COMPENSATION OF POWER QUALITY PROBLEMS USING ACTIVE POWER FILTER

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ABSTRACT: *Sensitive loads are greatly affected by power quality disturbances in the system. The increased reactive power, harmonics and unbalance cause in line losses, instability and voltage distortion. When harmonics travel upstream and produce drop across the line impedance. Passive filters do not provide any solution for unbalance and variable reactive power compensation.*
    A shunt active power filter (APF) can realize the appropriate solution for all the above said problems. APF is used to compensate harmonics and reactive current drawn by nonlinear and linear loads. The system is examined with and without APF to minimize the power quality problems such as voltage sag and harmonic distortion for linear and non-linear loads. The FFT analysis is done to find the total harmonic distortion. The proposed scheme has a fast response and is able to maintain bar sinusoidal source current for harmonic compensation. The proposed scheme offers good solution to uncertainties in power system due to power quality problems. The circuit is simulated using MATLAB/SIMULINK.

Keyword: Shunt active filters, Power quality disturbances, Harmonic distortion, Linear and Non linear load

I. INTRODUCTION

The AC power system has always been susceptible to problems regarding reactive power and unbalance from the very beginning. It has worsened with the increased used of power electronic converters as some of these converters not only increase reactive currents, but also generate harmonics in he source current. The increased reactive power harmonics and unbalance cause an increase in line losses, instability and voltage distortion when harmonics travel upstream and produce drop across the line impedance, which corrupts the power system.

Conventionally shunt passive filters are used to suppress the harmonics and their application provides limited fixed reactive power compensation moreover passive filters do not provide any solution for unbalance variable reactive power compensation.

Active power filters (APF) are power electronic devices operated in power systems for conditioning purposes. In most of the cases, APFs are primary designed for current or voltage harmonic compensation or isolation. Additional features, such as reactive power compensation or voltage regulation may be performed by some topologies. The APF compensation principles were proposed in 1970, and the significant development of power electronics technology has allowed engineers to make the APF a practical reality today [1]-[2].

Two fundamental configurations of stand-alone filters, either active or passive, have evolved: the series and the parallel filter. Combinations of one active and one passive filter in different configurations are known as hybrid filters [3].

A shunt active power filter can realize the appropriate solution for all the aforesaid problems. In [3] have discussed power quality problems in distribution systems and their solutions using power electronics equipments. The performances of the APF in distribution line under fault have also discussed.

In [4] has discussed using both APF and passive filters for compensating current harmonic distribution and power factor improvement. The method propos is improved generalized integrator controller.

II. SYSTEM STUDIED

In this paper harmonic generated by linear and non linear loads are compensated using APF with and without transmission line. In this following cases are studied
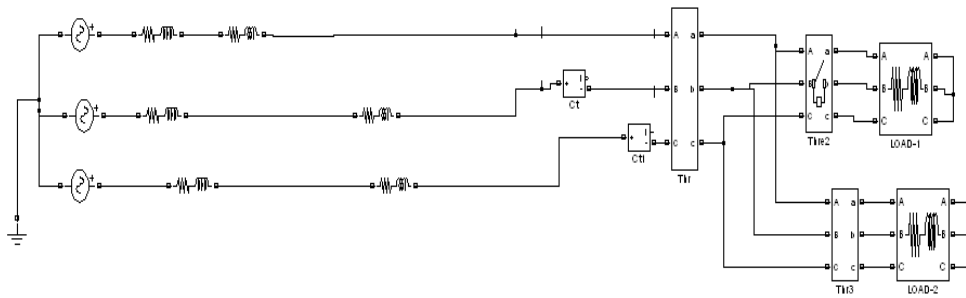***2.1 Linear Load without APF***

