A Review on Hybrid series Active Filter Harmonics Reduction using Fuzzy Logic Controller

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***Abstract*— Power quality (PQ) issues in the distribution network and their solutions have accept more attention in the today's life. This paper describe the effects of Harmonics by nonlinear load (power electronics devices) of the Power System network and also explain the reduction in Harmonic distortion. It generate various disturbances to the Power System. It incorporate the Harmonic reduction using Hybrid series active power filter (HSeAF) by using fuzzy logic controller to upgrade the power quality and the simulation for the same. The study of simulation of a fuzzy Logic controller of a single phase hybrid series Active Power Filter to better power quality by remunerate harmonics and reactive power need by a nonlinear load is introduce. The superiority of fuzzy logic control is that, it can't necessitate to correct mathematical model. This is more powerful than conventional nonlinear controllers. The remuneration process is based on current only, it near to different from traditional methods, which incorporate knowledge of harmonics or reactive power essential of nonlinear load.**

***Index Terms*— Hybrid series Active Power Filters, Harmonics, fuzzy logic controller, Nonlinear load etc.**

I. INTRODUCTION

In today's world, with the increase of nonlinear loads in industrial manufacturers, have quality of power taken as serious issue and various custom power devices are use to resolve these power quality problem. Previously the passive filters were used to solve serious harmonic issues of the grid side. For gainful and simple assembly of passive filters were use but new technique is essential due to the some drawback of passive filter like necessity of a isolate filter for each harmonic current, and having characteristics of limited filtering, the negative effects caused parallel and series resonance between the grid and the filter impedance. The hybrid series active power filter which is implemented to control the shortcomings of the passive filter. It involves voltage or current source inverter, a DC link storage and an output filter. The APF is use to utilise power electronics machineries to generate current components and also neglect the harmonic currents from the nonlinear loads. When an Hybrid series active filter is compared to a passive filter, result gives active filter has a complex structure and costly. The power quality drawbacks such as harmonic compensation, reactive power compensation, voltage imbalance and flicker. Even the active power filter is an powerful compensation technique will use to solving problem of this condition, the hybrid active power filters developed by using composition of active and passive filters.

II. BLOCK DIAGRAM:

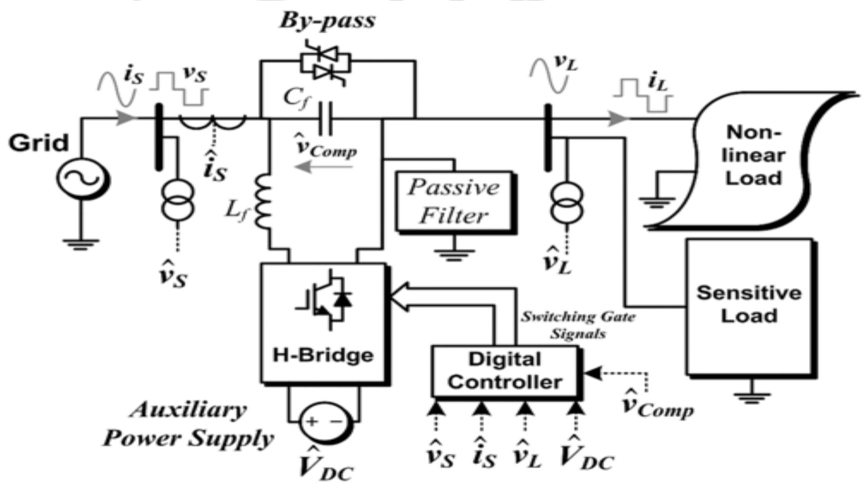


Fig.1. Electrical diagram of the THSeAF in a single phase utility

III. FUZZY LOGIC CONTROLLER

Over the past few decades, the use of fuzzy logic controller, in control systems has gained popularity or FLC's are an best choice when taking mathematical formula calculations are not possible. FLC's actual operation can be divided into three steps:
(1) Fuzzy fication
(2) Fuzzy processing

(3)Defuzzification
It serves as an energy storage element to supply the real power difference between load and source during the transient period. In the steady state the real power supplied by the source should be equal to the demand of real power of the load adding a small power to isolate the losses in the active filter.

