A Review on Power Quality improvement in Three Phase Four Wire System using Fuzzy Logic Controller with PLL based Shunt Active Power Filter

[1]Aviral kumar, [2]Dr. A K Kori

[1]Research Scholar, [2]Professor
Department of Electrical Engineering,
Jabalpur Engineering College, Jabalpur, India

***Abstract*— After having abundance of power in current power sector now we move to the quality of power, so the power quality is main concern to our research scenario. For the effective use of equipment which is connected to the power system we make sure that it must be secure of damage due to quality issues. So it is necessary to improve our power quality for distribution system. Current harmonic distortion is one of the drawbacks for power quality. In this paper the author proposed the effective reduction technique of current harmonics by the use of shunt active filter which is based on the automated controlling techniques. The author proposed power quality improvement technique for three phase four wire system by the help of three phase four leg voltage source inverter. For controlling purpose we use fuzzy logic with PLL based controller, Hysteresis current controller which provides gate signal to voltage source inverter. By the gate signal of voltage source inverter shunt active filter injects current to the distribution system to mitigate current harmonics. And the whole process is examined by Simulink model as the author proposed in MATLAB.**

***Keywords*—Fuzzy logic controller, PLL, Hysteresis current controller, shunt active filter**

I. INTRODUCTION

Many researchers work on the power quality improvement on behalf of different systems, aspects, controlling systems. In this paper author proposed an aspect for controlling shunt active filter for nonlinear load, which is varying in nature. In this paper the author proposed the controlling process which is more accurate than earlier one. Fuzzy logic with PLL based shunt active filter is used in the proposed model. For the three phase four wire proposed system three phase four leg voltage source inverter used, where the gate signal, which controls the injected current to mitigate harmonic current by shunt active filter, is fed by the various controlling action like fuzzy logic with PLL based controller, hysteresis current controller and reference current generator. First the dc ink voltage which is compared with reference voltage gives error signal which is the input for fuzzy logic controller than the output of fuzzy logic controller is given to the reference current generator where in presence of source voltage and load current, reference current is generated which is input to the hysteresis current controller where it is compared with actual current and gives the gate signal to voltage source inverter and according to this signal current is injected to the system which is same in magnitude with harmonic current but opposite in phase .In this way the harmonic current is mitigate and our power quality is improved on the harmonic current reduction side.

The basic schematic model of proposed paper is shown in fig.(1) where the source is connected to nonlinear load in between a shunt active filter is attached which injects current which is equal in magnitude of harmonic current but opposite in phase.

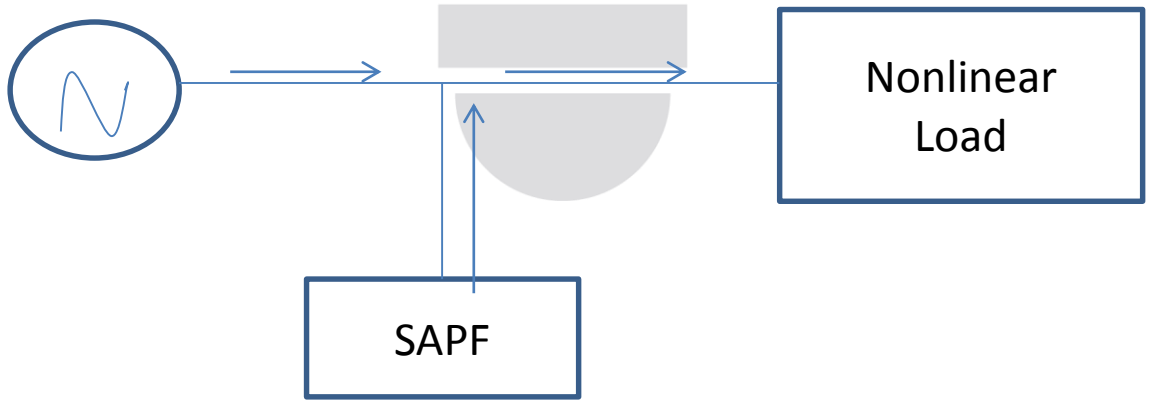

Fig1.Schematic model of proposed system

II. SHUNT ACTIVE FILTER

The popular approach for cancelling the harmonics in power system is deals with shunt active filter and it also compensate reactive power from the line. As our system considered three phase four wire system and according to objective shunt active power filter

better suited. The shunt active power filter is controlling with different techniques is injecting compensating current for harmonics current, which is in equal in magnitude but opposite in phase with harmonics current.

III. EXISTING RESEARCH WORK

To improve the power quality many researchers have worked for harmonic reduction techniques and controlling shunt active filter. Some of the research work related to the power quality improvement is mention in the given below.