Figure 1: Transmission line connected with load

Figure 1 Shows 3 phase transmission line connected with linear load and performance of the system has been studied without APF.
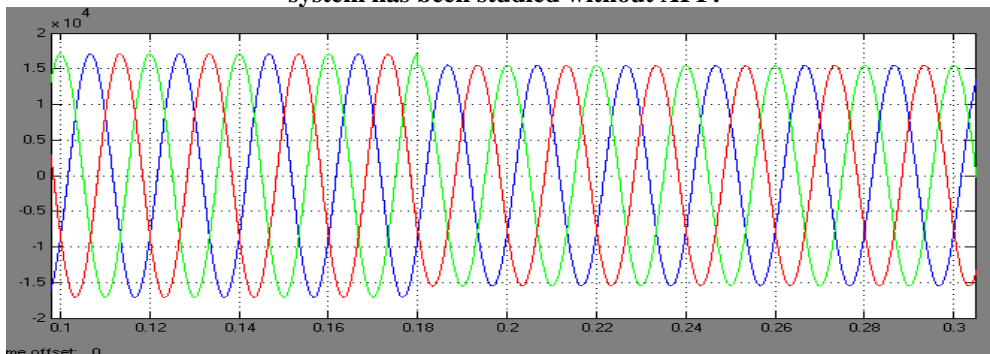

Figure 2: Voltage sag

Figure 2: shows the voltage sag measured across the load after connecting the linear Load to the transmission line. It is found in the waveform due to the linear load there is voltage sag at the time 0.18(sec).
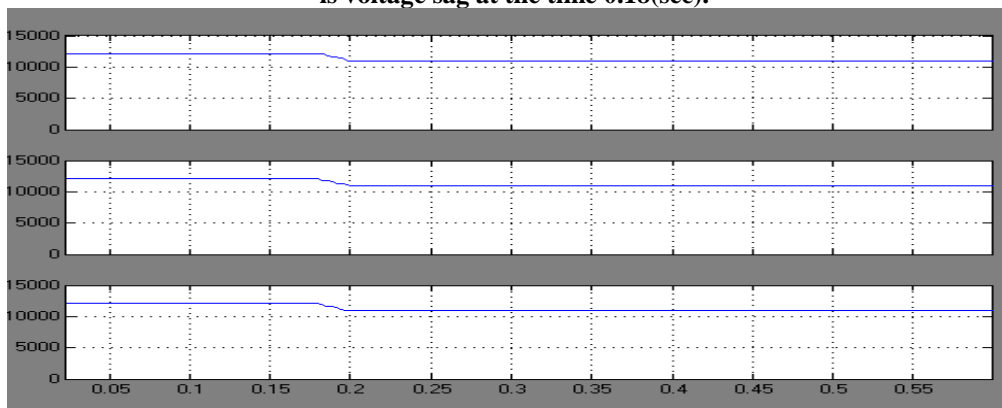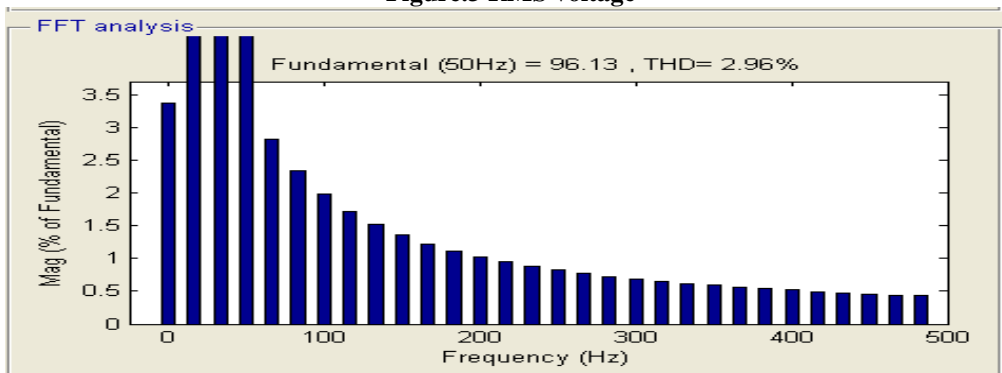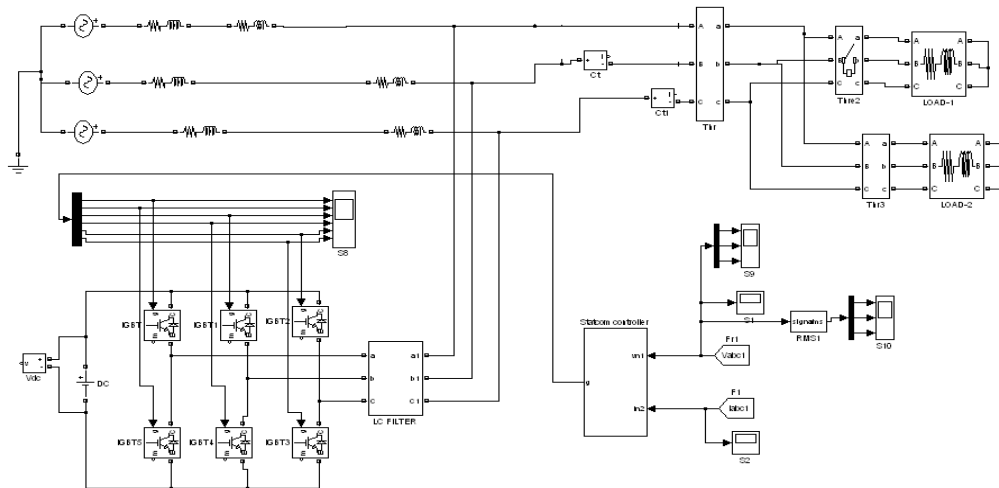