IV. CONTROLLER CIRCUIT:

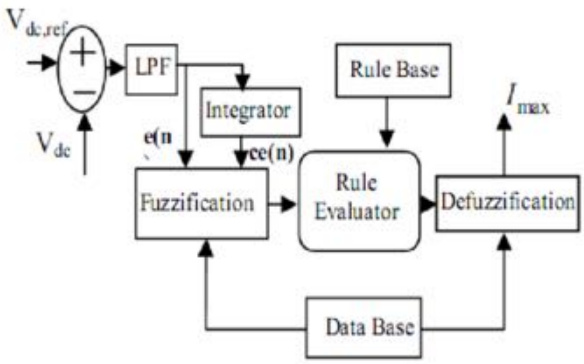


Fig. 2. Control strategy for fuzzy controller

A reference value maintained at the dc capacitor voltage. However, the real power balance between the source and the load will be disturbed because of load condition changes the real power balance between the source and the load will be disturbed. This changes reference voltage away from the dc capacitor voltage. In order to protect the proper operation of the active filter, the peak value of the reference current must be balance to change proportionally the real power produce from the source. The real power supplied by the source is equal to that consumed energy by the load. Thus, in this direction the peak value of the reference source current can be acquire by manage the average voltage of the dc capacitor. the real power supplied by the source is not sufficient to supply load demand because of a smaller dc capacitor voltage than the reference voltage Therefore, the source current (i.e. the real power produce from the source) require to increased, while a large dc capacitor voltage than the reference voltage use to minimize the reference source current. This change in capacitor voltage has been compare from the simulation. The ripple voltage of the dc capacitor results by the injection of real reactive power. Generally, filter these ripples mostly used A low pass filter which found a finite delay. when avoid the use of low pass filter the capacitor voltage is sampled at the zero crossing of the source voltage. A substantial change in reference current and it makes the compensation is non instantaneous during transient.
Hence the phase voltage is sampled at the zero crossing of given voltage and rapid compensation occur. a little higher dc capacitor voltage rise or dip during transients, but the less settling time is due to the Sampling only twice in a cycle as differentiate to six times in a cycle. Here it is shown how elimination of harmonic is done in Inverter by Pulse Width Modulation (PWM) technique by solving the non linear equations. To determine switching angles of an Inverter Equations are used. Switching angles play an important role to produce the actual output by eliminating selected harmonics. In order to form the set of equation, fundamental component is given actual output value and all other harmonics are equated to zero. The equation which is derived for Total Harmonic distortion of the output voltage and current of an inverter is used in order to eliminate the harmonics that are produced in the inverter.

V. A REVIEW

[1] Shunt Active Power Filters (Shunt APFs) describes for industrial purposes the most important and most widely used filters, the fact that they eliminate the Harmonic current with a neglected amount of active fundamental current supplied to compensate system losses, but also they are acceptable for a wide range of power ratings. IGBTs are Modern power electronic devices which give path to configure non harmonic generating shunt APFs, this paper gives attention on this type of configuration namely the voltage source inverter based three phase shunt active power filters having aim to introduced an overview on the given matter.

[2] Shunt active power filters (APF) are commonly used in power systems for the reduction of current harmonics and improvement of the power factor with nonlinear loads, like diode rectifiers. The main component of the APF comprise a pulse width modulation (PWM) power converter. The low order harmonics of the line current are reduce the force, but in electromagnetic interference (EMI) connected to the grid gives results using the switch mode operation of the converter.
Specially, group of harmonics develop in the frequency spectra of voltages and currents of the converter at multiples of the switching frequency. This paper fetch the discrete spectral power of those harmonics to the steady spectral power density is suggest for mitigation of the EMI. It is more effective for non-uniform switching periods using a novel random PWM method (RPWM II). In distinction to the existing PWM methods, the sampling frequency of the digital modulator is constant and equal to the average switching frequency in RPWM II. Results are presented using Computer simulations and They demonstrate significant reduction of the EMI, a accomplishment achieved at practically having no cost.

