FUZZY CONTROL BASED APF WITH DG INTEGRATION FOR POWER QUALITY IMPROVEMENT IN DISRIBUTION SYSTEM

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Abstract-Power quality is the major problem in the electrical distribution network, out of various power quality problems; harmonics problem is major in distribution network. Various FACTS controllers are proposed for mitigation of power quality problem in the distribution network for harmonic compensation Active power filter is proposed. Another major problem in the power system network is increasing load demand day by day to meet the increasing in load demands renewable energy sources (RES's) are inter connected to the distribution network. For integrating any type of renewable energy sources (RES's) we need a voltage source converter (VSC) one for power quality improvement, another for integration of DG. This work proposes a fuzzy controlled SRF theory based APF with DG integration In the proposed system the fuzzy control circuit will perform the function of harmonic elimination, so that the need for an APF (Active Power Filter). Implementation of a fuzzy logic controller by using voltage as feedback for significantly improving the dynamic performance of proposed APF module with good stability factor is to be achieved. The system of DG integration with APF controlled by Fuzzy is modeled using MATLAB\Simulink. The operating conditions are demonstrated to improve the power quality is simulated using MATLAB/SIMULINK.

Key words: Active power filters (APF), Distributed generation (DG), Fuzzy logic controller and power quality.

I.INTRODUCTION

Power quality problems are classified into two types, first one is voltage quality and second one is current quality [1]. Current quality problems are occurred due to non-linear loads in order to reduce these current quality problems we need shunt compensation, in shunt compensation active power filter is used as harmonic eliminator various control strategies are proposed in the literature out of those simplified d-q control is used in this paper.

The Renewable energy source (RES) integrated at distribution level is termed as distributed generation (DG). The utility is concerned due to the high penetration level of intermittent RES in distribution systems as it may pose a threat to network in terms of stability, voltage regulation and power-quality (PQ) issues [2]. Therefore, the DG systems are required to comply with strict technical and regulatory frameworks to ensure safe, reliable and efficient operation of overall network. With the advancement in power electronics and digital control technology, the DG systems can now be actively controlled to enhance the system operation with improved PQ at PCC However, the extensive use of power electronics based equipment and non-linear loads at PCC generate harmonic currents, which may deteriorate the quality of power [3].

Generally, current controlled voltage source inverters are used to interface the intermittent RES in distributed system. Recently, a few control strategies for grid connected inverters incorporating PQ solution have been proposed. The primary contribution of this paper is a d-q control algorithm designed and implemented specifically for this application. Traditionally, active power filters have been controlled using pre-tuned controllers [4], [5].

The introduction of change in voltage in the circuit will be fed to fuzzy controller to give appropriate measure on steady state signal. The fuzzy logic controller serves as intelligent controller for this propose. This paper presents the mathematical model of the 4L-VSI and the principles of operation of the proposed predictive control scheme, including the design procedure [6].

Active power filters are usually employed to solve the power quality problems. In this paper, a PV generating system is connected to grid and the PQ is maintained without using APF (Active Power filter) [7] .There are different ways by which PQ can be maintained. Here, we have Conventionally, PI, PD and PID controller are most popular controllers and widely used in most power electronic appliances however recently there are many researchers reported successfully adopted Fuzzy Logic Controller (FLC) to become one of intelligent controllers to their appliances. Two independent fuzzy controllers have been designed for DG interface and that controllers will perform the function of active power filtering (eliminating harmonics), thereby increasing efficiency, reliability and quality [8].

This paper deals with a single-phase inverter for DG systems requiring power quality features, such as harmonic and reactive power compensation by using fuzzy logic controller

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for grid-connected operation [9]. The complete description of the selected current reference generator implemented in the active power filter is also presented. Finally, the proposed active power filter with fuzzy control and the effectiveness of the associated control scheme compensation, power quality improvement is simulated using MATLAB/SIMULINK.

II.Active Power Filter Configuration

A). APF connected in Distribution system.