**Figure.3 RMS voltage**

Figure 4 FFT analysis

Figure 3: Shows RMS voltage variation due to addition and load. Figure 4 shows the FFT analysis for the voltage measured across the load to determine the level of the harmonic distortion. The total harmonic distortion found using linear load with APF is 2.96%.

**2.2 Linear Load with APF**

Figure.5 Circuit diagram with STATCOM

Figure 5: shows transmission line is connected with both linear load and APF. Shunt active power filter has been connected across the three phase power generator to compensate the harmonic generated by the linear load.
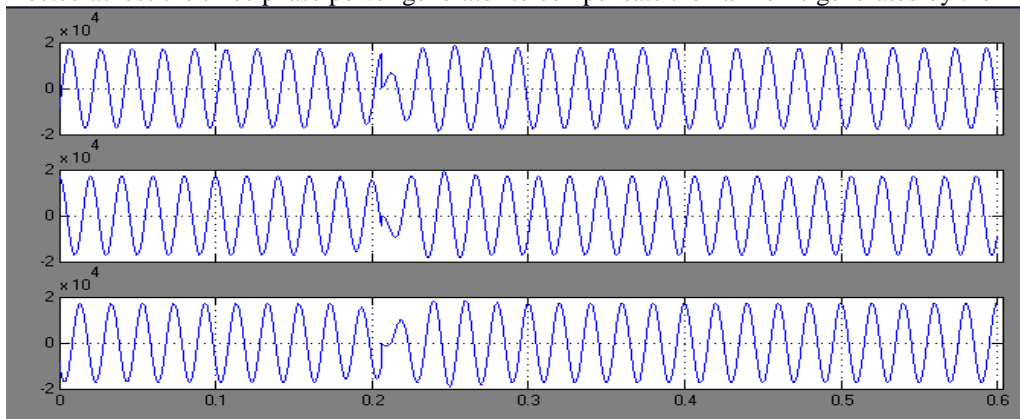
Figure.6 voltage measured across the load with APF

Figure.6 voltage measured across the load with APF it is observed from the wave form after the instant 0.18(sec) in all the three phases voltage sag was completely eliminated due to the addition of STATCOM in the transmission line.

