|---|
| **1** | 2,46 | **26** | 0,01 |
| **2** | 0,04 | **27** | 0,04 |
| **3** | 1,61 | **28** | 0,01 |
| **4** | 0,02 | **29** | 0,07 |
| **5** | 0,96 | **30** | 0,01 |
| **6** | 0,02 | **31** | 0,05 |
| **7** | 0,45 | **32** | 0,01 |
| **8** | 0,03 | **33** | 0,01 |
| **9** | 0,31 | **34** | 0,01 |
| **10** | 0,02 | **35** | 0,04 |
| **11** | 0,29 | **36** | 0,01 |
| **12** | 0,02 | **37** | 0,04 |
| **13** | 0,17 | **38** | 0,01 |
| **14** | 0,01 | **39** | 0,01 |
| **15** | 0,1 | **40** | 0,01 |
| **16** | 0,01 | **41** | 0,03 |
| **17** | 0,08 | **42** | 0,01 |
| **18** | 0,01 | **43** | 0,03 |
| **19** | 0,05 | **44** | 0,01 |
| **20** | 0,01 | **45** | 0,02 |
| **21** | 0,05 | **46** | 0,02 |
| **22** | 0,01 | **47** | 0,03 |
| **23** | 0,08 | **48** | 0,01 |
| **24** | 0,01 | **49** | 0,02 |
| **25** | 0,07 | **50** | 0 |

Table 9 is the magnitude of the harmonic current for 50-order phase S on April 5, 2023 at 15:41 PM

**Table 9. 50th-order harmonic current values of phase S**

| Orde | Ih (A) | Orde | Ih (A) |
|---|---|---|---|
| **1** | 23,08 | **26** | 0,01 |
| **2** | 1,67 | **27** | 0,01 |
| **3** | 1,77 | **28** | 0,01 |
| **4** | 0,16 | **29** | 0,01 |
| **5** | 1,58 | **30** | 0,01 |
| **6** | 0,13 | **31** | 0,01 |
| **7** | 0,67 | **32** | 0,01 |
| **8** | 0,12 | **33** | 0,01 |
| **9** | 0,29 | **34** | 0,01 |
| **10** | 0,05 | **35** | 0,01 |
| **11** | 0,09 | **36** | 0 |
| **12** | 0,04 | **37** | 0,01 |
| **13** | 0,12 | **38** | 0 |
| **14** | 0,02 | **39** | 0,01 |

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| | | | |
|---|---|---|---|
| **15** | 0,05 | **40** | 0 |
| **16** | 0,02 | **41** | 0 |
| **17** | 0,07 | **42** | 0 |
| **18** | 0,01 | **43** | 0,01 |
| **19** | 0,03 | **44** | 0,01 |
| **20** | 0,01 | **45** | 0,02 |
| **21** | 0,04 | **46** | 0,02 |
| **22** | 0,01 | **47** | 0,01 |
| **23** | 0,04 | **48** | 0,01 |
| **24** | 0,01 | **49** | 0,01 |
| **25** | 0,02 | **50** | 0 |

Table 10. is the magnitude of the harmonic current for 50-order phase T on April 5, 2023 at 15:41 PM

**Table 10. 50th-order harmonic current values of phase T**

| Orde | Ih (A) | Orde | Ih (A) |
|---|---|---|---|
| **1** | 10,5 | **26** | 0,01 |
| **2** | 1,31 | **27** | 0,08 |
| **3** | 1,89 | **28** | 0,01 |
| **4** | 0,11 | **29** | 0,07 |
| **5** | 0,95 | **30** | 0,01 |
| **6** | 0,04 | **31** | 0,03 |
| **7** | 0,62 | **32** | 0,01 |
| **8** | 0,05 | **33** | 0,04 |
| **9** | 0,6 | **34** | 0,01 |
| **10** | 0,03 | **35** | 0,05 |
| **11** | 0,46 | **36** | 0,01 |
| **12** | 0,02 | **37** | 0,02 |
| **13** | 0,19 | **38** | 0,01 |
| **14** | 0,01 | **39** | 0,03 |
| **15** | 0,08 | **40** | 0,01 |
| **16** | 0,01 | **41** | 0,03 |
| **17** | 0,1 | **42** | 0,01 |
| **18** | 0,01 | **43** | 0,01 |
| **19** | 0,06 | **44** | 0,01 |
| **20** | 0,01 | **45** | 0,02 |
| **21** | 0,03 | **46** | 0,02 |
| **22** | 0,01 | **47** | 0,03 |
| **23** | 0,06 | **48** | 0,01 |
| **24** | 0,01 | **49** | 0,01 |
| **25** | 0,03 | **50** | 0,01 |

