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Harmonic Reduction and Power Factor improvement in three phase three wire system by using Passive Filters

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Abstract *– With the Development of Morden Technologies a Vast number of Non-Linear Loads are used in Power System, which causes Harmonic Distortion in the Power System. This Paper Proposes the Study of Harmonics Present in the Power System. Harmonic Filter (Passive type Filters) are used as mitigate this type of Power Quality Problems. Through this Paper we come to know about the Harmonics and their significance effect on the system regarding the Harmonics distortion caused by Non-Linear Loads. Matlab/Simulink Software has been used for the simulation purpose. The Result have been obtained with and without installation of filters and then it is observed that after installation of filters Harmonics of the Current are reduced and Power Quality is improve.*

Keywords *– Power Quality, Harmonics, Harmonic Distortion, Passive Filter, PCC(Point of Common Connection)*

I. INTRODUCTION

The Grid Voltage is normally taken to be a pure Sinusoidal at a suitable fundamental frequency of 50Hz. This Voltage is applied to the load (weather it is Linear of Non-Linear) applying a sinusoidal voltage to Linear Load it produces Sinusoidal Current at the same Frequency, and applying the voltage to a Non-Linear load does not produce Sinusoidal Current waveform. In which the Current is not proportional to the applied voltage. This Current can be identified to be repetitive at the fundamental frequency. Harmonics Current and Voltage are caused by the interaction of Non-Linear Loads [1].

1.1. Power Quality

Harmonics defined in terms of IEEE Standard 1159-1995[2] as "Any Sinusoidal frequency component, which is a multiple of the fundamental frequency". Harmonics frequency can be even or odd multiples of the sinusoidal fundamental frequency. Harmonics and Reactive Power regulation are upcoming issues and increasing in Distributed Power System. Vital use of Power Electronics appliances has made power management smart, flexible, and efficient, but side by side they are leading to power pollution due to injection of Current and Voltage Harmonics. Harmonics Pollution Creates Problems in the integrated Power System. It is having adverse effect on the Power System Network. This is Power Quality Problems. Power Quality defined as "any occurrence manifested in Voltage, Current or Frequency deviation that results in damage, upset, failure or misoperation of end user equipment" [3].

1.1.1 Harmonincs Distortation & effects

When a nonlinear load is fed from a sinusoidal supply, non-sinusoid, distorted current containing harmonics will be drawn from the supply. A voltage drop for each harmonic will be produced when this harmonic current will pass through the source impedance resulting in harmonic voltage at the PCC. The amount of voltage distortion depends on the source impedance and current[4].

No.	Item	Impact
1	Rotating machines	Overheating, loss of efficiency, pulsating torque, shaft fatigue, reduced life, acoustic noise emission
2	Transformer	Overheating, reduced life, acoustic noise emission
3	Power factor capacitor	Overloading, reduced life, fuse disconnection
4	Fuses and circuit breaker	Nuisance tripping, reduced life
5	Cables and conductors	Increased temperature, inability to provide full current rating without overheating, reduced life

Table 1.1.Effect of poor PQ on power system components

1.2. Harmonic Distortion Mitigation Techniques

Harmonic distortion in power system can be minimized through three basic approaches. They are i) Passive filter, ii) Active power filter, iii) Hybrid active power filter. In this paper we will discuss about harmonic distortion mitigation techniques by using Passive Filter.

II. PASSIVE FILTERS

The Passive Harmonic Filters are having some Passive Elements such as Resistor (R), Inductor (L), and Capacitor (C). There are different types of Passive Filters available – Single Tuned, Double Tuned, Second-Order Filters, Third-Order Filters, and C-Type Damped Filters. The different types of Passive Filter circuits are presented in Figure 1. [4]. Passive Filters have always been considered as a good alternative for Current Harmonics compensation and displacement power factor correction. In other way Passive Filters have been used to compensate low frequency Current Harmonics while High-Pass Passive filters are used for attenuate the amplitude of high frequency Current Components [5].