RMS variation of three phase voltage has been given in the **Figure.7**
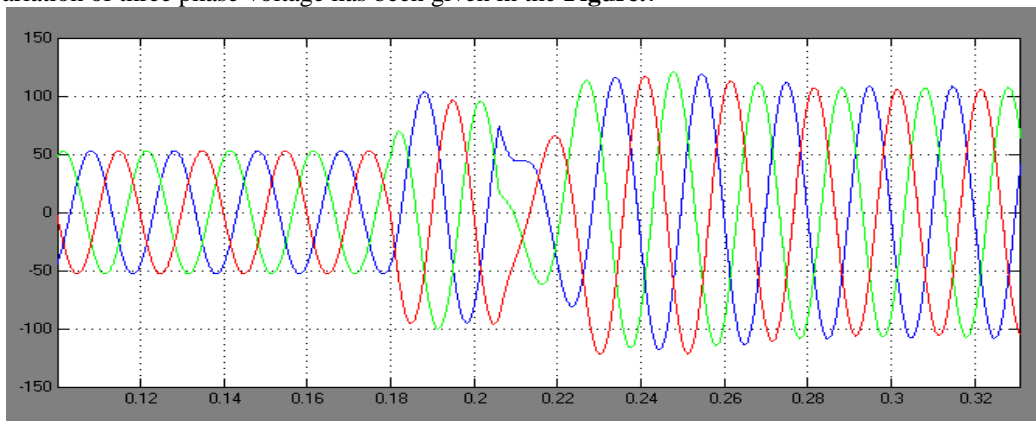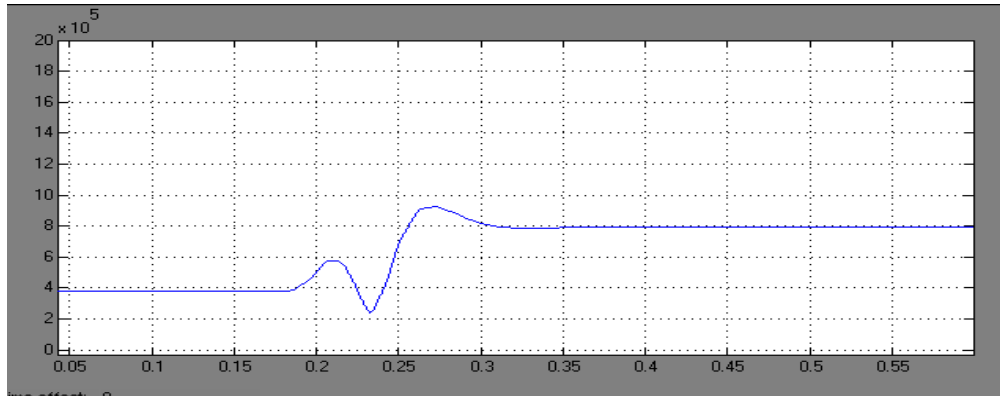

