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Single Phase Shunt Active Power Filter with Fuzzy Controller: A Review

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Abstract: *The presented single-phase Shunt Active Power Filter with fuzzy controller has demonstrated to be able to compensate the harmonic currents and the power factor produced by loads, making the current at the source side to become almost sinusoidal and in phase with the system voltage. This current compensation can also prevent voltage harmonics. APF simulation using MATLAB Simulink is proven to be very useful for studying the detailed behavior of the system for harmonic and unbalance compensation, under steady state and transients. Conventional passive filters, namely LC passive filters, possess the merits such as the simple structure, low cost and can compensate reactive power along with harmonics elimination. But PF based on resonant principle have many disadvantages, such as large size, fixed compensation, tuning problems etc. To overcome aforesaid problems, active filters came into picture to provide appropriate solution best suited to the compensation necessities under dynamic load conditions. This paper presents the study and simulation of Shunt Active Power Filter using hysteresis current controller for different non-linear loads.*

Key Words*: Fuzzy, Shunt filter, APF*

I. Introduction

In modern power distribution system to improve the quality of power is the most important topic of research now days. As before 20 years almost all the load which are used for the industrial and consumption purpose are passive loads and linear in nature and thus they have very less number of non-linear loads, thus they have very less affect over the power system. As by the introduction of several modern electronic devices and their easier availability and more user friendly so they their use on large scale cause the use non-linear devices. the power which is control by the modern power electronic devices like SCR, IGBT, power diodes, MOSFET become increased rapidly, thus due to this their use in industrial and commercial appliances considerably increased. Along with this there are several electronic devices has been used to increase the efficiency and power factor of wind solar and other renewable power generation methods. As the above stated devices has several benefits but on the other hand there are some drawback of using such devices are also present like increase in use of power electronic devices.

Thus the raid use of this semiconductor device will cause the harmonics and the reactive power disturbances. Such harmonics and the reactive power will from several problems like overheating of transformer, large amount of neutral current, lower power factor, damage to the power electronic device and the error in functioning of sensitive devices. [1]. Thus for the elimination of harmonics formed by these power system we use the active power filters which are install along with the PCC.

The active power filter will inject the compensating current to the PCC and by this it will eliminate the harmonics and this make the source current sinusoidal. Thus by using the active power filter we can improve the harmonic pollution as well as lower power factor. As the active power filter are widely adopted in three phase systems, and by making some modifications in the control schemes this can be used in the single phase system and thus the harmonic will be minimized at the low voltage system.

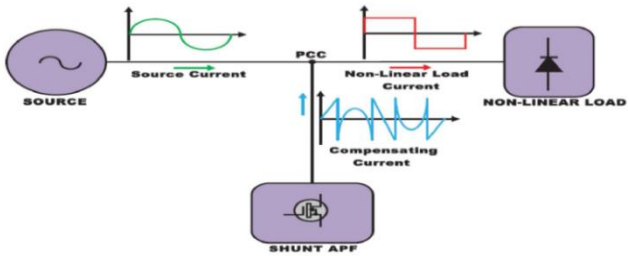

Figure 1: Error! No text of specified style in document.
Block diagram for active power filter connected system [1]

The rest of research paper is design as follows. The overall previous work is described in Section II. Section III describes problem formulation. performance parameter describe in section IV. Finally, Section V describes the conclusion of paper.

II. Literature Review

Literature review has been carried out for defining the research problems. A review of literature is presented in the following section.

Bhonsle et.al, in this paper the author discussed about the realization of standards and the guidelines like IEEE-519-1992/ IEC 61000 that will discuss about the involvement of both the utility and consumer responsibilities, to take the harmonic content with in a specific level to provide the higher quality power to the system. Generally to eliminate the harmonic we use the conventional active power filters. As the conventional passive power filter like the LC passive filters, has the various advantages over the active power due to their simple structure and the lower cost and they will compensate the reactive power by eliminating the reactive power component. But in this power factor which is based on the resonant is have several disadvantages like it will increase the system size, having fix compensation value and having various tuning issues etc. thus to solve all these problems associate with them we use the active power filters which will

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best suite the compensation requirements in dynamic load conditions. Thu in this paper the author presents the study about the SAPF simulation results by using the current controller [1].

Sultan et.al, in this the author describe that he high power industrial appliances, which are electronic based, will cause the high level of disturbances in the supplied electricity. Thus in this system we discussed about the power quality problems in terms of related standards and in the every possible way to increase this. When we are going from single to three phase network system and discuss about the active and passive filtering system the paper will present the simulation results which we get from the three phase active filter prototype [2].