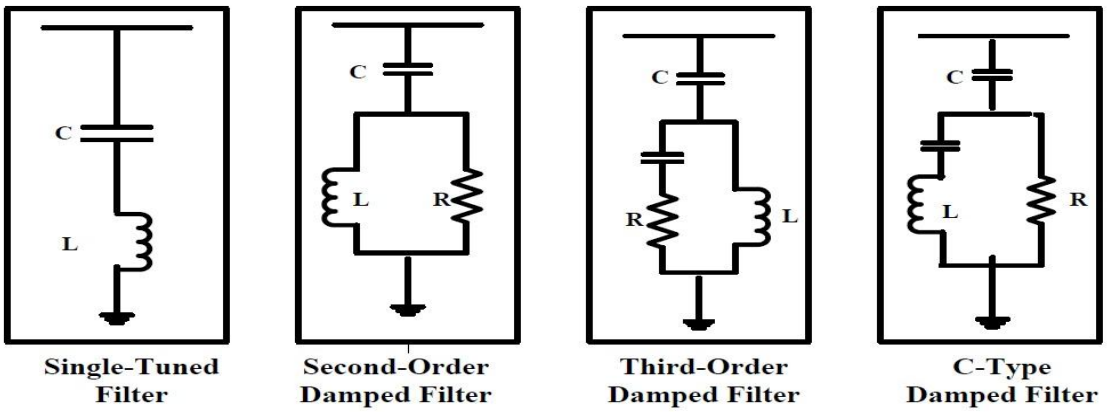

Figure1. Types of Passive Filters

Passive Filters are to be designed for reduce Harmonics and other Power Quality effects at particular points in power system. Each installation is different, the size and placement of the filters varies accordingly. Usually, Passive Filter having different types of parallel paths that present relatively low impedance to the various Harmonics. Harmonics Currents flow into this reduced impedance such that the harmonic voltage at that point is reduced. In some cases, there will be sufficient source impedance must be reduced that a single filters at that location can absorb harmonics from the multiple harmonics source. This point might be the point of common connection (PCC) [6] [7].

III. SIMULATION AND RESULTS

The Simulation Passive Type Filters is analyzed with and without use of filter in three phase three wire system. The main Simulation MATLAB Simulink model is shown in Figure 2 & Figure 7.

3.1 Model of Three Phase Three Wire System without Filter

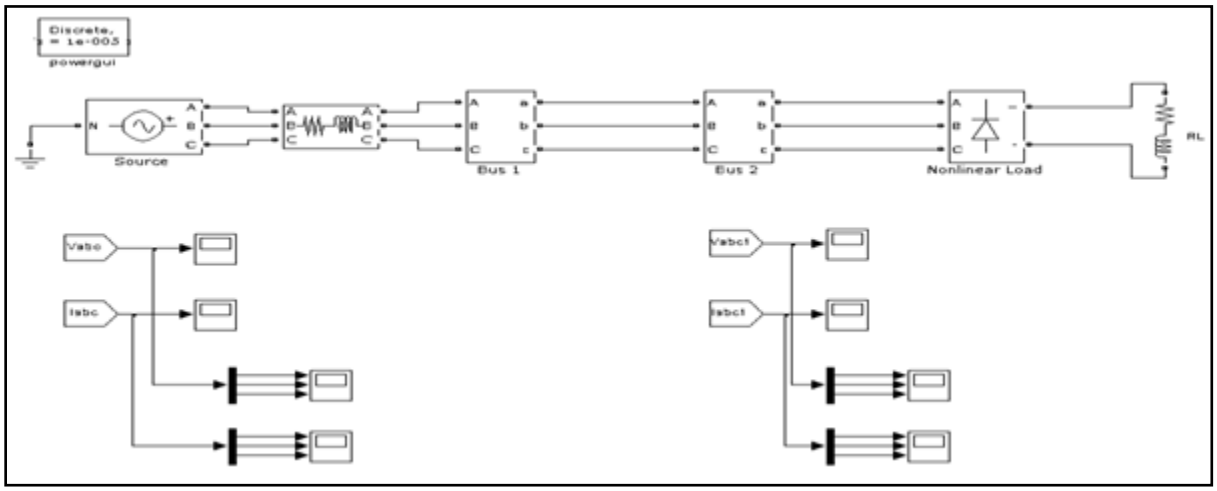

Figure 2 Model of Three Phase Three Wire System without Filter

In Figure 2 there is a direct supply feed to the load. Here Load is nonlinear type load. The nonlinear waveforms of current appear on the load measurement side because of nonlinear load, which is directly affecting the source current. By the nonlinear connection of load the sinusoidal source current is become distorted and become nonlinear just like load current. So, in this condition load current is equal to source current ($i_L = i_S$) shown in Figure 3 and Figure 4.