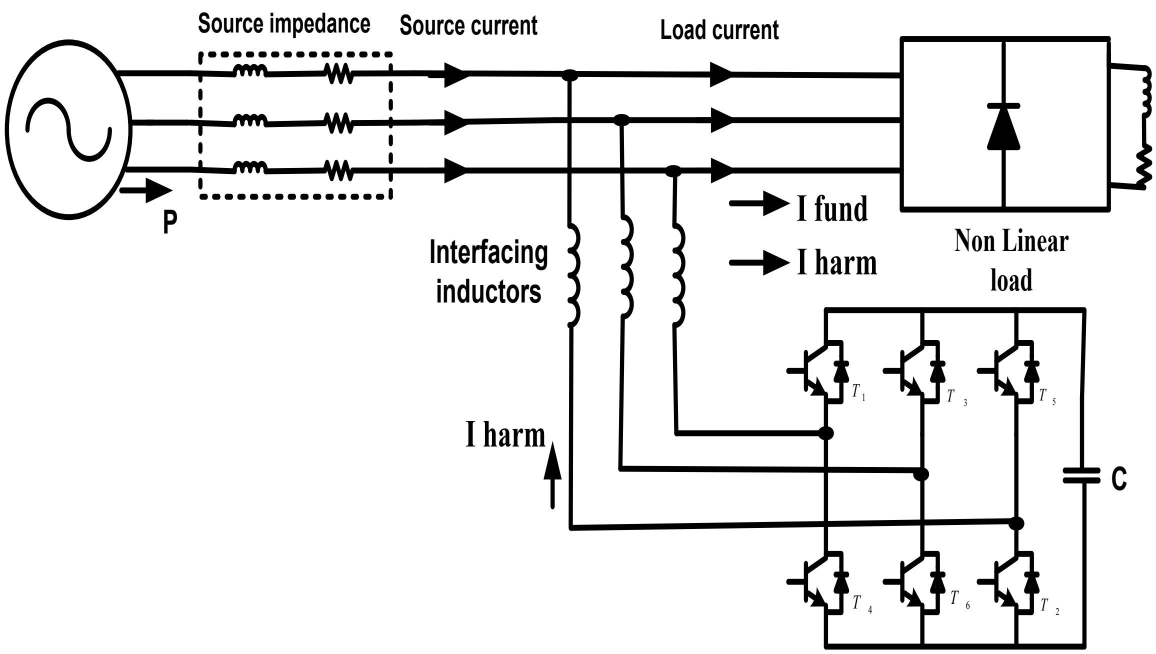

Fig.1. Active power filter connected in distribution system.

Active power filter generates compensating currents and induces these generated compensated currents in to the system thus mitigating harmonics in the system. Unwanted neutral currents might flow caused due to non-linear loads with uncompensated and unbalanced systems. In this case, a three phase APF can deliver compensation. Active power filters are of different types. Series compensators, shunt compensators or combination of both series and shunt compensators called UPQC [10]. Here in this paper shunt active power filter was considered to mitigate the harmonic pollution in the system containing non-linear and inductive type of loads. A typical arrangement of inverter as shunt active power filter was connected is showed in fig.1. This is a converter based

APF with VSI configuration. VSI configured APF is low cost, simple, expandable to multi-level and consists of a self-supporting DC Voltage. This shunt active power filter can effectively mitigate harmonics.

The APF shunted at PCC in distribution system and also at PCC we have ac source is connected with source impedance. This three phase ac source is supplies a active power to load and load is connected with nonlinear loads which has nonlinear type load is connected with this load reactive power demand is high on source and harmonics will generated [11]. We need to eliminate what are problems will be produced by load by using APF is shunted with system.

In this paper we use DQ theory control strategy with the APF is showed in fig.2. This controller with internal PI controller generates the reference currents and after comparing the original feedback signal with the reference currents, produces error signal. The controller controls the switches of the VSI accordingly and thus the currents will be injected in to the system through VSI converter [12]. These are called compensating currents or negative currents that compensate the harmonics at the source point. Active power filter should be capable of nullify the variations in component of instantaneous power and also the reactive power of fundamental frequency. A simple control strategy called active and reactive power (DQ) theory can control the APF by defining instantaneous active power and reactive power. The definitions apply in either the αβ0- or dq0-domains and for balanced sinusoidal three-phase systems would yield constant values. There are various representations of the equations such as complex power or a two-dimensional cross product. The total set-up of system with APF along with its control circuit was shown in figure.2.

Those dq0 values passed through HPF then go to inverse transformation means dq0 converted into abc parameters. PI controller is used for comparing dc voltage reference and actual then added with direct axis component of controller. The inverse transformation value is actual current is compared with reference current then connected to hysteresis controller; it generates gate pulses to switches used in inverter.