**Table 11. Comparison of calculated and measured THDi values**

| April 5, 2023 (15.41PM) | THDi Calculation Result | THDi Measurement |
|---|---|---|
| *Phase* R | 81,09% | 81,20% |
| *Phase* S | 13,03% | 13,02% |
| *Phase* T | 25,63% | 25,67% |

Based on Table 11, it can be seen that the difference in THDi values that occurs between the calculation results and the measurement results for phase R, phase S, and phase T is very small. The difference for phase R is 0.11% smaller than the value of the calculation results, for phase S is 0.01% larger than the value of the calculation results and for phase T is 0.04% smaller than the value of the calculation results. This is due to the rounding factor of the value of the tool used to measure the harmonic current of each order, namely the Power Quality Analyzer Meter (PQA Meter) and the tools used to perform calculations such as Microsoft Excel software.

### 3.4 Simulation of Electrical System in Architecture Building Before Installation of Single-Tuned Filter

**Table 12. Running results of THDi and THDv values in the architecture building**

| Place | Running Result | | IEEE Standard 519-2014 | | DescriptionTHDi | DescriptionTHDv |
|---|---|---|---|---|---|---|
| | THDi (%) | THDv (%) | THDi (%) | THDv (%) | | |
| Bus 1 | 13,5 | 0,678 | 15,0 | 5,0 | Meet | Meet |
| Bus 2 | 13,5 | 0,8 | 15,0 | 5,0 | Meet | Meet |
| Fase R | 80,43 | 0,8 | 15,0 | 5,0 | Does Not Meet | Meet |
| Fase S | 12,25 | 0,8 | 15,0 | 5,0 | Meet | Meet |
| Fase T | 25,55 | 0,8 | 15,0 | 5,0 | Does Not Meet | Meet |

Based on Table 12, the value of THDi in the simulation of the phase R electrical system does not meet the IEEE 519-2014 standard of 15% for ISC/ILOAD 100-1000A, however, the value of THDv meets the IEEE 519-2014 standard for voltages <1kV.

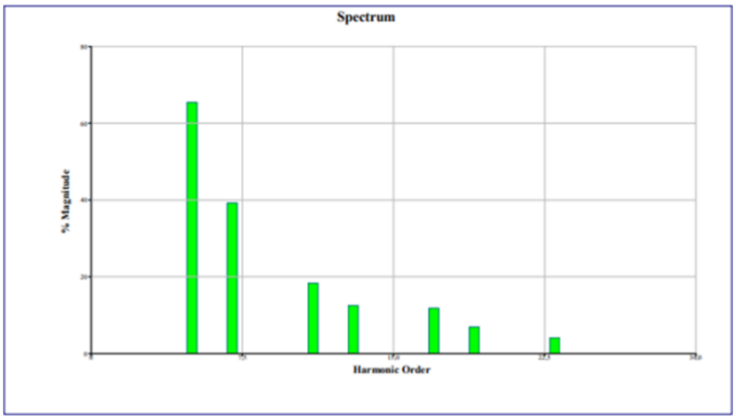


**Figure 3. Running result of the electricity system on April 5, 2023**

### 3.5 Filter Installation Planning

Passive filter is one method to reduce harmonics in the electrical network, the components in the passive harmonic filter are R, L, and C which can be tuned for 1 or 2 orders. Single-Tuned filters are filters with a single tuning tuned to one order of harmonics

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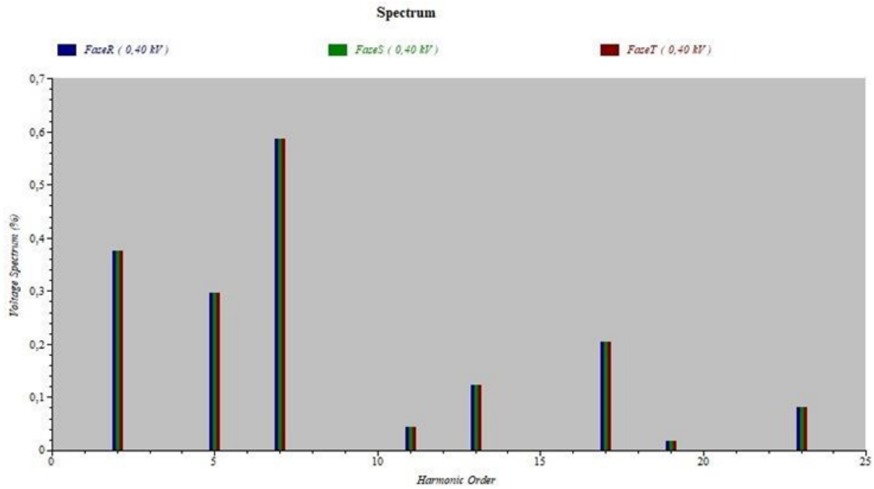
which are generally low-order harmonics such as 3rd order, 5th order, and 7th order. The main component of a passive filter is a capacitor that is connected in series or parallel in order to obtain the desired voltage rating and kVAr. In this simulation, a Single-Tuned filter is used which is connected in series. Then an inductor is used to be able to withstand the high frequency sheath, namely the skin effect. Result of calculation as follow.