1. Patil et.al (2017) In this paper the generalized instantaneous power theory is explained for the production of reference current. As the reference current is main concern for the controlling action of shunt active filter. According to this theory we can convert three phase quantity into two phase quantity for system of active and reactive component. A fundamental result of generalized instantaneous reactive power theory is applied for correction of power factor in three phase circuit.

2. Gotherwal et.al (2016) This paper mainly focused on to differentiate the direct current control and indirect current control techniques. In direct current control technique the phase components of voltage and current are converted into the alpha beta components by Clarke's transformation. This two axis frame based coordinate system infers the instantaneous active reactive power components. This power is comprised of two components namely the oscillating component and the direct component. These components are separated in order to differentiate the harmonics from the fundamentals of the load currents with the help of a low pass filter (LPF) with feed forward effect. The reference current then calculated with the basic power formula. The indirect current control technique is simpler, provides better performance and requires less hardware comparative to direct current control technique. In this method the source currents are taken as reference currents for comparison, only average component of active power flows through control scheme and reactive component is zero and after that switching signal are obtained.

3. Kumar et.al (2016) In this paper A PLL based unit vector template is used for obtaining reference values. Unit vector templates are different phase input voltage is unitized by multiplying with gain factor equal to its peak amplitude and then passed through phased through phased locked loop to obtain proper phase delay. From the unit factor thus obtained, reference load voltages can be obtained by multiplying with unit magnitude equal to peak of load voltage.

4. Udayasri et.al (2016) In this paper working of dc link capacitor explained. The capacitance of the DC-capacitor controlled in order to reduce the harmonics completely. This is done by matching the capacitance of the capacitor to the value equal to the value which reduces the harmonics completely, so that it is necessary to compensate for active load power and reactive load power. But by eliminating the active load power, will results in the voltage distortion of the dc-capacitor. Thus active load power is absorbed into the dc-capacitor and dc-capacitor suppresses the voltage fluctuation.

5. P. K. et.al (2016) This paper mainly concern about the drainage power utilization for charging of battery and this battery is connected across the dc capacitor. The functions of dc capacitor then defined on behalf of battery. The dc capacitor has two functions. It maintains a dc voltage with a small ripple in steady state and serves as an energy storage element to supply the real power difference between load and source during the transient period. At the time of transient load, an active power mismatch occurs and the dc link voltage fluctuates. Conventionally this fluctuation is regulated using the grid power. In this paper, the drainage power stored in the battery is used to provide the voltage regulation, thereby reducing active filters dependency on grid power. When the battery has enough power to maintain the voltage across capacitor, it provides the voltage regulation.

6. Gupta et.al (2015) In this paper reference current generator and hysteresis current controller techniques explained. The performance of an active filter depends on many factors, but mainly the selected reference generation scheme. The reference current for each phase are such that if the filter current is same as the reference current then the objective of the filter is fulfilled. From many techniques, the instantaneous active and reactive power theory (p-q theory) is used in this paper. Hysteresis current controller is worked to track the reference current, voltage source inverter needs proper gate pulse which is given by the current controller. The actual source currents are mentioned instantaneously, and then compared to the reference currents generated by the proposed algorithm. In the order to get accurate control, switching of IGBT device should be such that the error signal should approaches to zero, thus provides quick response.

7. Prasad et.al (2015) In this paper the basic idea about the shunt active filter is compared with STATCOM. The shunt active filter, with a dc capacitor or dc voltage source has a topology similar to that of static compensator (STATCOM) used for reactive compensation in power transmission systems. Through power electronic switching, the active filter introduces current or voltage components of the nonlinear loads. Shunt active power filters compensate load current harmonics by injecting the equal but phase opposite compensating current

8. Pedapenki et.al (2015) In this paper fuzzy membership functions are explained on control basis. Fuzzy based controller is used in controlling for generating signal for shunt active filter to operate with proper compensating current to mitigate harmonic current. The fuzzy control system consists of fuzzification, defuzzification, knowledge base and decision making units. The inputs are error e and change in error and the output is the amplitude of reference current. The inputs are fuzzified

in fuzzification block by using data base of the knowledge base and sent to decision making block to get the output exploring the rule set by using the rule base of the knowledge base. The output obtained from difuzzification block.

9. P et.al (2011) In this paper PLL with fuzzy logic controller based fuzzy logic controller is explained. The phase locked loop circuit is meant for operation under distorted and unbalanced voltages. It automatically determines the frequency and the fundamental positive sequence components of three phase line voltages. The algorithm of PLL is based on three phase instantaneous active power expression. The PLL output multiplied with fuzzy logic controller output determines the required reference current.

IV. CONCLUSION

In this review paper, we conclude that the shunt active power filter is basically developed with its controlling schemes. The development of controlling scheme for injection of proper compensating current is equal in magnitude but opposite in phase of harmonics current. The techniques of controlling is estimated with previous research papers and analyze further for better accuracy and fast controlling scheme for shunt active power filter for three phase four wire system.

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