B). d-q control strategy for APF.

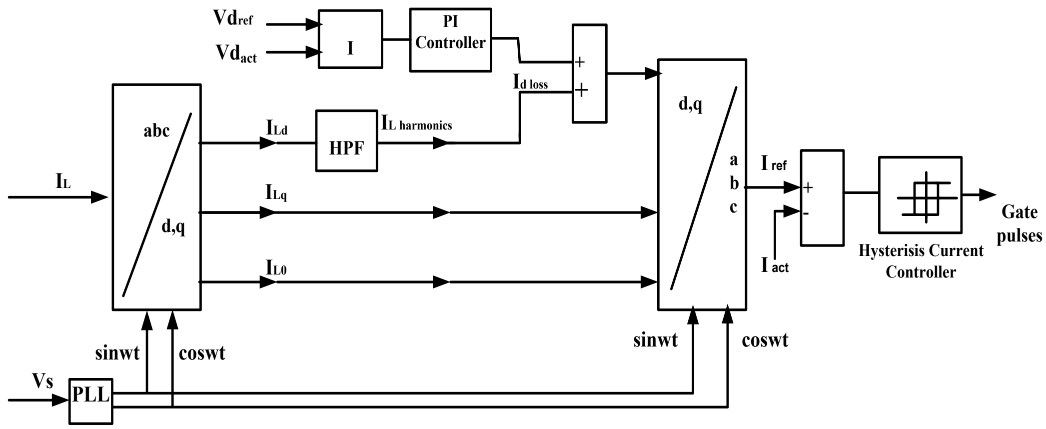

Fig.2. d-q Control strategy.

III. DG Integrated APF.

The shunt APF is controlled by a controller to generate reference currents and also to generate compensating currents. Basically the non-linear components in the load current are first sensed at the load point and the signal is fed to controller. The controller conditions the signal in the system by inducing compensating currents through proper interfacing. Sensing agents senses the load currents at the load point and fed back to the controller [11].

The active power filter with integration of DG is showed in fig.3. Here the inverter is connected with PV cell is showed. The generated PV cell is fed to inverter then injected into distribution system at PCC. The Integrated DG with APF is mitigates certain harmonics produced in distribution system.

A. Fuzzy control of Active power filter (APF) with DG integration.

The identified Load frequency control and interconnection problems can be effectively reduced by controlling AGC. Fuzzy logic is wide employed in controlling technique. The word "fuzzy" maintain fact that the logic concerned will wear down ideas that can't be expressed as "true" or "false" however rather as "partially true". Though various approaches like genetic algorithms and ANN will perform even as well as formal logic in several cases, formal logic has the advantage that the answer to the matter is forged in terms that human operators will perceive, so their expertise is employed in the look of the controller of prognosticative current control. The linguistic variables area unit outlined as (NB, NM, NS, Z, PS, PM, PB) that means negative big, negative medium, negative small, zero, positive small, positive medium and positive big. The membership functions area unit shown in below Fig.4.

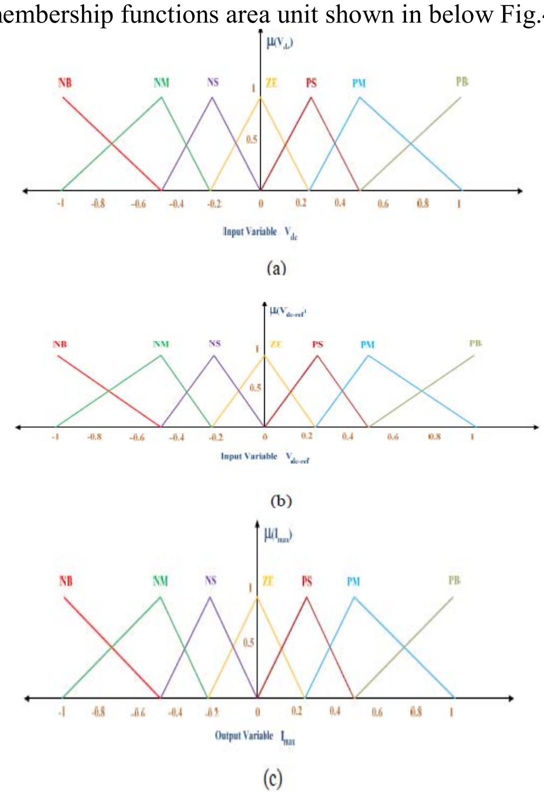

Fig.4 (a) Input ANF normalized membership function; (b) Input Vdc-ref Normalized Membership Function; (c) Output Imax Normalized Membership Function.

