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DESIGN OF FILTER FOR SIX PULSE CONVERTER

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Abstract- ***Non-linear loads produce harmonic currents that can travel to other locations in the power system and eventually back to the source. Harmonic currents can produce a variety of effects that are harmful to the power system. Harmonic currents are a result of the characteristics of particular loads. As long as we choose to employ those loads, we must deal with the reality that harmonic currents produced by a non-linear current source will not unduly interfere with the rest of the power system is to filter out the harmonics. Application of harmonic filters helps to accomplish this.***

Keywords: filter, harmonic, MATLAB

I.INTRODUCTION

Harmonic filters are broadly classified into passive and active filters. Passive Filters, as the name implies, use passive components such as resistors, inductors and capacitors. A combination of passive components is tuned to the harmonic frequency that is to be filtered.

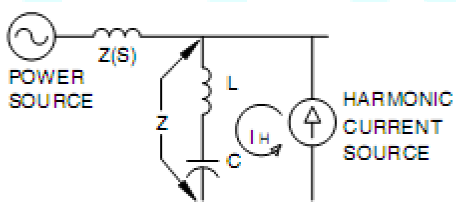

Figure 1: Series tuned filter

Figure 1 is a typical series tuned filter. Here the values of the inductor and the capacitor are chosen to present low impedance to the harmonic frequency that is to be filtered out. Due to the lower impedance of the filter in comparison to the impedance of the source, the harmonic frequency current will circulate between the load and the filter. This keeps the harmonic current of the desired frequency away from the source and other loads in the power system. If other harmonic frequencies are to be filtered out, additional tuned filters are applied in parallel.

Non-linear loads produce harmonic currents that can travel to other locations in the power system and eventually back to the source. As we saw earlier, harmonic currents can produce a variety of effects that are harmful to the power system. Harmonic currents are a result of the characteristics of particular loads. As long as we choose to employ those loads, we must deal with the reality that harmonic currents produced by a non-linear current source will not unduly interfere with the rest of the power system is to filter out the harmonics. Application of harmonic filters helps to accomplish this.

II.HISTORY

The term "harmonic" originates from acoustics, where it signifies the vibration of a string or column of air at frequency, which are integer multiples of that frequency. These harmonics can occur at any frequency. Including frequencies below fundamental frequency, depending on the operating speed of the drive. This phenomenon introduces a totally new dimension , as "traditional harmonics" were always assumed to occur at specific frequencies only . A distorted AC supply signal can be seen as a pure sinusoidal waveform (supply frequency component) with noise or pollution signals (harmonics) imposed .The degree of distortion is given by magnitudes of individual harmonics present and/or by total harmonic distortion (THD)Filters of some sort are essential to the operation of most electronic circuits. It is therefore in the interest of anyone involved in electronic circuit design to have the ability to develop filter circuits capable of meeting a given set of specifications.

The filters are made up of passive components: resistors, capacitors, and inductors, so they are referred to as passive filters. A passive filter is simply a filter that uses no amplifying elements (transistors, operational amplifiers, etc.). passive filters require no power supplies

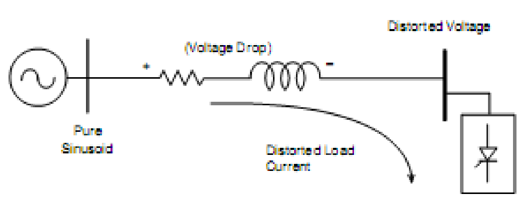

Figure 2: Harmonic currents flowing through the system impedance results in harmonic voltages at the load

Passive filters are of two types, series passive filter and shunt passive filter.

Series Passive Filter: These filters are connected in series with the power system, to block the particular frequency we use series passive filters. They offer high blocking impedance to the desired frequency.

Shunt Passive Filter: If more than one harmonic frequency is allowed to block or eliminate then we use shunt passive filters. These provide a shunt path to the harmonics and are placed on the harmonic source bus.

