Shunt Active Power Filter with Fuzzy Controller

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Abstract:- The 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. 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. Controlled algorithm is Hysteresis current control based power filter Voltage source inverter is controlled by Hysteresis current control 2 KHz switching frequency of hysteresis current control in Voltage source inverter power device loss.

Keywords: PWM, ANFIS, PCC, Fuzzy Logic

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. 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].

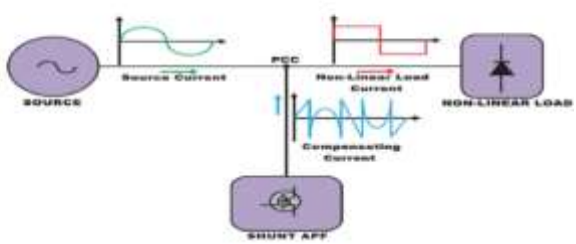

Figure 1 Block diagram for active power filter connected system [1]

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.

The rest of paper is design as follows. The problem statement of research work is described in section II. Modeling of Controller is described in section III. The complete description of Fuzzy controller described in section IV. Simulation results & analysis is described section V. The overall conclusion of research work describe in section VI.

II. Problem Statement

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 are 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 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.

III. Modeling of Controller

As we know that he primary component of current and voltage will play the most important role in delivering the active power at the load end. So we use this method in the generation case of reference current. We can calculate the active power consume by the load as P_{VLoad} and P_{iload} P which show the DC active power is contribute by the fundamental component of the voltage and the current and the harmonic component are the major factor alter the active power.

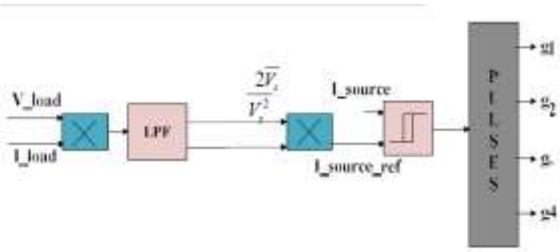

Fig. 2 Control algorithm for generation of reference current and gate pulse

As by the filtration the active part will be removing and the reference point will be produced. Then here we make the comparison among the actual source current and the reference current and after this the error signal will passed from the controller to generate the gating pulse for driving the voltage source inverter as it shown fig 2

IV. Fuzzy Logic Controller Structure

Generally in a FIS we have four functional blocks which are shown in figure 3 below:

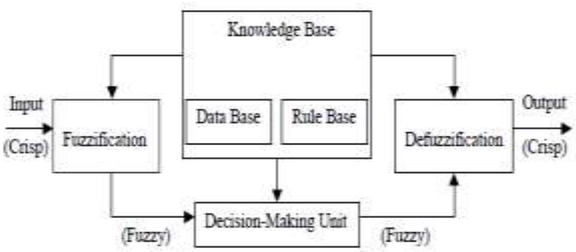

Figure 3 Basic fuzzy inference system

The first block is a fuzzification interface that will perform the transformation for the crisp input to the degree of match with the linguistic values. the second block shows the knowledge base that have the numbers of fuzzy if then rules and shows the membership functions. The next is decision making unit which is also said to be inference engine, the function of this to perform the interface operation on rules. Then next is defuzzification which will perform the function of transforming the results into the crisp outputs. Thus on the basis of fuzzy reasoning types we can classify the FIS system into different types:

• Takagi-Sugeno fuzzy inference system:

This proposed system is only used for the Takagi-Sugeno type rules. The results thus obtained from this are the weighted average for every rule. When the rule is having the crisp value then the entire output become the weighted average of the every crisp output value. There are some feature which effect the fuzzy controller performance these are as follows:

1. Setting fuzzy rules
2. Scaling factors.
3. Membership functions

V. Simulation & Result Analysis

This chapter deals with the various control mechanisms for controlling room temperature and humidity. We implement three different control mechanism for controlling room temperature and humidity that is conventional PID controller, Fuzzy logic controller and ANFIS controller and finally make comparison to see the controller that gives the better results.

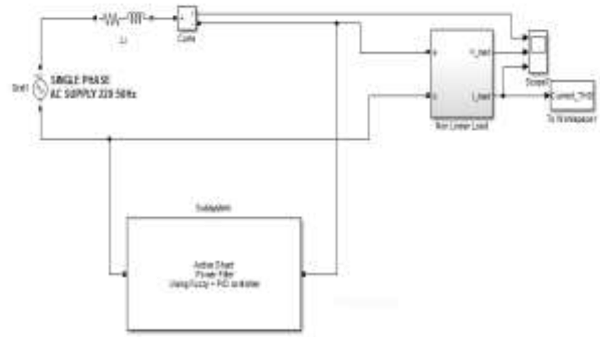

Fig 4 Simulink Diagram of Single Phase loaded Filter

Fig 4 gives the Simulink model of single phase loaded filter. The model contain active shunt filter with PI & Fuzzy Controller.

