ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijareeie.com

Vol. 6, Issue 4, April 2017

Power Quality Improvement Using Fuzzy Logic Based UPQC

Anagha W. Waghadkar[1], M.R. Salodkar[2]

PG Student [EPS], Dept. of Electrical Engineering, G.H. Raisoni College of Engineering, Amravati, Maharashtra, India[1]

Assistant Professor, Dept. of Electrical Engineering, G.H.Raisoni College of Engineering, Amravati, Maharashtra, India[2]

ABSTRACT:Our power system is facing various power quality problems such as voltage sag, voltage swell, harmonics, flicker etc. Main reason to focus on these power quality problems is due to the increased use of sensitive loads i.e. loads whose performance depends upon the quality of power being supplied to them. The power quality problems have increased due to the increased use of non-linear loads such as furnaces which are the main cause to create the various power quality problems in our power system.

In order to reduce these power quality problems and maintain a proper supply for the sake of good operation and long life of the equipment, system has to be developed using UPQC based upon the Fuzzy logic.

KEYWORDS: Fuzzy logic controller(FLC), voltage sag, flicker, harmonics, unified power quality conditioner (UPQC), voltage swell.

I.INTRODUCTION

There has been a continuous rise of nonlinear loads over the years due to intensive use of power electronic control in industry as well as by domestic consumers of electrical energy. The utility supplying these nonlinear loads has to supply large vars. Moreover, the harmonics generated by the nonlinear loads pollute the utility. The basic requirements for compensation process involve precise and continuous VAR control with fast dynamic response and on-line elimination of load harmonics. To satisfy these criterion, the traditional methods of VAR compensation using switched capacitor and thyristor controlled inductor coupled with passive filters are increasingly replaced by active power filters (APFs). The APFs are of two types; the shunt APF and the series APF. The shunt APFs are used to compensate current related problems, such as reactive power compensation, current harmonic filtering, load unbalance compensation, etc. The series APFs are used to compensate voltage related problems, such as voltage harmonics, voltage sag, voltage swell, voltage flicker, etc. The unified power quality conditioner (UPQC) aims at integrating both shunt and series APFs through a common DC link capacitor. The UPQC is similar in construction to a unified power flow controller (UPFC). The UPFC is employed in power transmission system, whereas the UPQC is employed in a power distribution system.

Further, the control of UPFC based on the conventional PI control is prone to severe dynamic interaction between active and reactive power flows. In this work, the conventional PI controller has been replaced by a fuzzy controller (FC). The FC has been used in APFs in place of conventional PI controller for improving the dynamic performance. The FC is basically nonlinear and adaptive in nature. The results obtained through FC are superior in the cases where the effects of parameter variation of controller are also taken into consideration. The FC is based on linguistic variable set theory and does not require a mathematical model. Generally, the input variables are error and rate of change of error. If the error is coarse, the FC provides coarse tuning to the output variable and if the error is fine, it provides fine tuning to the output variable. In the normal operation of UPQC, the control circuitry of shunt APF calculates the compensating current for the current harmonics and the reactive power compensation. In the conventional methods, the DC link capacitor voltage is sensed and is compared with a reference value. The error signal thus derived is processed in a controller. A suitable sinusoidal reference signal in-phase with the supply voltage is

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijareeie.com

Vol. 6, Issue 4, April 2017

multiplied with the output of the PI controller to generate the reference current. Hysteresis band is normally (most often but not always) is imposed on top and bottom of this reference current.

Our power system is facing various power quality problems such as voltage sag, voltage swell, harmonics, flicker etc. Main reason to focus on these power quality problems is due to the increased use of sensitive loads i.e. loads whose performance depends upon the quality of power being supplied to them. The power quality problems have increased due to the increased use of non-linear loads such as furnaces which are the main cause to create the various power quality problems in our power system.

The current power system is dealing with the poor power quality issues and the reason behind this poor power quality and the reason behind this poor power quality is voltage fluctuations, harmonics, transients and reactive power demands and these problems arise due to changing trend of our demand. Now a days in our demand the share of power from power electronics devices has increased a lot and also coupling of grids to wind farms and solar farms has arised the problem of poor quality. These days the use of sensitive loads such as computers has increased to a great extent and thus this is the major reason for our concern about the power quality. These loads are also called as ‘sensitive loads’. The reason for these loads to become sensitive are the use of IC’s used in these devices which are sensitive to the quality of power being supplied. If the quality of power being supplied to these sensitive loads is not good then it may lead to a permanent damage of these loads. Power quality problems even result into slowing down of motors. Thus for the sake of better operation and long life of these consumer equipment, quality of power has to be maintained. In this project we overcome the various power quality problems which is must for the smooth operation and better life of equipment.