[3] For the possible frequency deviation of the fundamental grid frequency these method were used. This paper shows that the

KF-PLL can also be used to give the current references for shunt active power filters. It is considered references generation because of following given reasons: harmonics cancellation, harmonics and power factor correction displacement, harmonics and unbalance compensation and harmonics with unbalance and displacement power factor correction.

[4] The integration of series-active and shunt-active filters used in Unified power quality conditioners (UPQC's). UPQC is use to compensate the voltage flicker/imbalance, reactive power, negative sequence current, and also harmonics. The UPQC has the capability of improving power quality at the time of installation in power distribution network. The control strategy of the UPQC is described in this paper, with main a focus on the continue flow of active and reactive powers inside the UPQC system. And Experimental output results gives a laboratory model of 20 kVA, including with a theoretical analysis, are represesnt to verify the importance of the UPQC.

[5] For enhancement of power quality to eliminate harmonics current and improve power factor Shunt active power filters were used to systems using non-linear loads. At the current position different techniques exist to control active power filters. Some of them are based on expeditious reactive power theory [I] and others are using Park's transformation for the synchronous reference frame. The main aim of this paper is to introduced a new control method of shunt active power filters in unbalanced systems,both in load currents, and AC supply voltage, with a high penetration of harmonics. This control strategy is depend on the time domain analysis carried out by active power. With this control strategy one can make that the set formed by the nonlinear load and the shunt power filter works every time like a resistance, UPF (with unity power factor), or the current absorbed by the set is perfectly sinusoidal, by switch. For different load and line conditions system has been simulated and result gives waveforms of the line currents shown, with their contents of harmonic distortion.

[6] A capability and limitations of this technique is to increase the power capacity that can be operated by the shunt active power filters (APFs). The specific required capacity includes the reactive power and the amplitude of the current distortion provide by the APFs. The advantages of the given method include high versatility for enlarge capacity of system, high reliability due to no control interconnection, which reducing the demand of power capacity of APF, high substitutable due to identical APFs, stable reactive power and harmonic current sharing and also cost effective and so on. Three single phase 1KVA active power filters are demonstrated and implemented given by some experimental results.

[7] Generating of gate signal for inverters using the active power filter is the most important part. This paper described a Single Phase Application of Space Vector with Pulse Width Modulation for shunt active power filter. In traditional SVPWM, all phase currents are controlled together, but in this method each of phase currents is controlled independently from the measured currents of other phases. In another word, this method prevents from influence of other phase's errors in the control of selected phase. In this method, the design of control logic will be simpler than the traditional SVPWM. For showing the performance of proposed method a typical system has been simulated by MATLAB/SIMULINK. At the end, the results of described method are compared with the traditional SVPWM. The results gives that described method have better presentation in generation of the compensation current in the active power filter.

[8] PWM inverters, a time delay between back-to-back semiconductor switching are described to forbid a short circuit in the DC link. This activity causes the dead time reaction, which is adverse to the working of inverters. This paper assign with a new method that increase the feedback loop in Shunt active power Filter, in order to remunerate the deadtime action. A simple technique is based on an mean value theory can be used to remunerate this action For Shunt Active Power Filters (SAPF), the remuneration can be done in two dissimilar ways, one for the sustain forward arrangement and the other for response one. This paper proposed both methods and review the details, superiority of the feedback design with a new fast feedback loop that promise the dead-time remuneration an overall stability. Investigational results are introduced showing the performance of the proposed technique.

