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Harmonics mitigation using shunt active power filter by sinusoidal current control technique

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ABSTRACT

With the widespread use of power electronics devices such as rectifier, inverter etc. in power system causes serious problem relating to power quality. The main issue consideration in this analysis is harmonic, and this is because nonlinear load. To mitigate the effects from nonlinear loads shunt active power filter is places with the line. The control technique of SAPF is sinusoidal current control technique. Hysteresis current control scheme used for IGBT switching and generation of PWM. The simulation of control technique of SAPF is simulated in MATLAB/SIMULINK software. In this paper compare of balanced and unbalanced voltages. Obtained THD of this control technique by simulation analysis. The results indicates the SAPF can improve the power quality.

Keywords: *Harmonic, Power quality, Active filter, THD, Sinusoidal current control.*

1. INTRODUCTION

Use of power electronics switching devices more harmonics problem in power system. Harmonics is a major issues for the power quality. In nonlinear loads there are a power electronics switches. Due to these switches there are a more harmonics current drawn from the source and also reactive power drawn. By them there are a voltage unbalance and also problem for the neutral currents. In presence of harmonic current in power system the voltage distorted and then there are the power system equipment failure. There are a more effects including capacitor failure, overheating, overloading, low power factor, and frequency deviation. So the compensation of harmonics must be required. For the compensation of harmonics many techniques but the shunt active power filter is best one. [1].in shunt active power filter there are calculation for reference current and then generates the reference current for the compensation of harmonics. Shunt active power filter continuously monitor the harmonics current and reactive power flow in the network and generate reference current from distorted current waveform. So the SAPF has a dynamic performance and it is help to reduction of harmonic and reactive power with a small time delay. SAPF can be used with different current control strategy such as constant power control technique, sinusoidal current control technique, fuzzy logic, synchronous reference frame theory, generalized fryze control theory etc. For the compensation of harmonics and reactive power also in power system.

2. SOURCE OF HARMONICS

- Due to use of power electronics switches more harmonics generation in power system.
- Non-linear load such as UPS, SMPS, battery charger.
- In machine, the winding deteriorates generate the harmonics
- Due to design defects
- Loose connection
- Inrush current of transformer
- Generator itself generates

3. EFFECT OF HARMONICS

Harmonics may cause disturbance in power system. In there,

- Due to the lower harmonics like 5th and 7th Crawling in rotating AC machine.

- In metering equipments, generate additional coupling path then increasing the speed of disc and then cost increase.
- In communication network due to harmonics high noise levels.
- Presence of harmonic, neutral conductor over heating
- Increase eddy current loss in transformer
- Due to harmonics the cable heating and tripping of protection

4. CLASSIFICATION OF HARMONIC FILTER

Harmonic filters classified mainly three types: Passive filter, Active filter, Hybrid filter.

Passive filter

It is a combination of passive elements like capacitor and inductor. it is mainly use for lower order harmonics. Passive filters like a single tuned, double tuned high pass and c- type use for the mitigate harmonics. In passive filter for harmonic current control requires filter for each frequency.

Active filter

An active filter consist a operational amplifiers It is based on the reference current extraction. An active filter use for the compensation of higher order harmonics. There are harmonic current control monitoring many frequencies.

Hybrid filter

The combination of active and passive filter are hybrid filter. It is mitigate both lower and higher order harmonics. [2].

Shunt active filter

The active filter is connect in parallel to the nonlinear load for the cancelation of harmonics which produced by the loads. The source flow the sinusoidal current. The APF require to generate harmonic current and reactive current. The voltage source inverter generate the compensating current (ic) and then injected to the grid.an APF provide these current so the supply current (is) not distorted [4].

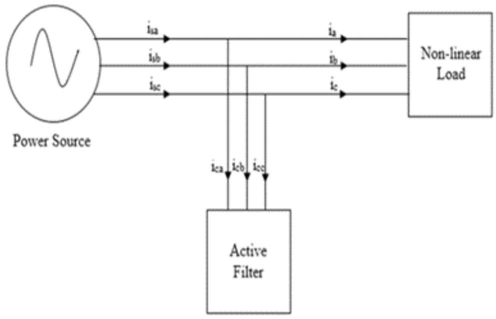

Fig. 1: Shunt active power filter

Figure 1 shows the shunt active power filters for the harmonic current and reactive power compensation. It is inject difference between load and source current but opposite in phase [4].so the source cannot affect due to the load. Series and shunt two basic types of active filter, which mitigate the voltage and current harmonics respectively.

