Journal Of Harmonized Research (JOHR)

Journal Of Harmonized Research in Engineering
5(2), 2017, 108-112

ISSN 2347 – 7393

Review Article

A REVIEW OF POWER QUALITY IN AC SYSTEM USING ACTIVE AND PASSIVE FILTER

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Abstract: In this paper review of the various configurations and control strategies available for active passive filters. To compensate aforementioned power quality problems to resolve the poor power quality problems power electronic based equipment has produced a great impact on the quality of electrical power supply. Modern day equipments are highly sensitive to variation from ideal sinusoidal voltages. Conventional power quality improvement equipments are providing solution a very promising solution for supply voltage

Index Terms: - Active Passive Power Filter Harmonics, Power Quality.

Introduction*:* The AC/DC power converters are broadly used in various applications like power supplies, dc motor drives, and frontend converters in adjustable-speed ac drives, HVDC transmission, SMPS, in process technology like welding, power supplies for telecommunications systems, and aerospace, military environment and so on. Power system harmonics are a menace to electric power systems with disastrous consequences. The line current harmonics cause increase in losses, instability, and also voltage distortion. With the proliferation of the power electronics converters and increased use of magnetic, power lines have become highly polluted. Both passive and active filters have been used near harmonic producing loads or at the point of common coupling to block current harmonics. Shunt filters still dominate the harmonic compensation at medium/high voltage level, whereas active filters have been proclaimed for low/medium voltage ratings. With diverse applications involving reactive power together with harmonic compensation, passive filters are found suitable Passive filtering has been preferred for harmonic compensation in distribution systems due to low cost, simplicity, reliability, and control less operation The design, advance development and fruitful application of single-phase, improved quality converters in domestic, commercial and industrial environment has made possible the

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Received on: May 2017
Accepted after revision: June 2017

design and development of three-phase, improved quality converters and their extensive use in different applications. Harmonic pollution and low power factor in power system caused by power converters have been a great concern. To overcome these problems several converters widespread use of non-linear loads in industries and extensive proliferation of energy-efficient power electronic based equipment's have led to many power quality problems in electrical power system and becoming a great concern for utilities and customers. These Non-linear loads draw harmonics and reactive power components of current from the utility. In three-phase systems, they could also induce imbalance and draw excessive neutral current. All these issues create serious problems for power quality. The effective compensation of harmonics, reactive power, neutral current and supply current balancing with other power quality improvement are essential for the utilities [1] as well as the end users. This attracted power electronics and power system engineers to develop dynamic and adjustable solutions to the power quality problems by various custom power devices like active power filter hybrid filter, unified power quality compensator etc. Many control algorithms with new / improved by various researchers in context to this. In this paper a review on the active passive filter harmonics power quality filters is presented. Perfect sinusoidal voltage at every point of the power network. In reality, it is almost impossible to accomplish such desirable conditions. Voltage and current waveforms deviate massively from a sinusoidal. These waveform deviations are described by the use of waveform distortion and usually called harmonic distortion. Even if harmonic distortion is a quite old phenomenon it today presents one of the main concerns for public utilities, distribution system operators as well as their end customers. Already in the first years of operation of power distribution networks, there were first disturbances.[4]The major concern at this time was the effect that harmonic distortion had for the electric machines itself. Another well-known issue was interference in the telephone lines. But in general it can be said that harmonic distortion in former times did not have the same dangerous potential like it has today. This paper presents the design and formulation of shunt passive filter to lower the harmonics and improve the power quality.

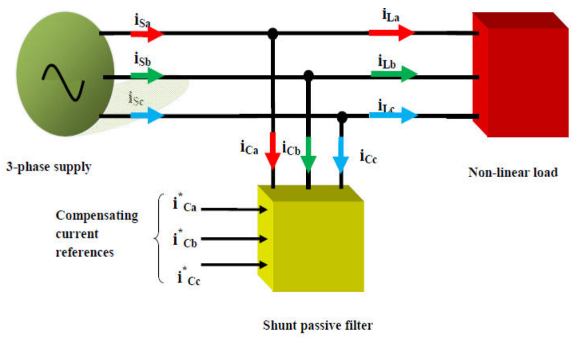

Fig1. Passive Filter

Passive Filter: The passive filters are used to mitigate power quality problems in six-pulse ac-dc converter with R-L load. Moreover, apart from mitigating the current harmonics, the passive filters also provide reactive power compensation, thereby, further improving the system performance. For current source type of harmonic producing loads, generally, passive shunt filters are recommended these filter apart from mitigating the current harmonics, also provide limited reactive power compensation and dc bus voltage regulation. However, the performance of these filters depends heavily on the source impedance present in the system, as these filter act as sinks for the harmonic currents. On the other hand, for voltage source type harmonic producing loads, the use of the series passive filters is recommended these filters block the flow of harmonic current into ac mains, by providing high impedance path at certain harmonic frequencies for which the filter is tuned. [7] Moreover, the harmonic compensation is practically independent of the source impedance. But, passive filter suffer due to the reduction in dc link voltage due to the voltage drop across the filter components at both fundamental as well as harmonic frequencies. A detailed investigation into the use of different configurations of passive