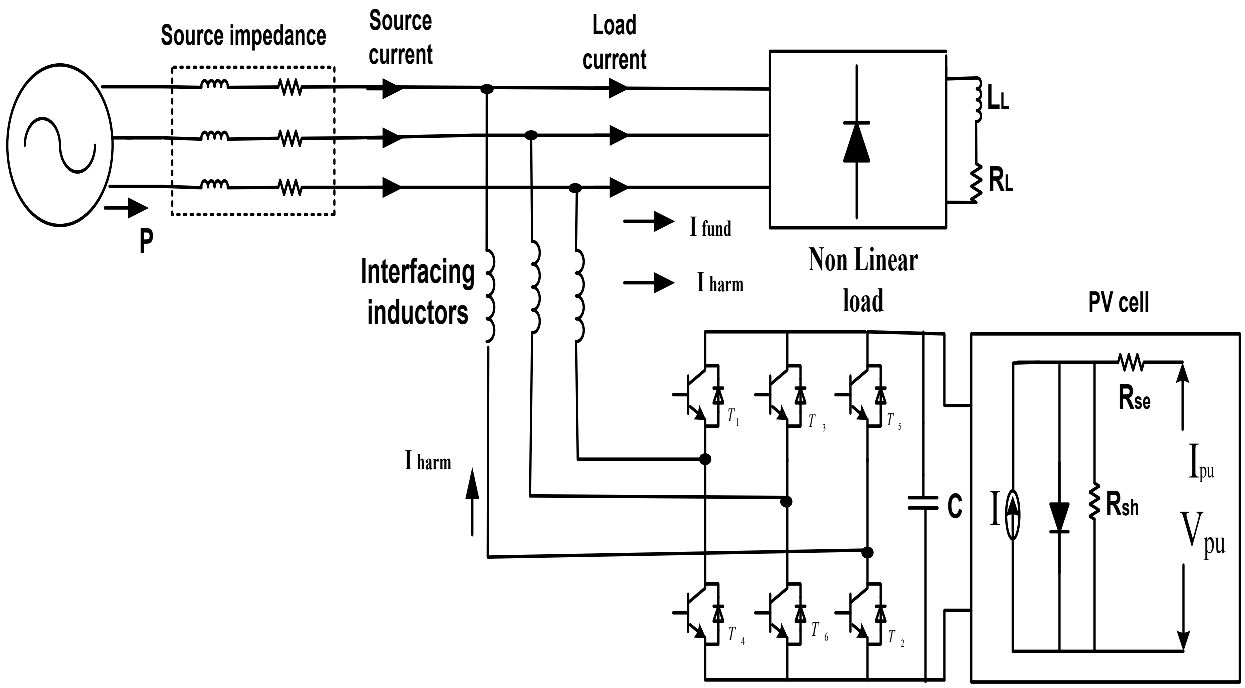

Fig.3. Active power filter (APF) with DG integration.

Table I. The Membership functions for FLC

E CE	NB	NM	NS	Z	PS	PM	PB
PB	Z	PS	PM	PB	PB	PB	PB
PM	NS	Z	PS	PM	PB	PB	PB
PS	NM	NS	Z	PS	PM	PB	PB
Z	NB	NM	NS	Z	PS	PM	PB

IV. MATLAB\SIMULINK RESULTS

Case.1 Active power filter (APF) without DG integration.

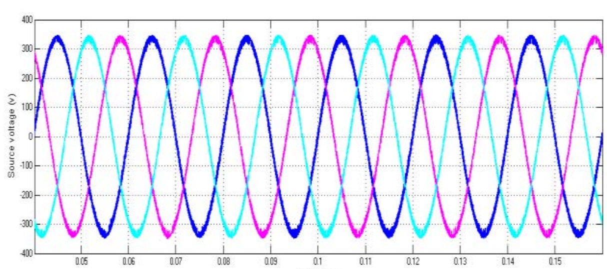

Fig 5: Simulink result of source Voltage without DG

The source voltage of distribution system is shown in fig 5. The peak amplitude of the phase voltage is 320 Volts.