**Table 13. Single-tuned filter specifications**

| Orde | Power (kVAr) | Capasitor (μF) | Inductor ($X_L$) | Resistor (R) | Q Faktor |
|---|---|---|---|---|---|
| 5th | 0,5698 | 31,8 | 4,005 | 0,08 | 50 |
| 7th | 0,5698 | 31,8 | 2,068 | 0,041 | 50 |

**3.6 Simulation of the Electrical System in an Architectural Building After the Installation of a Single-Tuned Filter**

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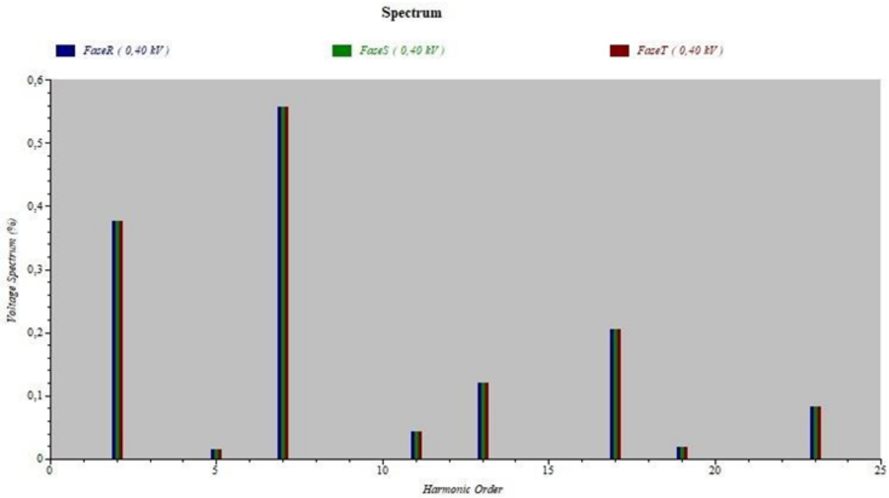


**(b)**

**Figure 4. Voltage spectrum (a) before and (b) after installation of the 5th order filter.**

Based on Figure 4, it can be seen that the value of voltage harmonics at 5th order has decreased for phase R, phase S, and phase T. This means that the installation of the 5th order Single-Tuned filter has succeeded in reducing the harmonic value at the tuned order.

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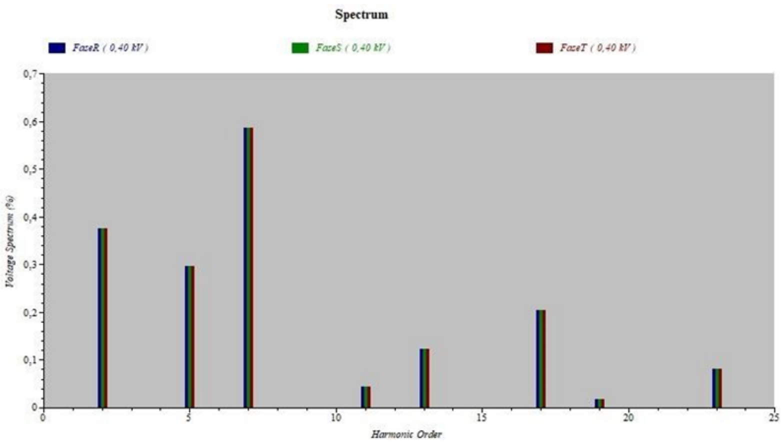