II.SYSTEM MODEL AND ASSUMPTIONS

With increasing applications of nonlinear and electronically switched devices in distribution systems and industries, power-quality (PQ) problems, such as harmonics, flicker, and imbalance have become serious concerns. In addition, lightning strikes on transmission lines, switching of capacitor banks, and various network faults can also cause PQ problems, such as transients, voltage sag/swell, and interruption. A shunt converter (also known as the shunt active power filter) can compensate for distortion and unbalance in a load so that a balanced sinusoidal current flows through the feeder. A series converter (also known as the dynamic voltage restorer) can compensate for voltage sag/swell and distortion in the supply-side voltage so that the voltage across a sensitive/ critical load terminal is perfectly regulated. One modern and very promising solution is the unified power-quality conditioner. UPQC is a custom power device that consists of shunt and series converters connected back to back on the dc side and deals with load current and supply-voltage imperfections. UPQC has attracted the attention of power engineers to develop dynamic and adjustable solutions to PQ problems. This led to the development of advanced control techniques and novel topologies for UPQC. Control techniques play a vital role in the overall performance of the power conditioner. The rapid detection of the disturbance signal with high accuracy, fast processing of the reference signal, and high dynamic response of the controller are the prime requirements for desired compensation.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijareeie.com

Vol. 6, Issue 4, April 2017

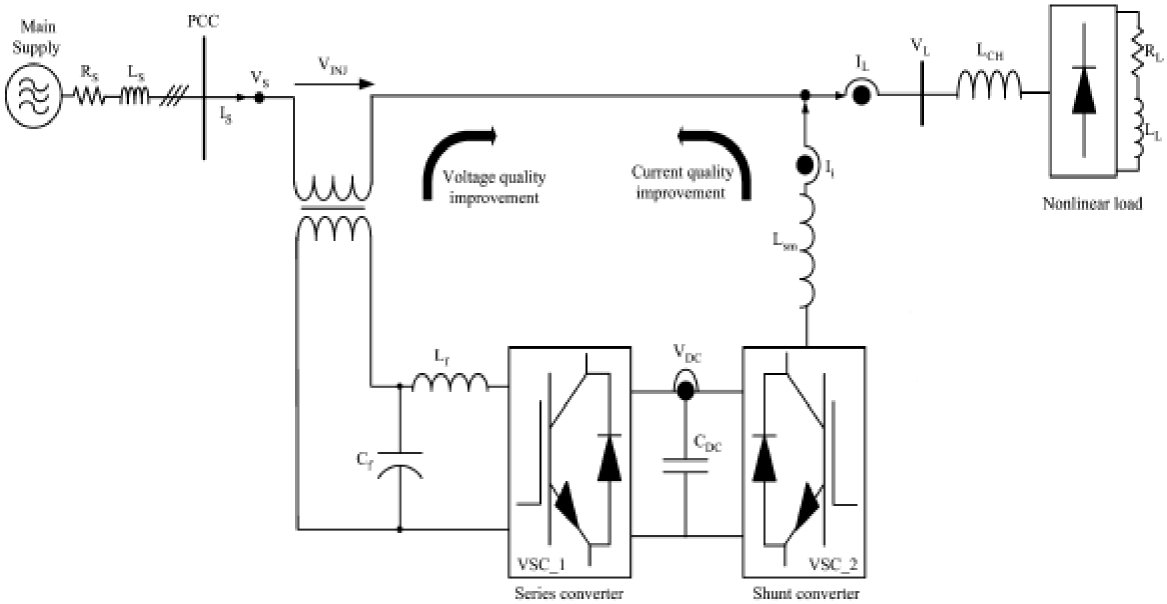

Fig 1: Modified diagram of UPQC

The key elements used in UPQC are

1. Main supply
2. LC filter
3. Series APF
4. Shunt APF
5. Non-linear load

Main Supply: The main supply used is the standard supply of rating 230V, 50Hz . A power supply is an electronic device that supplies electric energy to an electrical load. The primary function of a power supply is to convert one form of electrical energy to another and, as a result, power supplies are sometimes referred to as electric power converters. Some power supplies are discrete, stand-alone devices, whereas others are built into larger devices along with their loads. Examples of the latter include power supplies found in desktop computers and consumer electronics devices.
LC filter: An LC circuit, also called a resonant circuit, tank circuit, or tuned circuit, is an electriccircuit consisting of an inductor, represented by the letter L, and a capacitor, represented by the letter C, connected together. The circuit can act as an electrical resonator, an electrical analogue of a tuning fork, storing energy oscillating at the circuit's resonant frequency.

Series APF: Series APF is a series element which can act as a controlled voltage source. It injects voltage of negative harmonics through injection transformer. The capacitor is energy storage with self supporting i.e. with reactive power exchange. If we use a fixed dc source then there exists only a real power exchange through voltage source inverter.

Shunt APF: Shunt active power filter is a shunt connecting device which can be acts as controlled current source. It injects negative current harmonics to solve current related problems. The purpose of capacitor is same as series APF. The basic circuit of shunt APF and its basic function is explained in fig4.4. The functions of shunt APF are dc link voltage regulation, improvement of power factor by controlling reactive power.