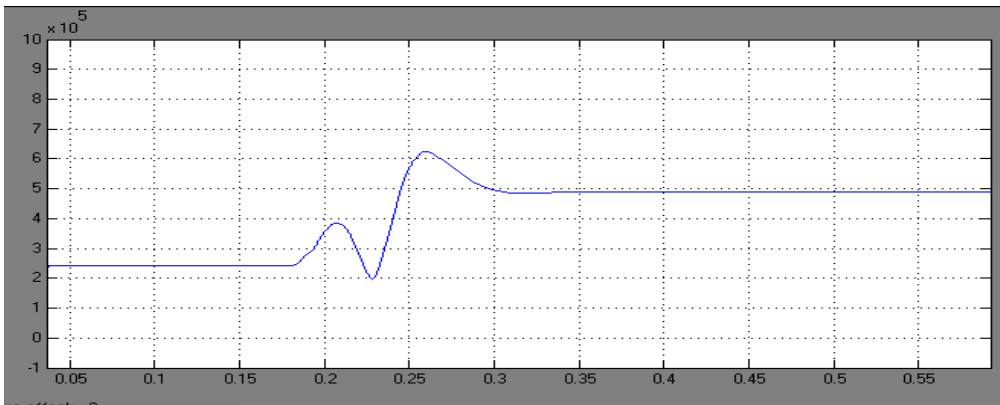**Figure 7: Three phase load current**

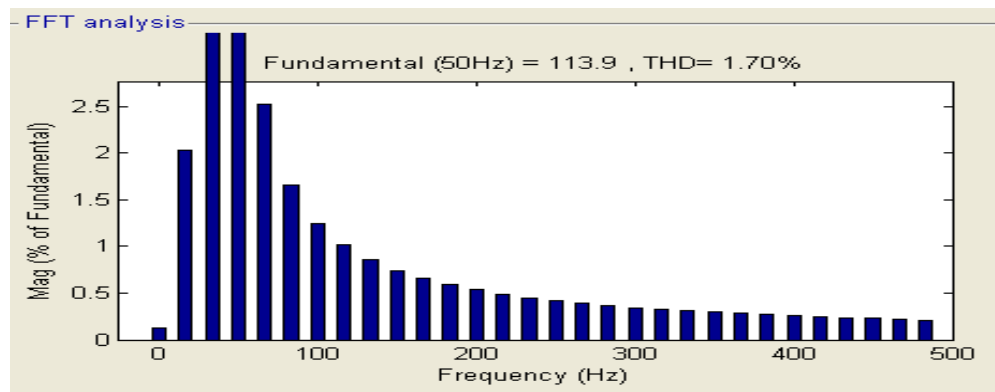**Figure.8 Real power**

Figure.9 Reactive power

Figure. 10 FFT analyses for current

Figure7: shows the variation of load current. Figure.8 and 9 shows the change in real and reactive power due to linear load. Figure 10: FFT analysis is applied to the voltage wave form of the linear load after the APF. It is observed that level of the harmonic is reduced to 1.70%.
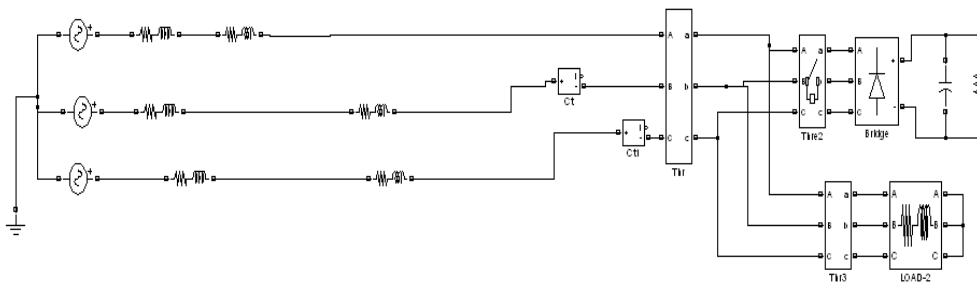
2.3 Non Linear Loads without APF