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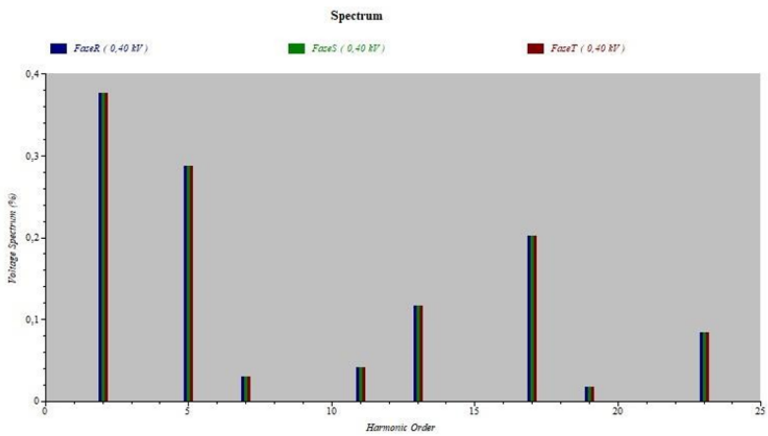
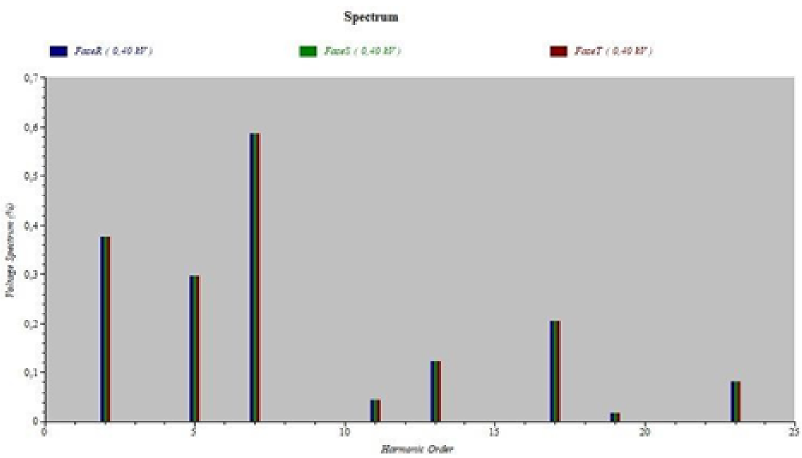



(b)

**Figure 5. Voltage spectrum (a) before and (b) after installation of the 7th order filter.**

Based on Figure 5, it can be seen that the value of voltage harmonics in the 7th order has decreased for phase R, phase S, and phase T very drastically compared to when using the 5th-order Single-Tuned filter. drastically compared to when using the 5th order Single-Tuned filter. This means that the installation of the 7th-order Single-Tuned filter has succeeded in reducing the harmonic value at the tuned order.




(a)

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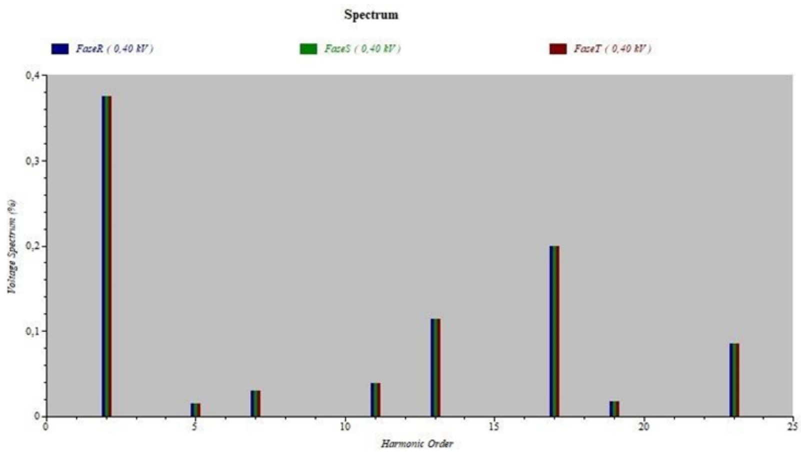


**(b)**

**Figure 6. Harmonic spectrum (a) before and (b) after installation of 2 filters.**

Based on Figure 6, it can be seen that the value of voltage harmonics in the 5th order and 7th order has decreased for phase R, phase S, and phase T. The 5th order and 7th order are one of the largest contributors to the value of harmonics in the electrical system. With the decrease in the value of harmonics in the 5th order and 7th order, the THDi value will also decrease.