Passive filters carry a current that can be expressed as a fraction of the load current at fundamental frequency. As for their cost, they are more expensive than series reactors often used to provide some harmonic attenuation, but they have the advantage of providing reactive power at fundamental frequency. For practical purposes, they are substantially used in industry.

Filter designs usually offer a robust mechanism that provides some minor filtering action for a fraction of other harmonic currents whose order is close to the tuning frequency, provided that no filters tuned at those frequencies exist.

III. DAMPING RESISTORS IN HARMONIC FILTERS

In order to control the impedance in a electrical system with harmonic current generation filter circuits are used. They allow to fix a low impedance at defined fixed frequency independent of the network. In order to build such filters the traditional electro technical offers the use of capacitors and inductors. By connecting this two elements in various configuration a well defined frequency response can be achieved. How ever the available components do have a very high quality factor, that means very low losses. This results in a system which is also very susceptible for undesired resonance's, or poor performance with variable frequency. In this cases resistors can help to improve the behaviour. They act as damping elements in a oscillating system, similar to the shock absorbers in the suspension of a car, where the springs and the mass of the car can be compared to the reactors and the capacitors in the electrical system. With adequate circuit design losses at fundamental frequency can be avoided and optimum results at harmonic frequency can be achieved. In general they smoothen the response at the tuning frequency in order to increase the immunity to frequency variation and component tolerances due to manufacturing and temperature. At the parallel resonance frequency they control the dynamic behaviour of the filter in order to avoid critical amplification of residual non typical harmonics and general noise.

At this point a resistance with variable resistance value can have a significant positive influence on the filter characteristic. At low harmonic distortion the resistance shall have a low value. This increases the damping of the system during unpredictable transient phenomena in the network like energizing of parallel circuits, transformers or the filter itself. With a low value in the resistor the switch on transient of the filter can be kept very short and we have maximum security in thesystem. At increasing harmonic currents the resistor should have a high value in order to reduce the impedance of the filter at the tuning frequency and improve the voltage quality for steady state harmonic current. This behaviour can be achieved by using a resistor with a high positive thermal coefficient for the resistivity. At low harmonic loads the resistor does not have any loss and is therefore at a low value. With increasing absorption of harmonic currents the resistive value increases and the filter quality improves. Now it is up to the designer to chose the right compromise between transient damping and harmonic absorption. But it general it can be said it is always useful to have a positive coefficient even if it is only for the transient of filter energizing.

IV.DESINGNING OF PASSIVE FILTER

Harmonic filters are installed so as to absorb harmonic currents by choosing the inductive and capacitive components to resonate at the required frequency. The impedance at fundamental frequency will still be predominately capacitive . At the resonant frequency , the harmonic currents are presented with a virtual short circuit.

Thus the voltage at the frequency , across the terminals of the filter will be close to zero. Filters are installed by consumers to prevent excessive amounts of internally generated harmonic current passing into the supply system. Other applications are to attenuate voltage distortion to reduce the potential damage caused by harmonic over voltages or to provide tuning for power factor correction capacitors for the sole purpose of avoiding harmful resonance with internal or external harmonic sources.

The size of the filter is defined as the reactive power that the filter supplies at fundamental frequency. It is substantially equal to the fundamental reactive power supplied by the capacitors.

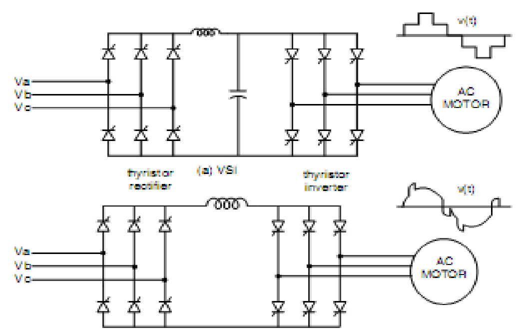

Figure 3: 12 pulse VSI and CSI

The total size of all the branches of a filter is determined by the reactive power requirement of the harmonic source and by how much this requirement can be supplied by the ac network. The ideal criterion of filter design is the elimination of all detrimental effects caused by waveform distortion including telephone interference.