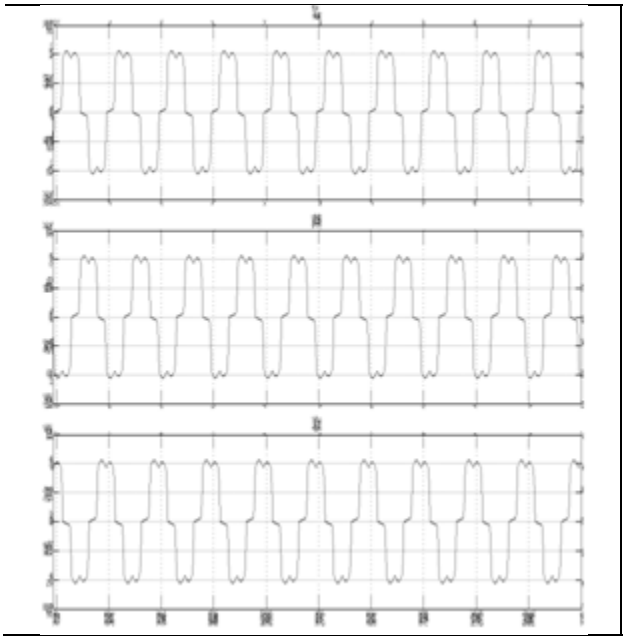

Figure 3 Load Current Waveform

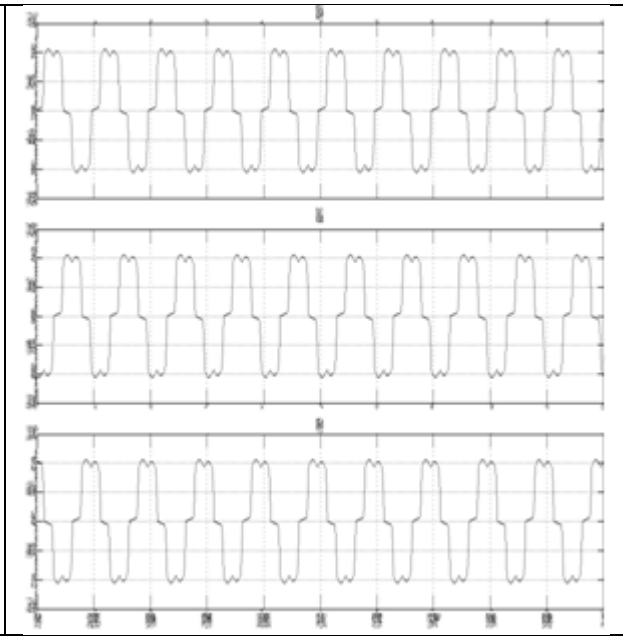

Figure 4 Source Current Waveform

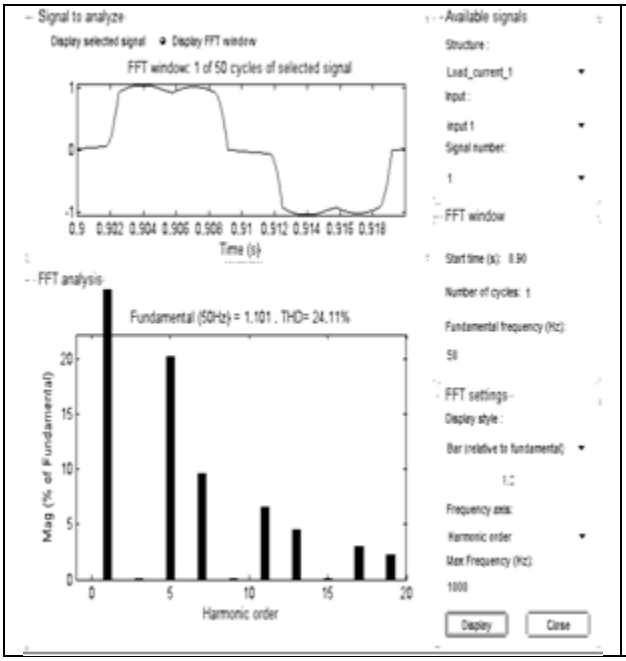

Figure 5 Load Current THD

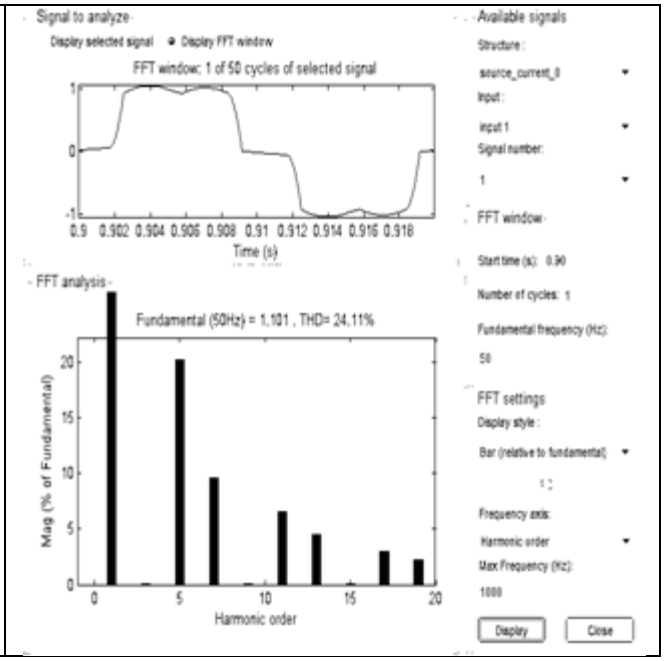

Figure 6 Source Current THD

By the FET analysis we can analyse the THD (Total Harmonic Distortion) of the system at load or Source side Current. By above analysis the observation is the THD at load side and source side is same which is 24.11% (%THD) shown in Figure 5 and Figure 6.

3.2 Model of Three Phase Three Wire System with Filter