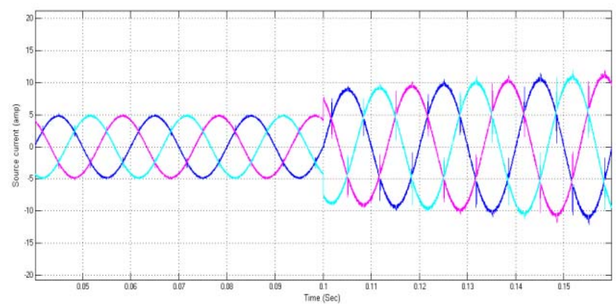

Fig 6: Simulink result of source Current without DG

The source current of the distribution system is doubled. Since there is no DG connected to the filter so the increased load current is supplied from source.

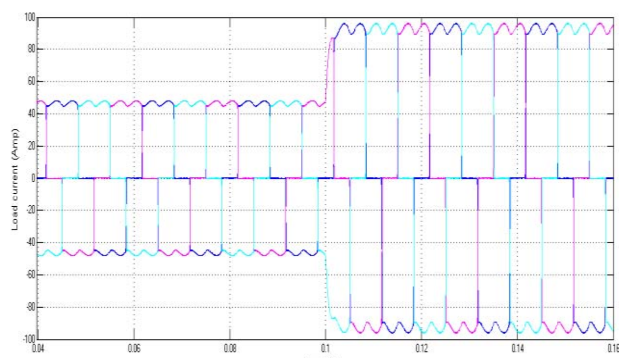

Fig .7: Simulink result of Load current without DG

The fig.7 shows the non-linear load current at T=0.1sec the load is doubled.

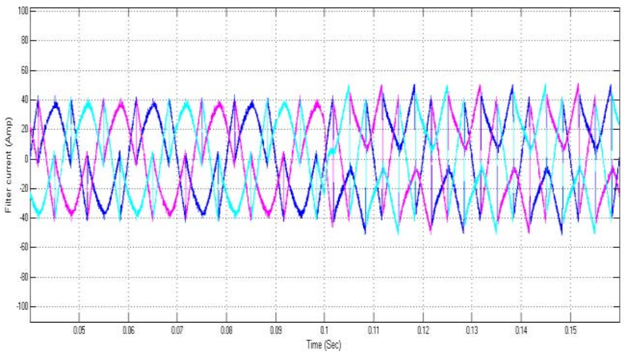

Fig 8: Simulink result of filter current without DG

Fig 8 shows the compensation of the active power filter. Since there is no DG integration from the filter even though load increases filter current is almost constant

Case.2 Active power filter (APF) with DG integration and PI controller.

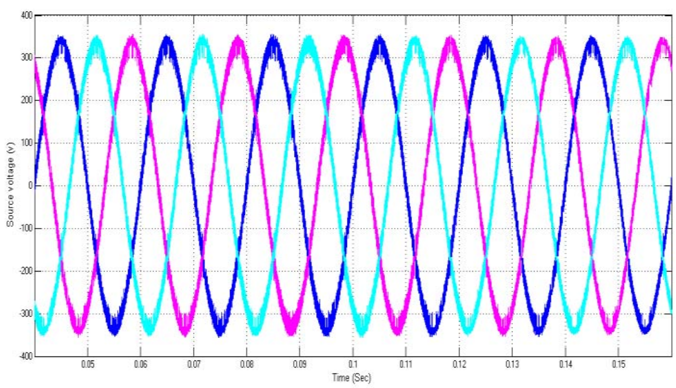

Fig .9: Simulink result of source voltage with DG and PI controller

Fig.9 shows the source voltage when DG is integrated and controlling is done with PI controller. Here also peak value of phase voltage is 320volts.