[9] The analysis and the application of a current controller in an active power filter (APF) based on a PWM voltage source electronic converter with three legs and four wires. The neutral wire is connected to the middle point of the DC capacitor voltage. The controller proposed here is an extension of the one proposed for a three-wire Shunt Active Power Filter. The controller is a two-level nested controller. The outer loop generates the reference current for the inner-loop. The latter, is a state feedback current controller with integral action. The former consists of
(i) a selective harmonic elimination technique and
(ii) a DC capacitor-voltage controller
This paper will focus on the neutral-wire current control and on the balance control of the DC-capacitor voltage. The performance of the control algorithm has been demonstrated using a test-rig with balanced and non-balanced non-linear loads.

[10] In recent years, the increase of non-linear loads in electrical power system has sparked the research in power, quality issue. The shunt active power filter (SAPF) is a power electronic device which has been developed to improve power quality. The current control of shunt power filters is critical since poor control can reinforce existing harmonic problems. Various control strategies have been proposed by many researchers. In this paper, a comparative estimation of the performance of two current control methods, resonant and predictive controller, is presented with identical system specification. The design procedure and principle of both current control methods are also presented in detail. Simulation results show the comparison of transient response, steady state control and performance in the presence of variation of supply impedance between two control techniques.

[11] P. T. Staats, et.al. proposes a statistical method for predicting the effect that widespread electric vehicle (EV) battery charging will have on power distribution system harmonic voltage levels. This method uses for a statistical model for nonlinear load currents to generate the prospective value of specific harmonic voltage levels. The statistical model for the harmonic currents produced by a concentration of EVs accounts for partial harmonics cancellation introduced by uncertainty and variation in charger start time and initial battery state of charge.

[13] W. R. N. Santos, et.al. presents a universal active filter for harmonic and reactive power compensation for single phase systems applications. The proposed system is a combination of parallel and series active filters without transformer. It is suitable for applications where size and weight are critical factors. The model of the system is derived and it is shown that the circulating current observed in the proposed active filter is an important quantity that must be controlled. A complete control system, including pulse width modulation (PWM) techniques, is developed.

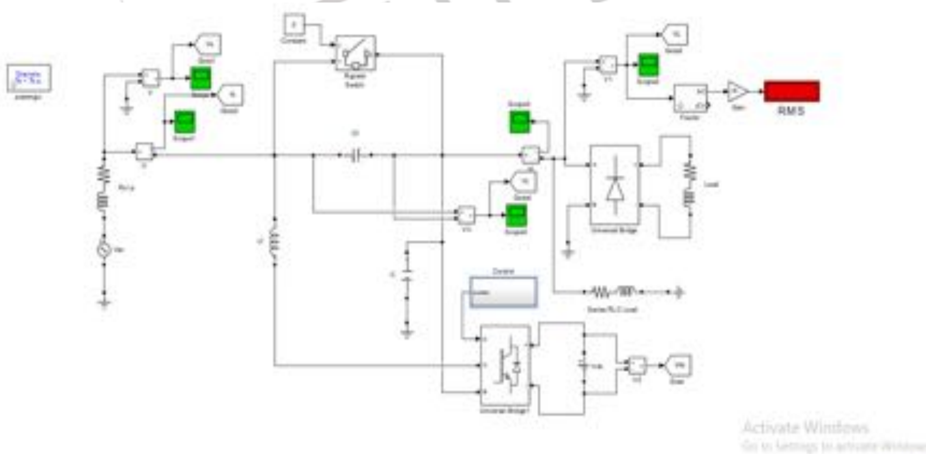
[12] A. Javadi, et.al. proposes a novel configuration of Series hybrid active filters. The proposed configuration could be connected to the grid without requiring a costly series injection transformer. This topology is capable of compensating current harmonics at the source and voltage distortion at the point of common coupling. Furthermore, an appropriate controller could compel the Transformer less hybrid series active filter (THSeAF) to perform as (UPQC) with quit similar behavior. The transformerless configuration is more cost effective than any other series compensators based mostly on a transformer to inject the compensating voltages. It cleans the power system from current distortions together with harmonics and unbalances, similar to a shunt active filter.