Filter such as passive shunt filter and passive series filters. The advantages and disadvantages of both configurations are discussed. It is observed that both these configuration fail to meet the IEEE standard 519 guidelines under varying load conditions. A novel configuration of passive hybrid filter (a combination of passive shunt and passive series filter) is designed and developed for power quality improvement. The main attraction of this configuration is that it can achieve the improved power quality even under varying load conditions, its rating is less and it can maintain that dc link voltage regulation within certain limits. The prototypes of these passive filters are developed and that test results are presented to verify the simulated results. Finally, a comparison of different power quality aspects in different configurations of passive filters is also presented for ac-dc converter with R-L load.

Classification of Passive Filters

Passive Shunt Filter: A passive shunt filter connected at input ac mains of six pulse Ac-dc converter with R-L load. This is the most commonly used configuration of passive filters. In this configuration different branches of passive tuned filters (low pass and high pass) tuned for the more dominant harmonics are connected in parallel with the diode rectifier with RL load. It consists of a set of low pass tuned shunt filters tuned at 5th and 7th harmonic frequencies and high pass tuned for 11th harmonic frequency. This passive filter scheme helps in sinking the more dominant 5th and 7th and other higher order harmonics and thus prevents them from flowing into ac mains. The diversion [9] of harmonic current in the passive filter is primarily governed by the source impedance available in the system. The higher value of source impedance offers better performance of the passive filter.

Passive Series Filter: For voltage source type of harmonic loads (such as diode rectifier with R-L load filter), passive series filter is considered as a potential remedy for harmonic mitigation. Here, the different tuned branches of passive filters are connected in series with the supply and the diode rectifier. Fig.2. shows the schematic diagram of a passive series filter connected at input ac mains. It consists of a set of low block tuned shunt filter tuned at 5th and 7th harmonic frequencies and high block tuned filter for 11th harmonic frequency. [6] These passive filters blocks most dominant 5th, 7th and other higher order harmonics and thus prevents them from flowing into ac mains. Here, the performance of the series filter is not much dependent on the source impedance. S in reduction in dc bus voltage due to voltage drop across filter components.

Passive Hybrid Filter: The use of passive shunt filter creates the problem of voltage regulation at light loads. It also increases the dc voltage ripple and ac peak current of the rectifier. On the other hand, passive series filter suffers from lagging power factor operation as well as the voltage drop across the filter components both at fundamental frequency as well as harmonic frequencies. To overcome these drawbacks, a combination of both these configurations is presented as passive hybrid filter. This configuration is able to supplement the shortfalls of both these passive filters and simultaneously it results in improvement in harmonic compensation characteristics for varying load condition even under stiff and distorted ac mains voltage.

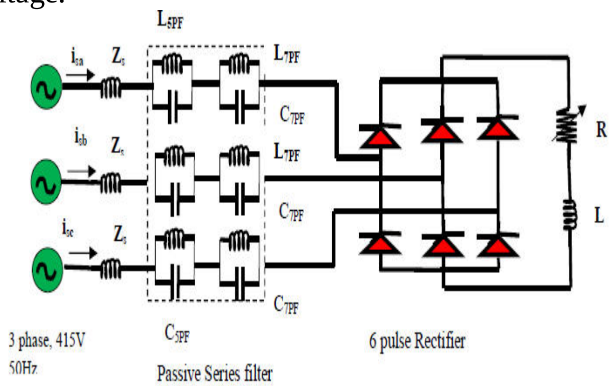

Fig.2. Schematic diagram of a ac-dc converter with R-L load and passive series filter at input

The basic compensation principle and design procedure of different passive filter in this work, mainly first order low pass filters and damped high pass filters are used for shunt configurations. For series configurations, single tuned first order filters and high block damped filters are used to form a composite filter.