5. SINUSOIDAL CURRENT CONTROL TECHNIQUE

H. akagi first introduced an instantaneous active and reactive power theory. The sinusoidal current control technique based on instantaneous active and reactive power theory. This technique same as constant power control technique only difference positive sequence analyzer[3].In there only positive sequence voltage given .The positive sequence is carried out by similar fashion as of reference signal extraction in constant power control technique. First the 3 phase unit currents are found out which are having only positive sequence component and also in synchronized with source voltage. Positive sequence is carried out by similar fashion as of reference signal extraction in constant power control technique. First the 3 phase unit currents are found out which are having only positive sequence component and also in synchronized with source voltage. After that the instantaneous active and reactive power are found out as per the constant power control. The pulsating components are removed using the low pass filter from both instantaneous active and reactive power. According to that, the reference signal is carried out using following equation.

$$\begin{bmatrix} i_{c\alpha}^{*} \\ i_{c\beta}^{*} \end{bmatrix} = \frac{1}{v_\alpha^2 + v_\beta^2} \begin{bmatrix} v_\alpha & v_\beta \\ v_\beta & -v_\alpha \end{bmatrix} \begin{bmatrix} P_{loss} - \tilde{p} \\ -q \end{bmatrix}$$

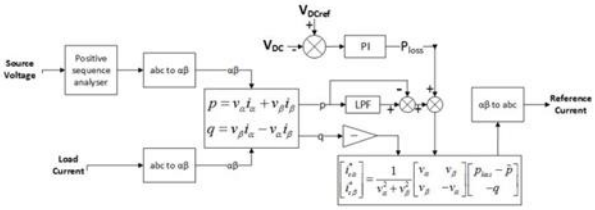

Fig 2: Block diagram of sinusoidal current control technique

Using inverse park transformation, the positive sequence voltages of three phase are carried out. In case of constant power control technique, the reference current would generate such that the only active power should flow from the supply, so it will not meant to make source current sinusoidal. Whereas in case of sinusoidal current control technique, the source current will be sinusoidal irrespective of active power supplied from the source.