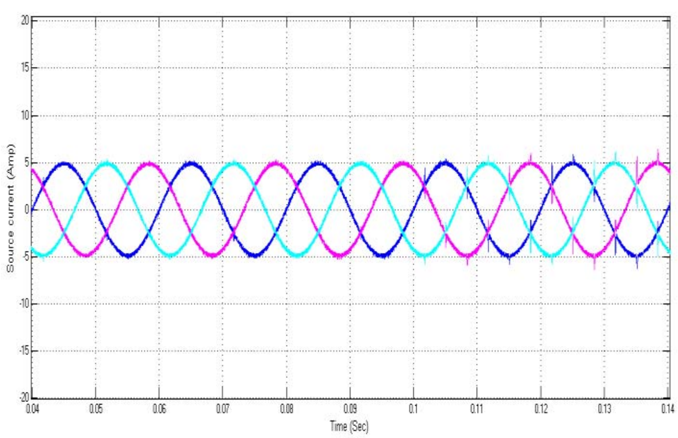

Fig .10: Simulink result of source current with DG and PI controller

Fig.10 shows the source current wave form when DG is integrated with active power filter (APF). From the fig it is clear that even though T=0.1 sec load is double source is almost constant.

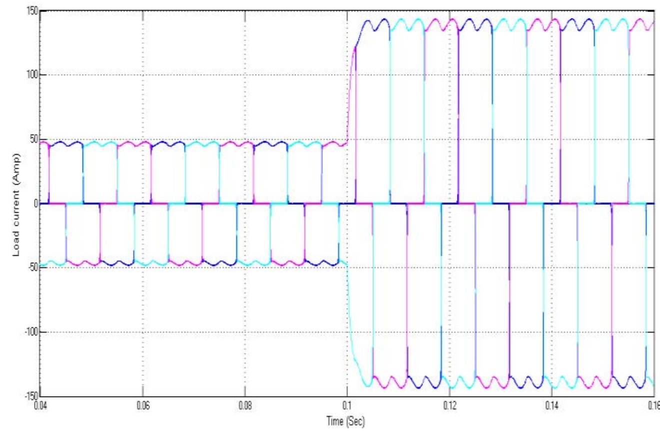

Fig .11: Simulink result of Load current with DG andPI controller

Fig.11 shows the non-linear load current at T=0.1 sec the load is doubled.

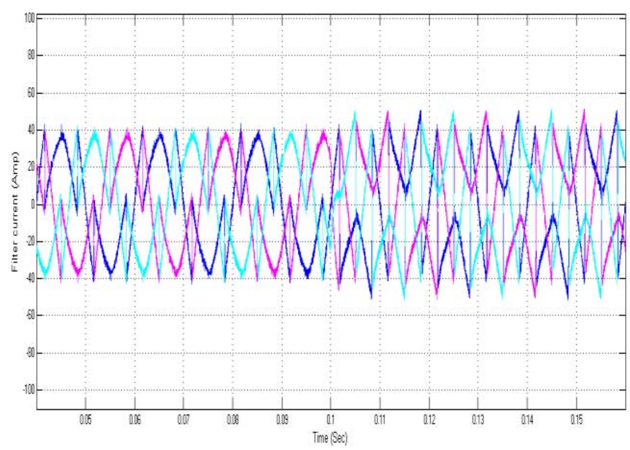

Fig 12: Simulink result of filter current without DG

Fig 12 shows the compensation current of active power filter (APF) at T=0.1 sec the filter current is increased due to increase in load.

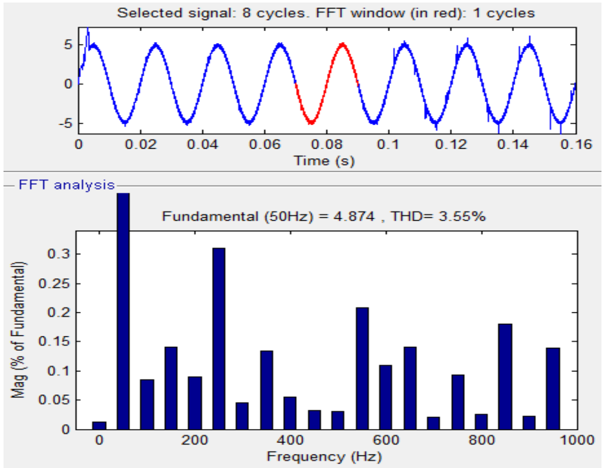

Fig .13: THD of source current with DG PI controller

Fig.13 shows the THD% of source current with DG and PI controller there in Distribution system. The THD is 3.55%.