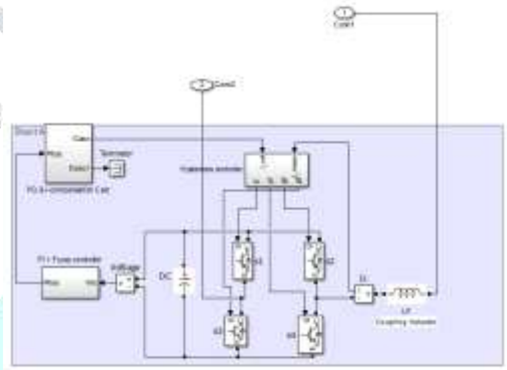

Fig 5 Active Shunt Filter used in Simulink Model

Active shunt filter is used in proposed Simulink model. It includes PQ & I Compensation. The hysteresis controllers are also including here. PI & Fuzzy controller are used to control the current & voltage.

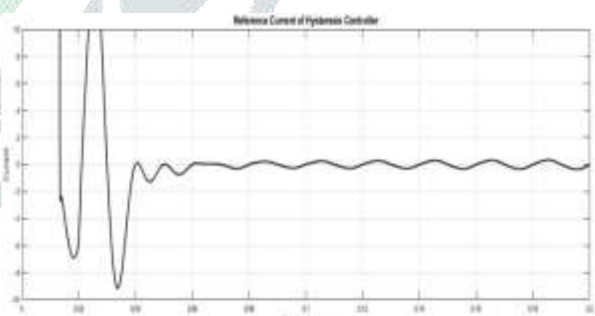

Fig 6 Reference Current of Hysteresis Controller

Fig 6 Shows Reference Current of Hysteresis Controller Vertical axis represents Current in Ampere and horizontal axis shows time in seconds. The maximum current is 10 ampere.

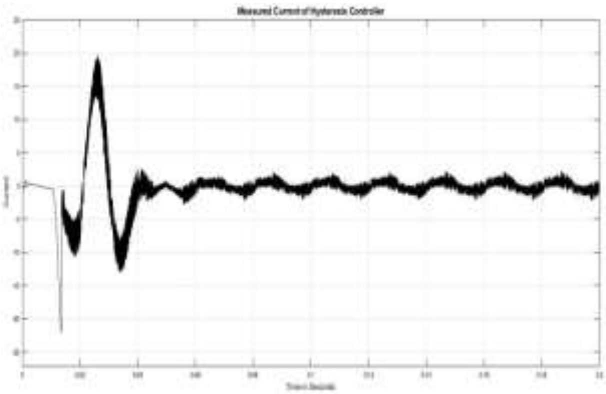

Fig 7 Measured Current of Hysteresis Controller

Fig 7 Shows Measured Current of Hysteresis Controller Vertical axis represents Current in Ampere and horizontal axis shows time in seconds. The maximum current is 19 ampere.

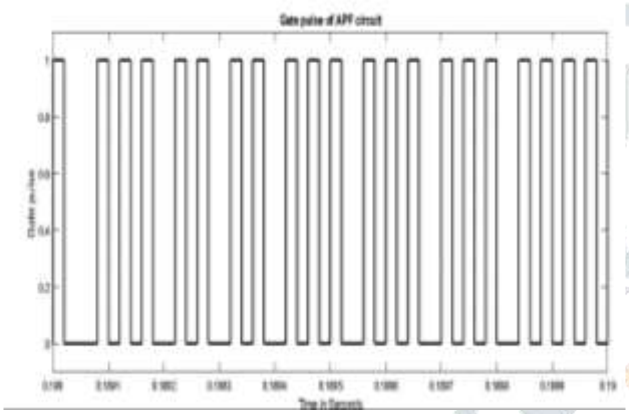

Fig 8 PWM signal Generated by Hysteresis Current Controller

Fig 8 shows the Pulse Width Modulation signal Generated by Hysteresis Current Controller which is having 3 KHz Switching Signal Gate Pulse. This signal help to reduce total harmonics of single phase nonlinear based electrical circuit with having Active Shunt filter control algorithm.

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

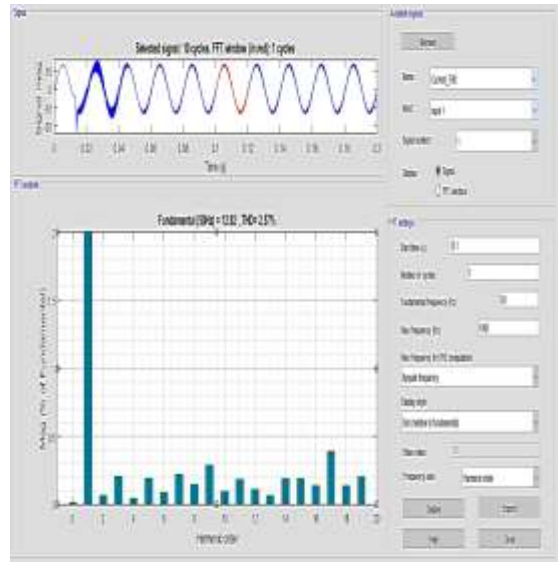

Fig 9 THD Calculation using FFT

THD Calculation using FFT is shown in fig 9. THD achieved from the fuzzy logic technique is 2.57 %. The fundamental frequency 50Hz gives total harmonic distortion are 12.32. THD is calculated from FFT tool box in MATLAB .

VI. 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. The following conclusion are observed from the Simulink design This control technique is efficient because it is reducing much THD. The Total harmonic distortion is 2 % by Hysteresis current control technique Controlled algorithm is Hysteresis current control based power filterVoltage source inverter is controlled by Hysteresis current control 2 KHz switching frequency of hysteresis current control in Voltage source inverter power device loss

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