6. SIMULATION MODEL AND RESULTS

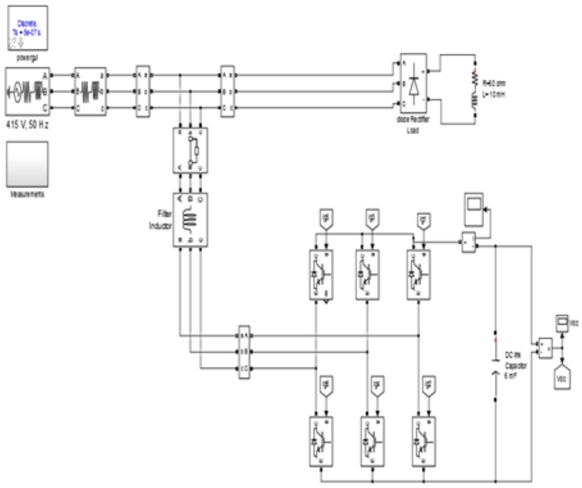

Fig.3: Simulation model of SAPF

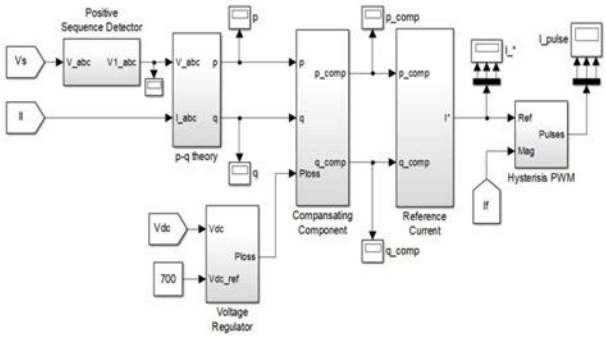

Fig 4: Sinusoidal current control technique

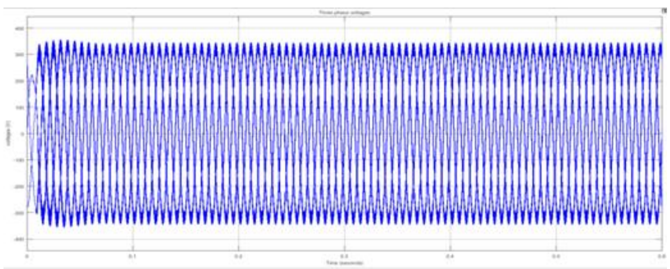

Fig 5: Balanced three phase voltages

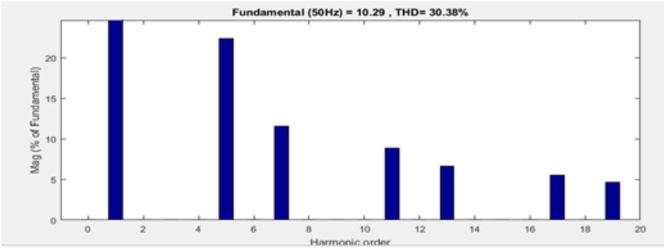

Fig 6: Harmonic spectrum of load side

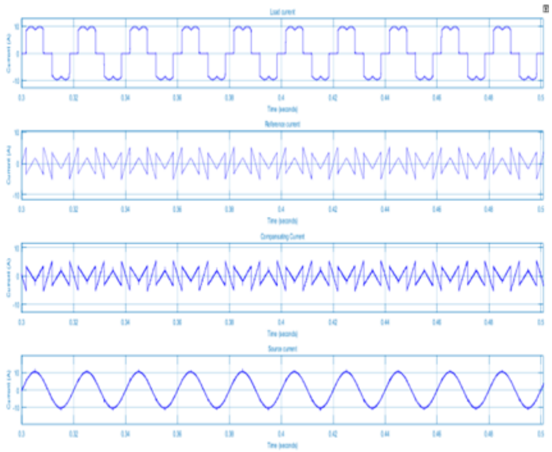

Fig 7: Current waveforms for balanced voltages

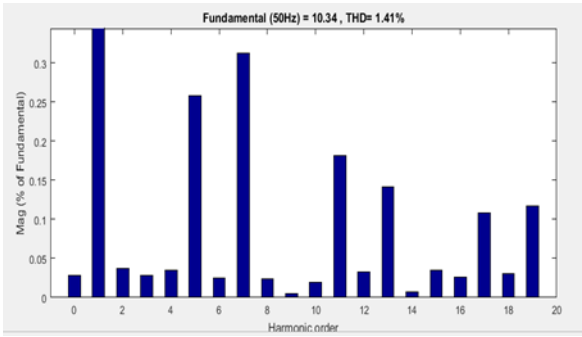

Fig 8: Harmonic spectrum of source side

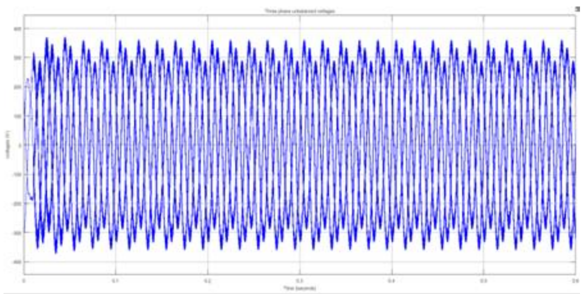

Fig 9: Three phase unbalanced voltages

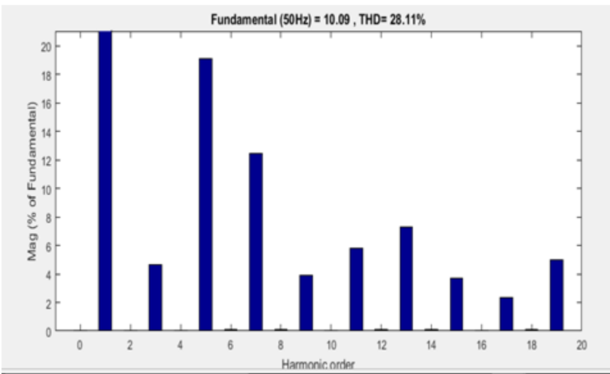

Fig 10: Harmonic spectrum of load side with unbalanced voltages

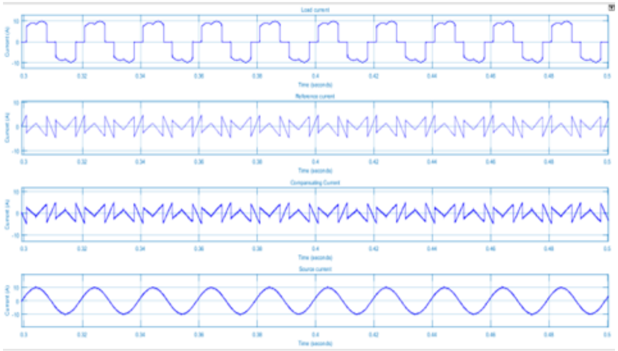

Fig 11: Current waveforms with unbalanced voltages

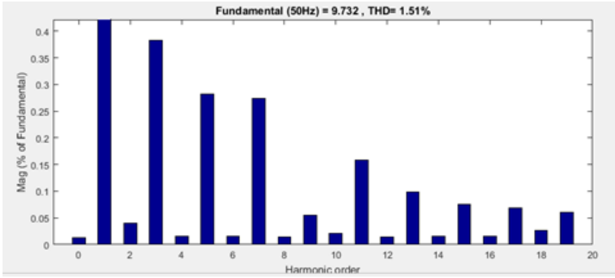

Fig 12: Harmonic spectrum of source side with unbalanced voltages

7. CONCLUSION

After perform the sinusoidal current control technique for shunt active power filter, we can easily understand that these technique good result for both the cases. For unbalanced voltages THD reduced from 28.11% to 1.51%.The aim of this technique is mitigate the harmonics and make source sinusoidal in unbalance voltages and it is shown in simulation results.

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