Harmonic metigation using Passive Filter

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Abstract

With the growing use of industrial drives, the problem of injected harmonics becomes critical. These harmonics require the connection of harmonic filter in the network. The filter is design to minimize harmonic distortion caused by source such as drives. several types of passive filters are effective in minimizing voltage distortion caused by non linear loads in industrial power systems .Different alternatives for filter design should be considered before making the final decision on filter configuration. Among the criteria used for performance evaluation are current, and voltage ratings of each of the filter component, and the effect of filter and system contingency conditions .The design and performance of passive filter will be discussed. It will reduce the current and harmonic distortion. The most of power quality problems are caused due to non-linear loads such as induction furnace and use of power electronic device. The non-linear load produces harmonics which destroy the sinusoidal nature of supply. So that it is important to mitigate this harmonics .The best method of mitigating harmonics is by using by filter. The series active filter is suitable for the mitigation of voltage harmonics. In this paper we discussed the control strategies of active filter which mitigate harmonics and maintain waveform sinusoidal.

Keywords: Passive filter,System simulation,Harmonics,THD

1.0 INTRODUCTION

The electrical power quality is term which refers to maintaining the near fundamental sinusoidal waveform of power distortion of voltage and current waveform at rated magnitude and frequency. Increase in the more use of power electronic device as well as induction Furnace increases the harmonics level at end users and on the overall power system. As well as it affects on power system stability, reliability. To avoid such effects it is important to asset the power quality. Power quality problems occur due to various types of electrical disturbances. Most of the disturbances depend on the amplitude or frequency and amplitude. Based on the duration of existence of disturbances, events can divided into short, medium or long type. Effects of harmonic include overheating of transformers, motors and cables, thermal tripping of protective devices and logic faults of digital devices. In addition, the life span of many devices is reduced. Thus we have used passive filter to mitigate harmonics.

1.1 METHODOLOGY

1.1.1Passive Filter

The passive harmonic filters are such that they are used for different voltage levels. In case of passive harmonic filters, the harmonics are reduced by using series or parallel resonant filter. The way these passive harmonic filters works is, a filter connected in parallel with the load and in series with inductance and capacitance is a current acceptor. A current acceptor is a parallel filter which is in parallel filter with the load and is in series with the inductance and capacitance. The filter passes as much current as the harmonics voltage nears the filter resonant frequency point. The passive thus eliminate the harmonics .If the individual load requirement is more than that of input load, the harmonic current should be eliminated. A capacitor is in series with an inductance is is a passive filter. The reduced harmonic frequency must be equal to the resonant frequency of the circuit. the impedance of the network and the low impedance of the filter thus eliminate the harmonic current. The passive filters are used in order to protect the power system by restricting the harmonic current to enter the power system by providing a low impedance path. Passive filters consisting of tuned series L-C circuits, are the most popular, and may produce unwanted side effects, particularly in the presence o capacitor which is used for power factor correction.

1.1.2Series passive filter

Series filter consist of a parallel inductor and capacitor and presents a large impedance .This filter has the property of purely inductive type or LC tuned characteristics .The operating principle of series passive filter is given by these two component connected in series that AC line reactor improve system magnitude of inductance in system that alters the path of current drawn in the rectifier circuit

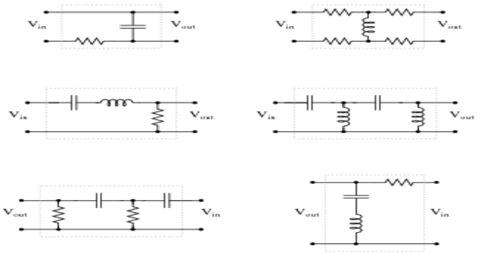

Fig 1:- Series passive filter

1.1.3Shunt Passive Filter

It is the most common method for the cancellation of harmonic current in the distribution system. Passive harmonic filter are basically designed on principle of either single tuned r band pass filter technology. As the name suggests shunt type filter are connected in system parallel with load. Passive filter offers a very low impedance in the networks at a tuned frequency to divert all the related current and at given tuned frequency. Design of passive shunt filter take place for the two purpose one is the filtering purpose and another one is to provide reactive compensation purpose of correcting power factor in the circuit at desired level. The advantage with the passive shunt filter is that it only carry fraction of current to the whole system ac power losses are reduced compare to series type filter. The shunt passive filter is also capable of filtering specific tuned harmonic frequencies such as 5^{th}, 7th, 11th etc.

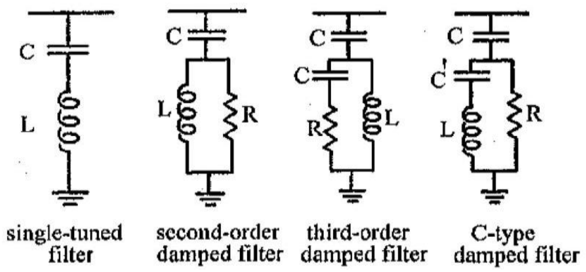

Fig 2:-Shunt Passive Filter

1.1.4 CALCULATION FOR DESIGN OF FILTER

1) *V=440V*

   I=2A

   Displacement power factor (cos1) =0.75

   Desired power factor (cos2) =0.9

2) *I)* $I1\ (cos\emptyset 1) = I2(cc$

   $I2 = I1\ (cos\emptyset 1)/(cos\emptyset 2)$

   $I2 = \frac{2*0.75}{0.9}$

   I2=1.66A

3) *I)* $Ic = I1\ (sin\emptyset 1) - I2(si$

   $Ic = 2(sin41.40) - 1.66(sin8.10)$

   Ic=1.09Amp

4) $Ic = \frac{V}{X}$

   $Ic = V/[R + j(XL - XC)]$

   $Ic = \frac{V}{[R+j(2\pi fL - 1/2\pi fC)]}$

5) $R = \frac{XL}{Q}$

   $R = \frac{2\pi f L}{Q}$

   $R = \frac{2\pi * 50L}{30}$

   $R = 10.47L$

6) $XL = XC$

   $2\pi f L = 1/2\pi f C$

   $L = 1/4\pi^2 f^2$

7) $Ic = \frac{V}{10.47L + j\left(\frac{2\pi f}{4\pi^2 f^2} - \frac{1}{2\pi f C}\right)}$