Now to mitigate harmonics of the system the passive filters are connected across the line which is shown in Figure 7.

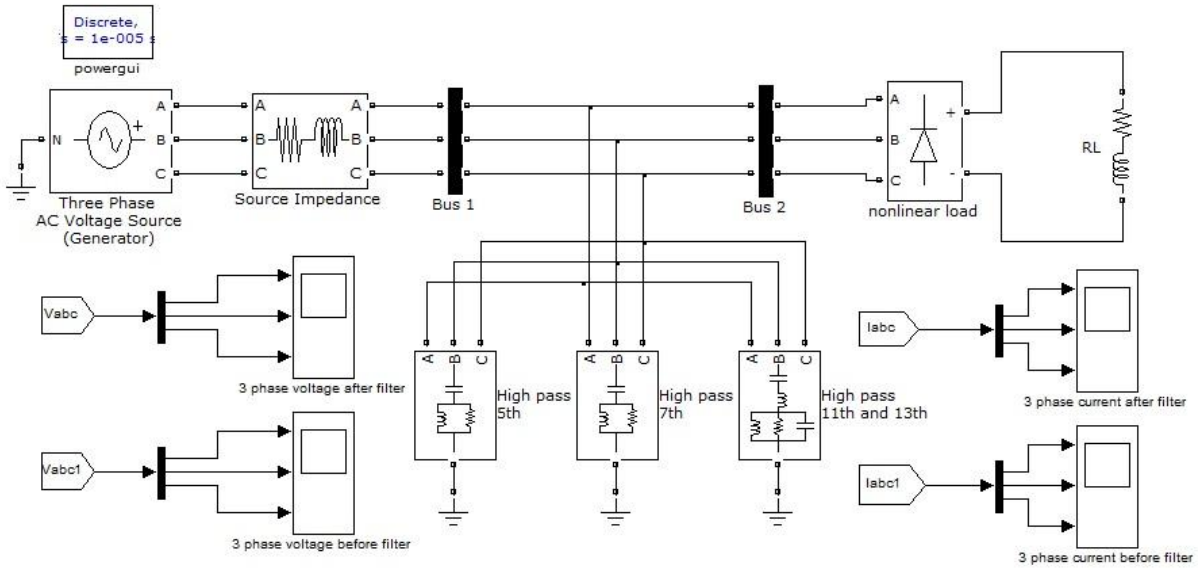

Figure 7 Model of Three Phase Three Wire System with Filter

In Figure 7 there is a direct supply feed to the load. Here Load is nonlinear type load. The nonlinear waveforms of current appear on the load measurement side because of nonlinear load, which is directly affecting the source current. Here with the use of Passive type Filter which is connect at PCC (Point of common connection) point which are used to reduce the harmonics at source current shown in Figure 8 and Figure 9. The THD 4.53% measure in Figure 10 and Figure 11.