[14] Eng. k. k. Sng, et.al. proposes a transformer less self charging dynamic voltage restorer series compensation device which is used to reduce voltage sags and swell. A detailed analysis on the control of the restorer for voltage sag mitigation and dc-link voltage regulation are presented. A nonlinear element is shown to exist in the regulator, the activation of which can adversely affect its stability. Proposed prototype to validate the analysis under both voltage restoration and self-charging operating conditions.

[15] H Fujita, et.al. proposes a combined system of a passive filter and a small rated active filter, both connected in series with each other. The passive filter removes load produced harmonics just as a conventional one. On the other hand, the active filter plays a role to improve the filtering aspect of the passive filter. This results in a great reduction of the required rating of the active filter and in eliminating all the limitations faced by using only the passive filter, leading to a practical and economical system.

[16] P. Salmerón, et.al. proposes control algorithm for a three phase hybrid power Filter, It is constituted by a series active filter and a passive filter connected in parallel with the load. The control strategy is based on the vectorial formulation for spontaneous reactive power, so that the voltage waveform injected by the active filter is able to compensate the reactive power and the load current harmonics and to balance asymmetrical loads. The proposed algorithm also improves the behavior of the passive filter.

VI. SIMULATION ANALYSIS:



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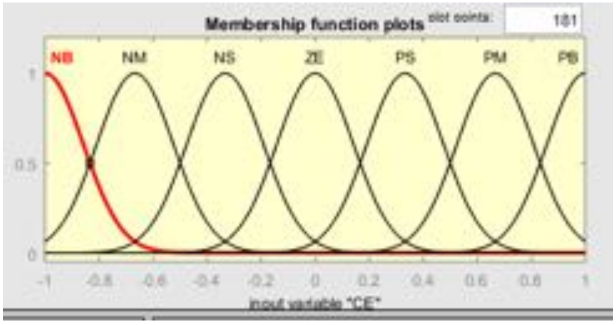

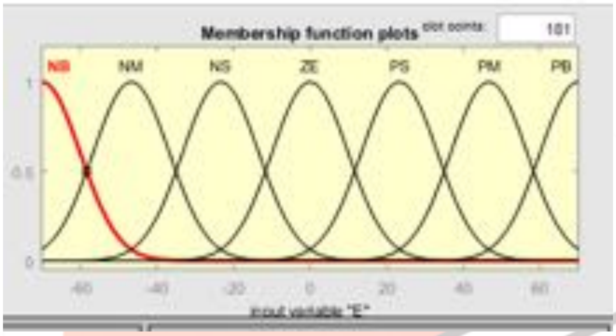

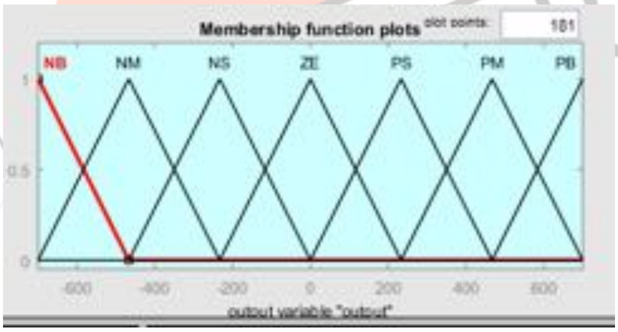

CONCLUSION

A study of harmonics involve in the voltage and current waveforms is display with an objective to know the existing level of harmonic distortion present in the Power System. Harmonics injected by very commonly used nonlinear loads are studied. In this paper we introduced harmonics of power system, inverter circuit and shunt active filter for the single phase and three phase circuit is simulated and the THD measured verifies the reduction of harmonics based shunt active filter. The Shunt AF is able to compensate balanced and unbalanced nonlinear load currents of a fourwire system with the neutral wire connected to the capacitor midpoint.

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