   $Ic = V * 4\pi^2 f^2 C/10.47$

   $1.09 * 10.47 = \frac{440}{\sqrt{3}} * 4\pi^2 * (350)^2 * C$

   $C = 0.009\mu f$

8) $L = 1/4\pi^2 f^2 C$

   $L = \frac{1}{4\pi^{2*}(350)^2 * 0.009 * 10^{-6}}$

   $L = 0.022mH$

9) $R = 2\pi fL/Q$

   $R = \frac{2\pi * 50 * 0.022}{30}$

   $R = 0.23$

1.1.5 Simulation and Waveforms

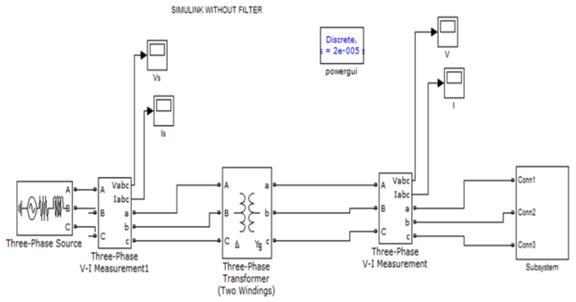

Fig 3: - Simulation without filter

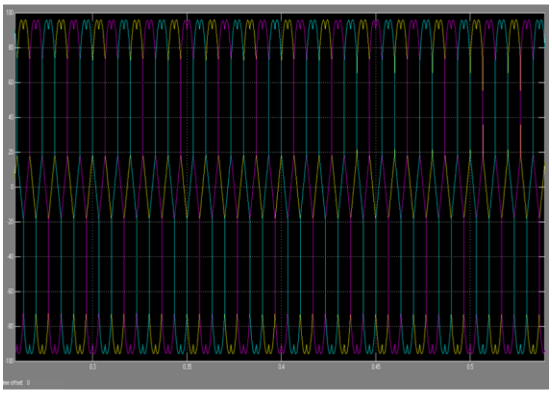

Fig 4: - Waveform for without filter

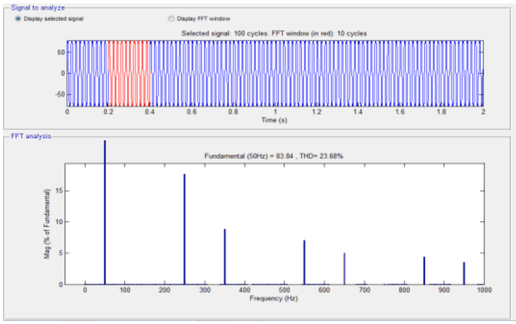

Fig 5:-FFT analysis for without fitter

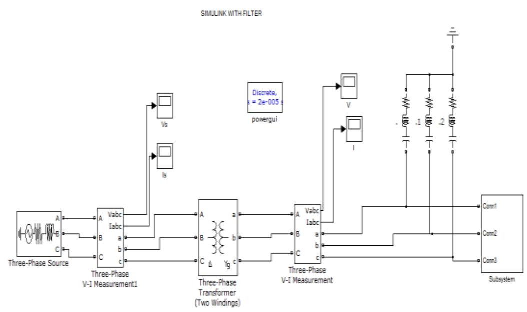

Fig 6: - Simulation for with filter

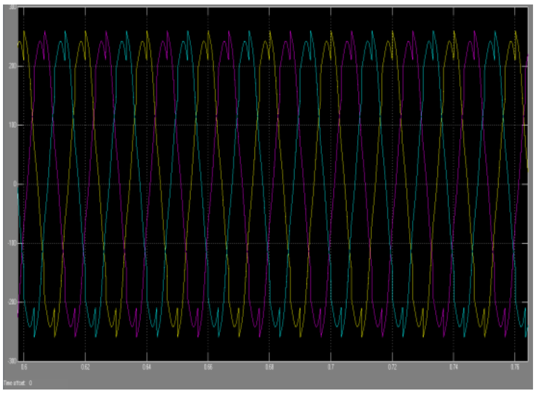

Fig 7:- Waveform for with filter

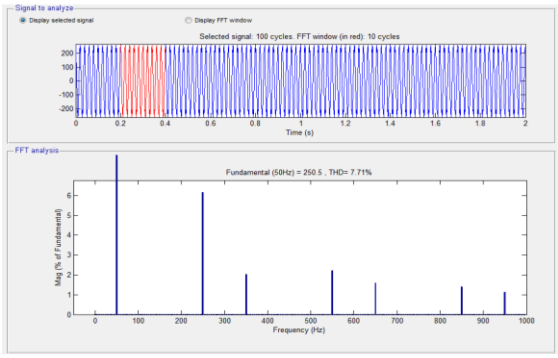

Fig 8:- FFT analysis for with filter

2.0 CONCLUSION

Harmonic causes damage to the electrical networks and can some times be dangerous.Passive filter are effective in minimizing voltage and current distortion caused by non linear loads.The capacitors in passive filters provide reactive power compensation to improve the power factor.Passive filter provides low impedance path to the harmonic current.Thus passive filter are an effective,easy and economical option to counter issue of harmonics arising in small and large scale power systems or network involving non linear loads.

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