Rahmani et.al, told that power Quality is a major consideration in all office equipments, industries and residential home appliances. Harmonics play a vital role in power quality issues. Harmonic is generated and deteriorating the quality of power due to non-linear load, which is connected to the electrical system. Based upon the load, there will be increase in harmonic voltage and currents in the system, which will affect the whole system. The limitations for harmonic voltages and harmonic currents have defined in IEEE 519 and IEC standards. That limitation can be achieved by using SAPF. This paper deals on shunt active power filter with PI controller. SAPF is designed by employing voltage source inverter with PWM. For R-L non linear load this harmonic mitigation is done. MATLAB/ SIMULINK model of this system is simulated and results are obtained through THD analysis [3].

Jain, S. Ket.al Generally in power electronics we have two faces of power distribution: (a) the first phase will consist of industrial and the daily use component which can be easily control to be identical with the power supply appliances and (b)and the second phase will help to solve the power quality problem which are generated by the controllers. Thus here we use the modern semiconductor switching devices widely in the large range of application in the distribution network, generally in local and industrial loads. The main example of such devices which are commonly used are, rectifier, TV or home appliances, UPSs, among others. Thus by using these power electronic devices we can get the more economical and reliable answer to effectively manage and control the electrical energy usage. As on the most of most of the power electronic devices, these semiconductor devices will show the nonlinear operational characteristics. As such kind of devices are used in large number and thus they pollute the modern power system. [4]

Kaur et. al in this paper the author present the study about the active pass filter for the single phase non-linear loads.Thus the use of active power filters the preparation for the future uses to improve the harmonics in PS due to their excellent dynamic characteristics. Thus by using active power filters we can get the more reliable and the handy solution for the harmonic problem.. as the current active filters are based on the PWM converters and thus they are connect with the lower and medium voltage distribution system may be in shunt or series [5].

Ramya et. al, shows that in a transmission system security, the calculation of ATC is quite important. ATC is equally important for market for casting in a deregulated power system. For formulation of AC power distribution factor, inputs like generator status, line status, and load status are important for neutral network the output is ATC. The method described, gives an accurate estimate of ATC among the system region and the load variation system. This method shows the importance in various application of power system, thus this method commands the system operator for the updation of ATC and also status of the generation units [6].

Fernández-Ramoset.al here a new control method for single-phase shunt active power filter (APF) is proposed. It integrates theDC bus voltage control and active power filter command current generation, according to the periodicity of source current and energy balance concept. The instantaneous harmonic compensation and linear DC bus voltage control are achieved, without complicated and involved control logic, by using cycle discrete control technique to DC bus voltage. Thus for the validation of this proposed model we generate the lab model of this system. Thus from the results of experiments and the simulation this has been found that the proposed method will give the much better and effective results. [7].

Henzler-Wildman et.al**,** in this paper the author discuss about the major issue of todays power generation which is to supply the higher power quality, which is called harmonic distortion. As now days in industrial applications the use of non linear load is continuously increased so this will cause the problem of harmonic distortion in system. In this paper the author present the active power filter which will deal with the simple control structure. Thus in the proposed method the voltage source inverter is used along with the PWN in APF. Thus here we create the MATLAB model of this proposed method and study the several anaylsis [8].

III. Problem Formulation & Challenges

The harmonics is the major factor in the fading of power quality which is called harmonic distortion. As due to the use of nonlinear load devices on larger range the harmonic distortion in the power electronic system is continuously increased. Thus the main issue of concern here is the reduction in the harmonic content of current. As the main cause of harmonic is nonlinear load and thus they will increase the fading of PS voltage and current waveforms. Thus the harmonic will cause the sine wave of voltage to deform in the irregular structure. Thus we can measure the harmonic present in the system by the measurement of THD. Thus due to this the active power filters are used to implement the power system for the harmonic compensation. As the harmonic pollution is the more prominent over the side of high voltage this is because they content the more single nonlinear loads, which cannot be accepted. Thus this is the major challenge to eliminate the current harmonics in power system. As there is some method to eliminate the harmonics are present from long time but they can not fulfill the harmonic elimination demand of today scenario. The shunt active power filter will provide the much better results as compare to the conventional method

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used for the harmonic elimination. As to get the better dynamic performance for the active power filter we need the better control schemes. As in most of the scheme where we use the active pass filter are uses the three phase quantity. [12-22].

IV. THD Calculation

THD is defined as the ratio of equivalent root mean square voltages of all harmonic frequencies over RMS voltage of fundamental frequency. Mathematically THD Define as THD $= \frac{\sqrt{\sum_{n=2}^{\infty} V_{n\_rms}^2}}{V_{fun\_rms}}$

V_{n_rms} is the RMS voltage of nth frequency

V_{fun_rms} is the RMS voltage of fundamental frequency.

V. Conclusion

Here we simulate the three phase three wire shunt active filter along with the controller which is based on the instantaneous active and reactive power which is simulate by the MATLAB/SIMULINK for the compensation of problems of harmonics and the reactive power which effect in the power electronic non-linear loads.

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