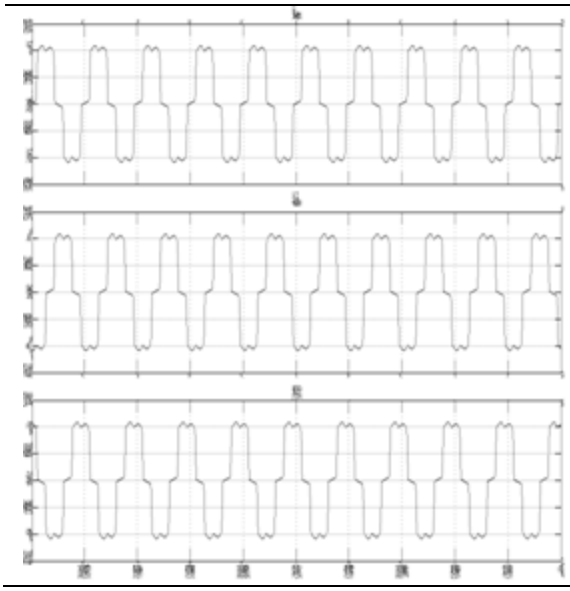

Figure 8 Load Current Waveform

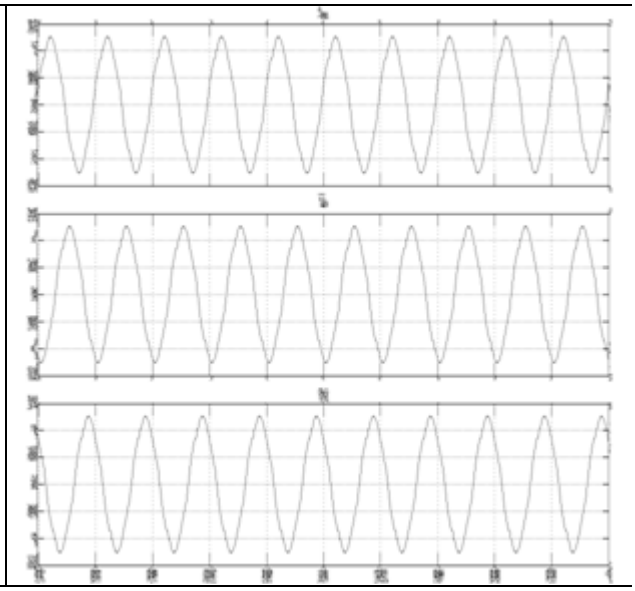

Figure 9 Source Current Waveform

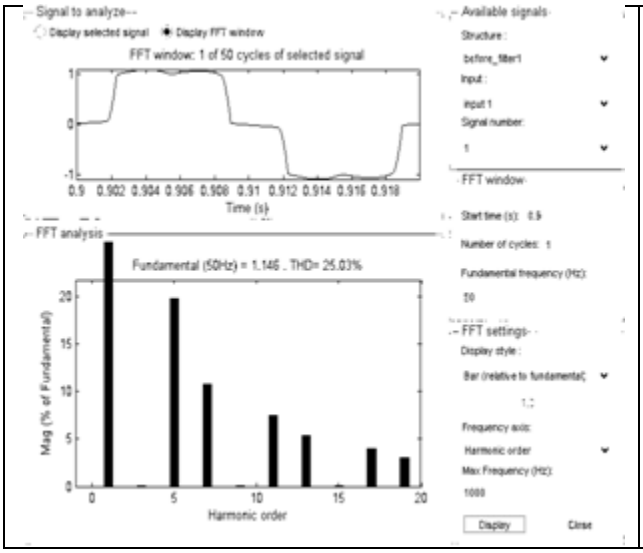

Figure 10 Load Current THD

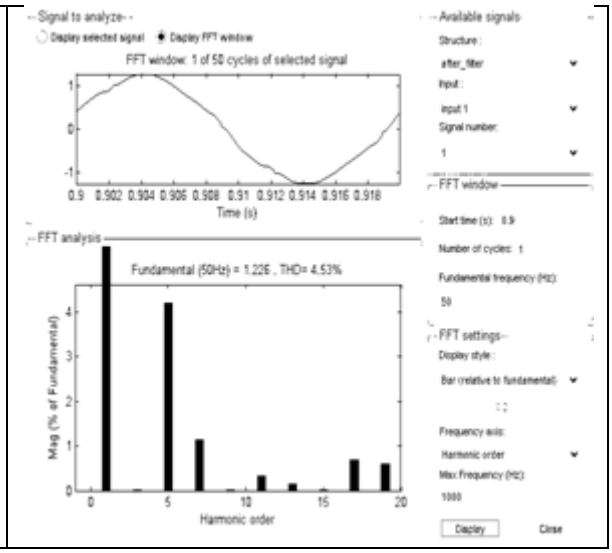

Figure 11 Source Current THD

IV CONCLUSION

To simulate the model of three phase three wire system with and without using of Passive Filters we getting the results. We can achieve and improve the power quality in the three phase three wire system. The result of simulation without filter THD is achieved 24.11% and with using of Passive Filter THD is achieved 4.73%. so, the total Harmonic Distortion of the system and its behaviour is analysed based on standards IEEE 519-1992.

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