Figure.11 Circuit diagram

Figure.11 shows a system consists non-linear load without APF. A bridge rectifier and a load is connected across the supply to ensure the performance of the transmission line without APF.
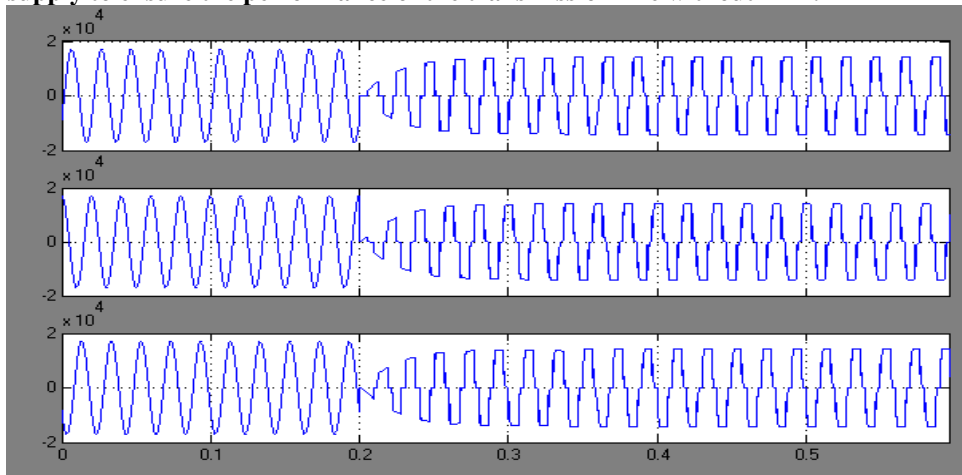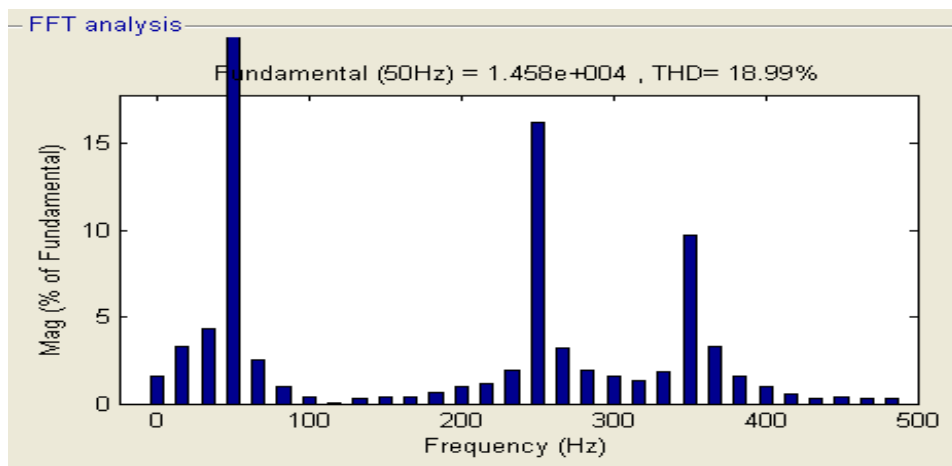

Figure.12 Load voltage

Figure. 13 FFT analysis

The voltage measured across the bridge has been shown in the Figure 12: Here bridge rectifier is considered as non linear load. It is found from the Figure 12 voltage sag is found at the instant 0.18(sec) to 0.26(sec). Due to non-linear load voltage wave form measured across the load is highly distorted with harmonic.
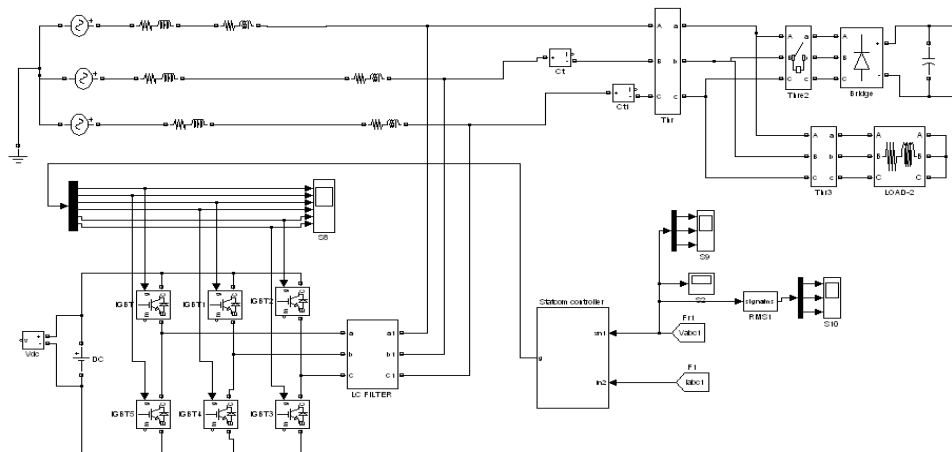