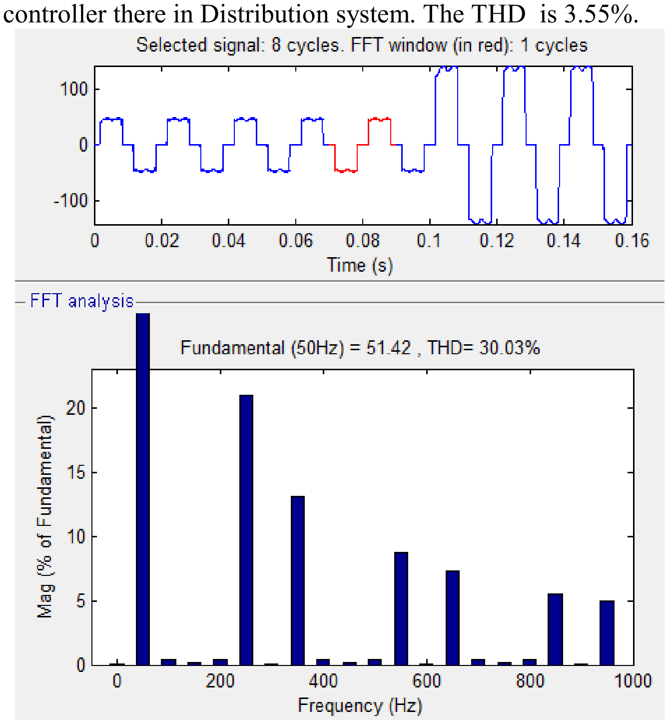

Fig .14: THD of load current with DG PI controller

Fig.14 shows the THD of load current of system with DG and PI controller there in system. The THD presented in system is 30.03%.

Case.3 Active power filter (APF) with DG integration and Fuzzy controller.

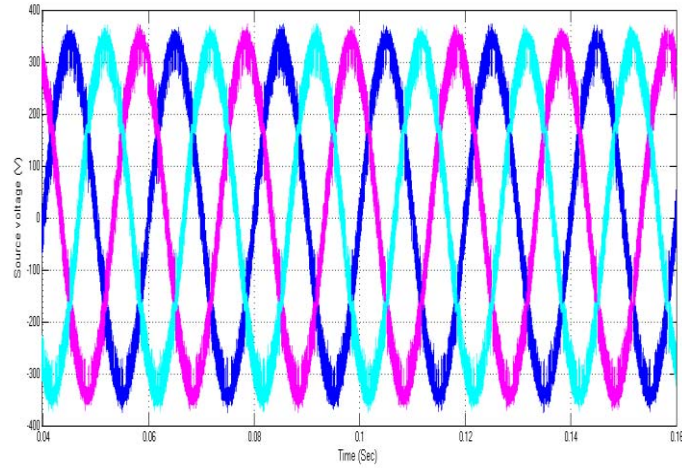

Fig .15: Simulink result of source voltage with DG and fuzzy controller.

Fig.15 presents the source voltage of system when DG is integrated and controlled by fuzzy controller.

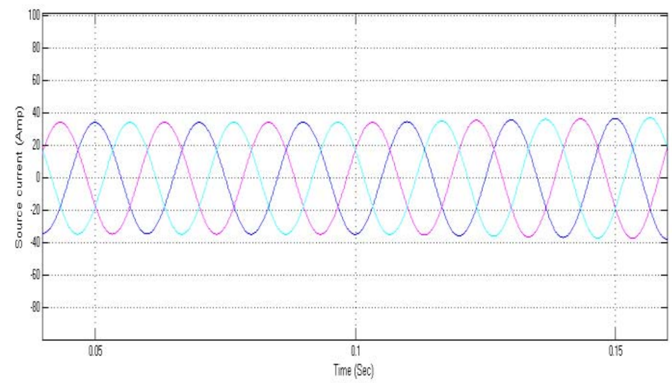

Fig .16: Simulink result of source current with DG and fuzzy controller

Fig.16 presents the sourcecurrent of system when DG is integrated and controlled by fuzzy controller. With fuzzy controlled the distortion in the source current is decreased. Here also due to DG integration even though load current increases source current is constant.