Active Power Filters: Many passive and active harmonic filters have been investigated to satisfy the power quality problems. Passive filtering has been preferred for harmonic compensation in the electrical system

Due to low cost, simplicity, Reliability, [8] and control less operation. Active power filters

(APF) have many advantages over the passive filters. They can suppress not only the supply current harmonics, but also the reactive currents and without causing harmful resonances with the power distribution systems like passive filters. In the beginning, the APFs were used for suppression of harmonics generated by thyristor based converters and inverters used in HVDC transmission system. However, the design could not become technologically and economically practicable until the last two decades when fast and cost effective semiconductor devices such as Insulated Gate Bipolar Transistors

Classification of Active Power Filters: Active Filters can be classified based on converter type, topologies and number of phases. On converter based CSI or VSI bridge structure. On topology based shunt, series, hybrid and UPQC. On the bases of no. of phases two-wire (single phase) and three- or four-wire three-phase systems.

Convertor Based Classification: In general, there are two types of converters used in active filters - CSI or VSI bridge structure. A current source PWM converter (CSI) is equipped with a dc inductor and a voltage source PWM converter (VSI) is equipped with a dc capacitor. Fig.3. shows CSI bridge structure.

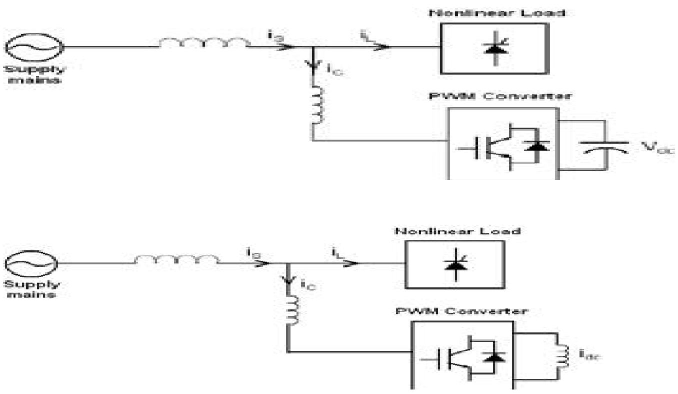

Fig. 3 Voltage Source PWM Converter Based and Current Source PWM Converter Based Shunt Active Power Filter Shunt Active Power Filter

VSI based filter that has a self-supporting dc voltage bus with a DC capacitor. It becomes dominant over CSI because of its high efficiency, lightweight, low cost and expandability to multilevel and multi-step versions.

Topologies Based Classification: Based on the topology, AF can be classified as series, shunt, hybrid active filters and UPQC. The appropriate topology is used as per the compensation required by the active filter. Parallel or shunt APF is the fundamental system configurations and it has been used in of three-phase three- or four- wire. Fig. 3 shows shunt APF, which consists of a [14] controllable voltage and current source respectively. It is mainly used to eliminate current harmonics, reactive power compensation and balancing unbalanced input currents. Shunt active filters carries only the compensation current plus a small amount of active fundamental current which is supplied to compensate for system losses. This cancels harmonics and/or reactive components of the nonlinear load current at the point of common coupling (PCC). When it is employed to three-phase four-wire systems, it also compensates the neutral current (zero sequence current) component

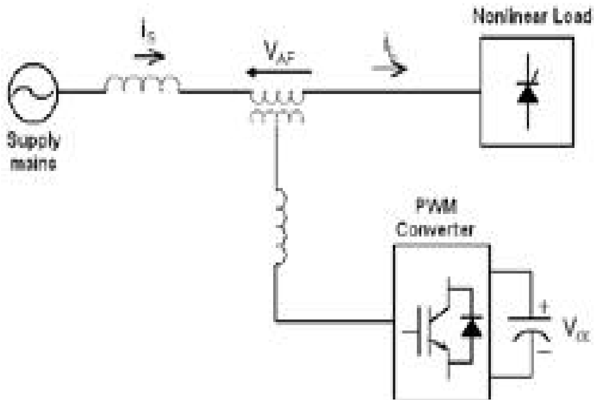

Fig. 4 Principle configuration of a VSI based series active power filter

Series active filter produces a PWM voltage waveform which is subtracted / added, on an instantaneous basis, from / to the supply mains voltage to maintain a pure sinusoidal voltage waveform across the load as shown in Fig. 4. It is similar to shunt APF, except that the interfacing inductor of shunt APF is replaced with the interfacing transformer. Its advantage over shunt active filters is that they are superlative for eliminating voltage-waveform harmonics, and for balancing three-phase voltages

Conclusion: Improve the performance of the APFs, improved control methodologies of APFs have been proposed to compensate aforementioned power quality problems.

Complexity of the control can also be greatly reduced with the conventional the main objective of this investigation has been to evolve different power quality improvement techniques for improving various power quality indices at ac mains as well as on dc bus in ac-dc converter with R-L load. It has also intended to determine the extent of improvement in different power quality indices in various techniques for application. In this paper has been on developing applications, where presently a six pulse diode bridge rectifier is being used. Ac-dc converters

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