**Table 14. Comparison of THD values before and after filter installation**

| Place | Hasil *Running* Simulasi Dengan *Software* ETAP | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Before Filter Installasion | | After 5th Order Filter Installasion | | After Installasion of 7th Order Filter | | After Installasion of 2 Filters | |
| | THDi | THDv | THDi | THDv | THDi | THDv | THDi | THD v |
| Fase R | 80,43% | 0,8% | 6,27% | 0,72% | 12,78% | 0,54% | 5,43% | 0% |

**3.7 Simulation of Electrical System in Architecture Building After Installation of Single-Tuned Filter in Each Phase**

**Table 15: Specifications of the 5th-order single-tuned filter for each phase**

| *Phase* | Power (kVAr) | Capasitor (μF) | Inductor ($X_L$) | Resistor (R) | Q Factor |
|---|---|---|---|---|---|
| R | 0,5698 | 31,8 | 4,005 | 0,08 | 50 |
| S | 0,759 | 45,28 | 2,812 | 0,05 | 50 |
| T | 0,82 | 48,48 | 2,628 | 0,052 | 50 |

The specifications of the 7th-order Single-Tuned filter for phase S and phase T can be seen in Table 16 below.

**Table 16: Specifications of the 7th-order single-tuned filter for each phase**

| *Phase* | Power (kVAr) | Capasitor (μF) | Inductor ($X_L$) | Resistor (R) | Q Factor |
|---|---|---|---|---|---|
| R | 0,569 | 31,8 | 2,068 | 0,041 | 50 |
| S | 0,759 | 45,28 | 1,435 | 0,028 | 50 |
| T | 0,82 | 48,48 | 1,34 | 0,027 | 50 |

## 4. CONCLUSION

Based on the description in the previous chapter about the use of Single-Tuned passive filters to reduce harmonics in the Samarinda State Polytechnic Architecture Building, it can be concluded:

1. The THD value of the current after measurements from March 29, 2023 to April 5, 2023 was the largest at 81.2% which occurred on April 5, 2023 at 15:41 PM in phase R. The results of the calculation of THD current on April 5, 2023 at 15:41 PM in phase R were 81.09% and the results of running with simulation were 80.43%. For the voltage THD value, the largest measurement result is 2.46% which occurred on March 30, 2023 at 11:47 pm in phase R.
2. This current THD value exceeds the IEEE 519-2014 standard of 15% for SCRatio 100-1000A where the largest current THD is 81.2% in phase R which occurred on April 5, 2023 at 15:41 PM. The amount of THD current in each phase has a different value because the amount of load connected to each phase is different. Unbalanced loads cause harmonics in the electrical system. For voltage THD below 5% and within the IEEE 519-2014 standard for system voltages < 1kV where the largest voltage THD is 2.46% which occurred on March 30, 2023 at 11:47 pm.
3. The installation of the 5th-order Single-Tuned passive filter by simulation can reduce harmonics in phase R. The THD value of the current in phase R after the 5th-order Single-Tuned passive filter is installed from 80.43% to 6.27%. The experiment of installing the 7th-order Single-Tuned passive filter can also reduce the THD current in phase R from 80.43% to 12.78% and the experiment of installing 2 passive filters tuned to the 5th order and 7th order reduces the THD value of a larger current from 80.43% to 5.43%.

## REFERENCES

1. Z. Aini and A. Mar'i, Design of single tuned filter against harmonics in distribution transformer, no. 4. Pekanbaru, Riau: Al-Mujtahadah Press, 2021
2. J. Napitupulu, "Study of harmonics in substations," J. Teknol. ENERGY UDA, vol. 8, no. 1, pp. 1-8, 2019.
3. I. G. Ariana, I. W. Rinas, and I. G. D. Arjana, "Analysis of the effect of harmonics on power losses (losses) on transformers in the Sedap Malam extension," Technol. Elektro, vol. 16, no. 1, 2017.
4. F. I. Pasaribu, "Non-linear loads and harmonic analysis," Journal of Electro and Telecommunications, vol. 5, no. 1. pp. 29-34, 2021.
5. V. Rexhepi dan N. Avdiu, "Analisis harmonisa dalam sistem tenaga listrik topik refrensi Kosovo: T4-kualitas daya listrik," 2012, [Daring]. Tersedia pada: https://www.researchgate.net/publication/270511238.
6. Mutiar, "Analysis of harmonic measurements caused by non-linear loads," Tech. Electro Polsri, vol. 5, no. 1, pp. 15-22, 2018
7. A. Dani, "Analysis of power losses on 150 kV transmission line at KIM substation," J. Indones. Sos. Technol., vol. 2, no. 11, pp. 1892-1901, 2021, doi: 10.36418/jist.v2i11.265.

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