Design Steps of Passive Filter: The harmonic current spectrum produced by the non-linear load is injected into a circuit consisting of filters in parallel with the ac system at the relevant frequencies and the harmonic voltage is calculated. These results are used to determine the specific parameters i.e. THD, TIF and IT factor.

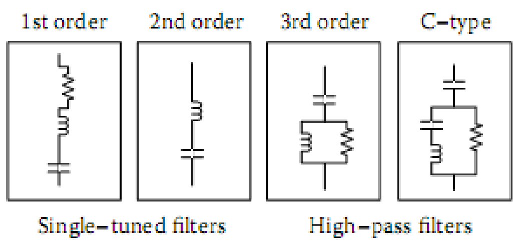

Figure 4: Electrical Diagram of Passive filters

Stresses in the filter components: Resistance, Inductance and Capacitance are then calculated and with their ratings losses are also determined.

There are 3 components which require detailed consideration in filter design:

(i) Current Source

(ii) Filter Admittance (Y_{fn})

(iii) System Admittance (Y_{sn})

Change in system parameters with respect to temperature

$$\delta = \frac{\Delta f}{f_n} + \frac{1}{2}\left[\frac{\Delta L}{L} + \frac{\Delta C}{C}\right]$$

Quality factor of the system

$$Q = \frac{1 + cos\emptyset_{sn}}{2\delta sin\emptyset_{sn}}$$

Total capacitance of the filter

$$Total\ C = \frac{Total\ MVAr}{jwV^2}$$

Inducance and resistance of the passive filter branch

$$L_n = \frac{1}{w_n^2 C}$$

$$R = \frac{wL_n}{Q}$$

$$f_0 = n * f$$

$$R = \frac{1}{2\pi f_0 C}$$

$$L_n = mR^2C$$

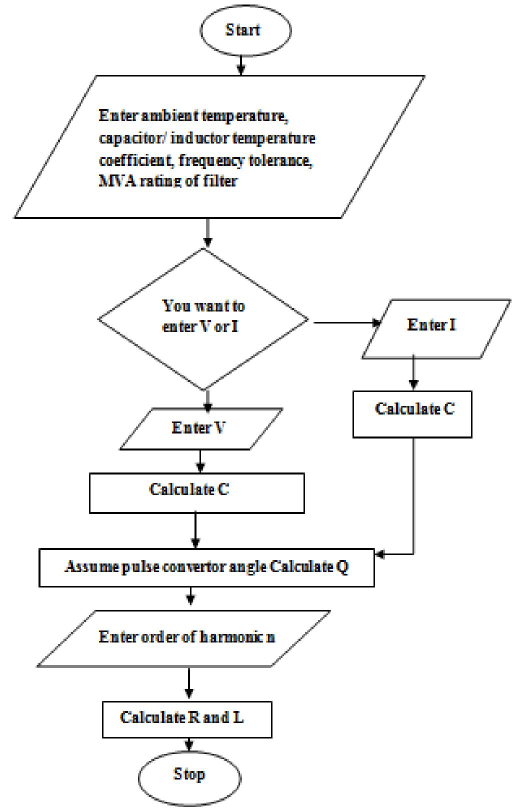

Figure 5: Step to develop passive filter

V. RESULT

The harmonic filter is designed according to the system requirement with five first order branches and one second order branch. The designed filter can able to remove harmonic of 3rd, 5th, 7th and 9th order harmonic as well as higher order harmonic.

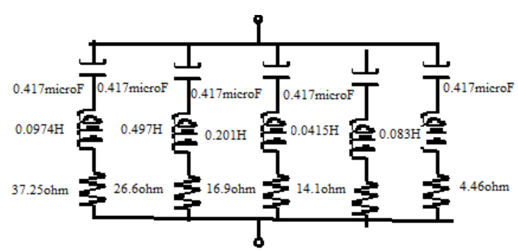

Figure 6: Designed passive harmonic filter

VI. CONCLUSION

We can design the passive harmonic filter for any system according to the user or system requirement. It is simplest way to design the passive filter on MATLAB to remove the harmonic content from the power system. It is necessary to use harmonic filter in system.

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