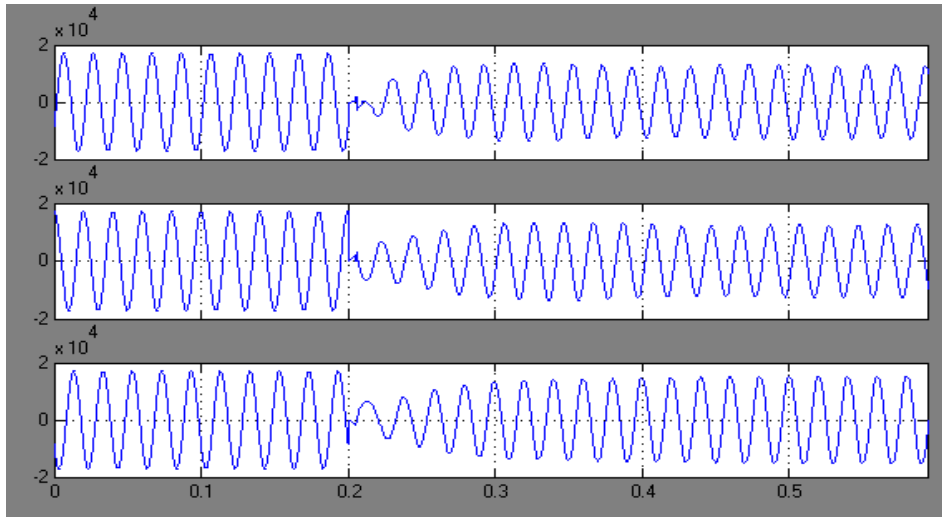**Figure. 14 Circuit diagram with STATCOM**
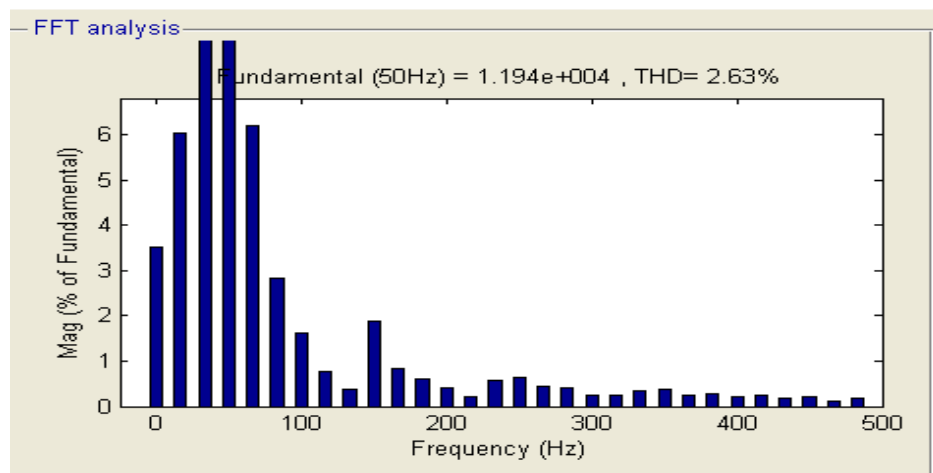
Figure.15 Three phase load voltage

Figure .16 FFT analysis

III. CONCLUSION

In this paper current decomposition technique based on instantaneous power theory power for SAPF is studied, simulink model is designed and THD is calculated to determine the level of the harmonic distortion. APF used here monitors the load current constantly and continuously adapt to the changes in load harmonics.

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