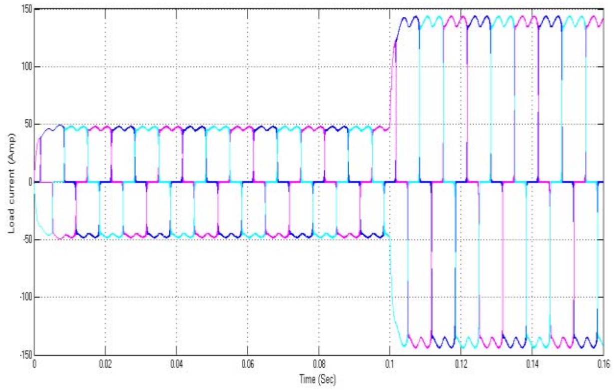

Fig .17: Simulink result of Load current with DG and fuzzy controller

Fig.17 presents the non-linear load current at T=0.1 sec the load is doubled

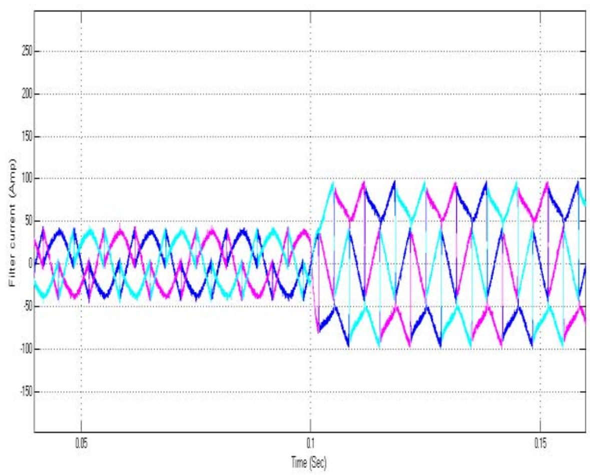

Fig .18: Simulink result of filter current with DG and fuzzy controller

Fig.18 presents the filter current of system when DG is integrated and controlled by fuzzy controller. At T=0.1sec due to increase in active power load filter current is increased.

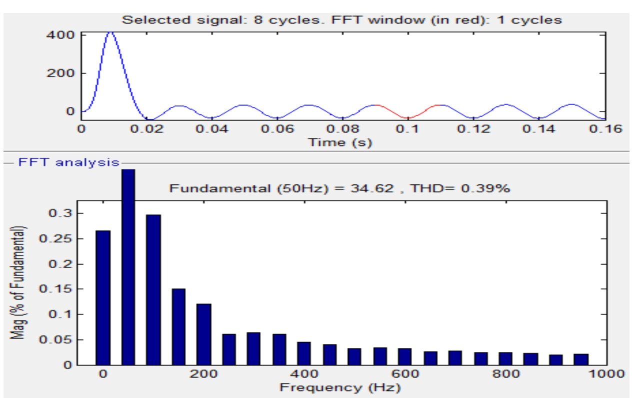

Fig .19: THD of source current with DG fuzzy controller

Fig.19 shows the THD% of source current with DG and Fuzzy controller there in Distribution system. The THD is 0.39%.

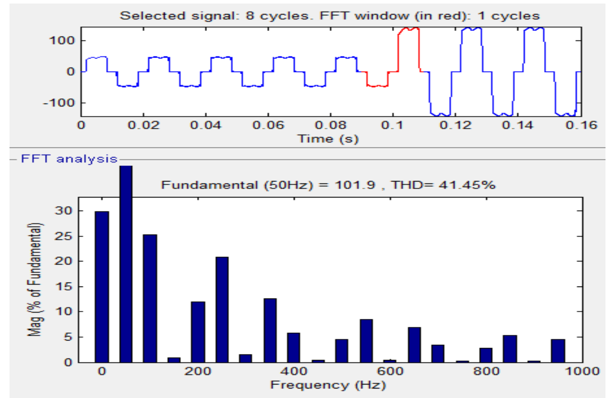

Fig .20: THD of load current with DG fuzzy controller

Fig.20 shows the THD of load current of system with DG and Fuzzy controller there in system. The THD presented in system is 41.45%.

V. CONCLUSION.

Due to the non linear load connected in the power system harmonics will presented, which effects power quality of the system to meet the increase in day by day load demand renewable energy source (RES) integrated at the distribution level. Instead of using separate converter for DG integration separate converter for power quality improvement, here we are integrating DG with APF. The APF is controlled by d-q theory with hysteresis controller is used to generate gate pulses to inverter. Here simulation results are presented for without DG integration, with DG and PI controller and With DG and fuzzy controller. The THD s at PI and fuzzy controller is presented compared to PI, fuzzy have less THD% in system

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BIOGRAPHY

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