Non-linear load: A nonlinear load in a power system is characterized by the introduction of a switching action and consequently current interruptions. This behaviour provides current with different components that are multiples of the fundamental frequency of the system. These components are called harmonics. The amplitude and phase angle of a harmonic is dependent on the circuit and on the load it drives. For a fundamental power frequency of 60 Hz, the

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijareeie.com

Vol. 6, Issue 4, April 2017

2ndharmonic is 120 Hz, the 3rd harmonic is 180 Hz, and so on. The harmonic currents flow toward the power source through the path of least impedance.

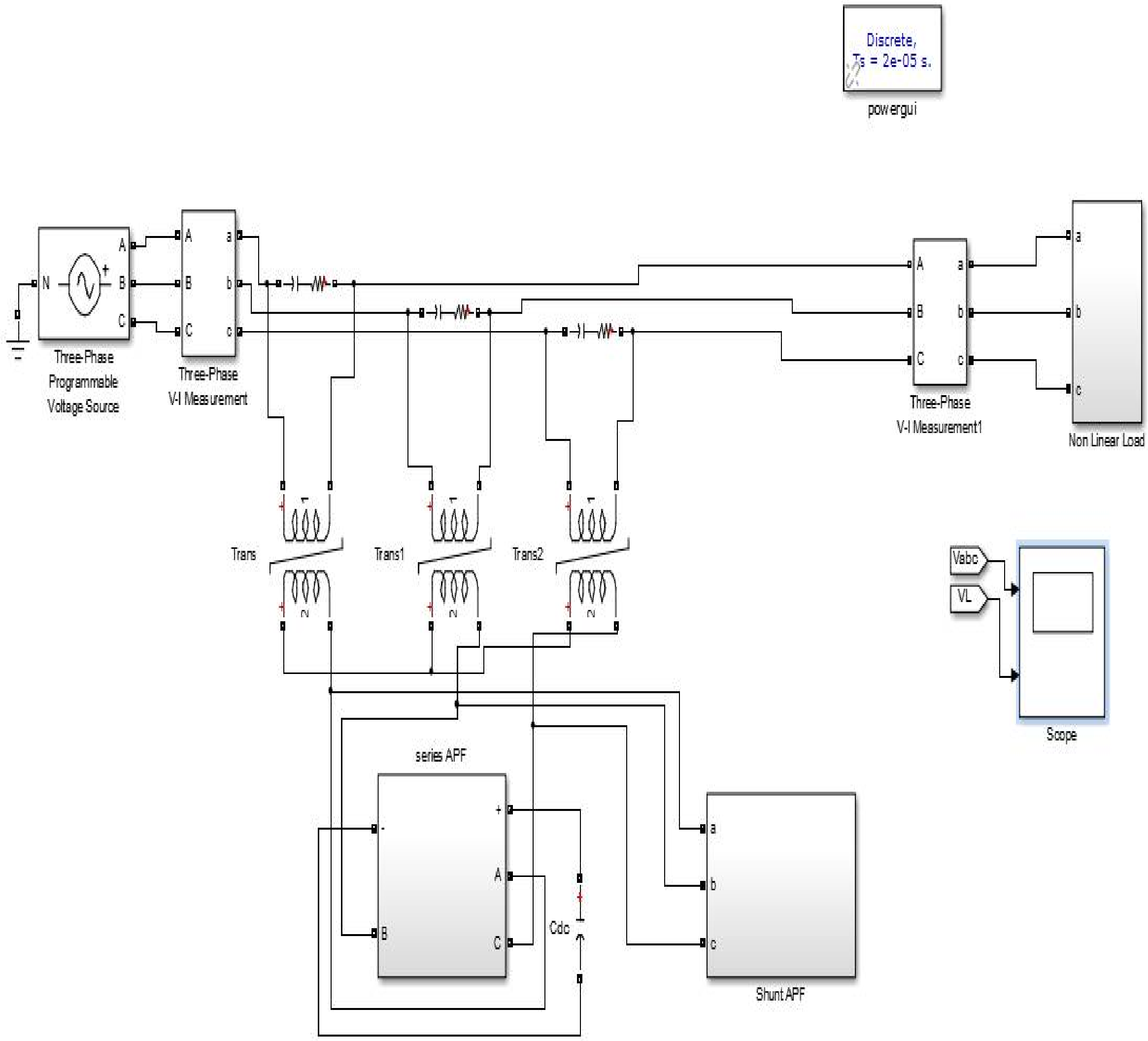

Fig 2:Simulink model using Fuzzy Logic Controller

The above figure shows the combined series shunt model of UPQC. In this model the entire UPQC is shown which is the combination of series and shunt APF.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijareeie.com

Vol. 6, Issue 4, April 2017

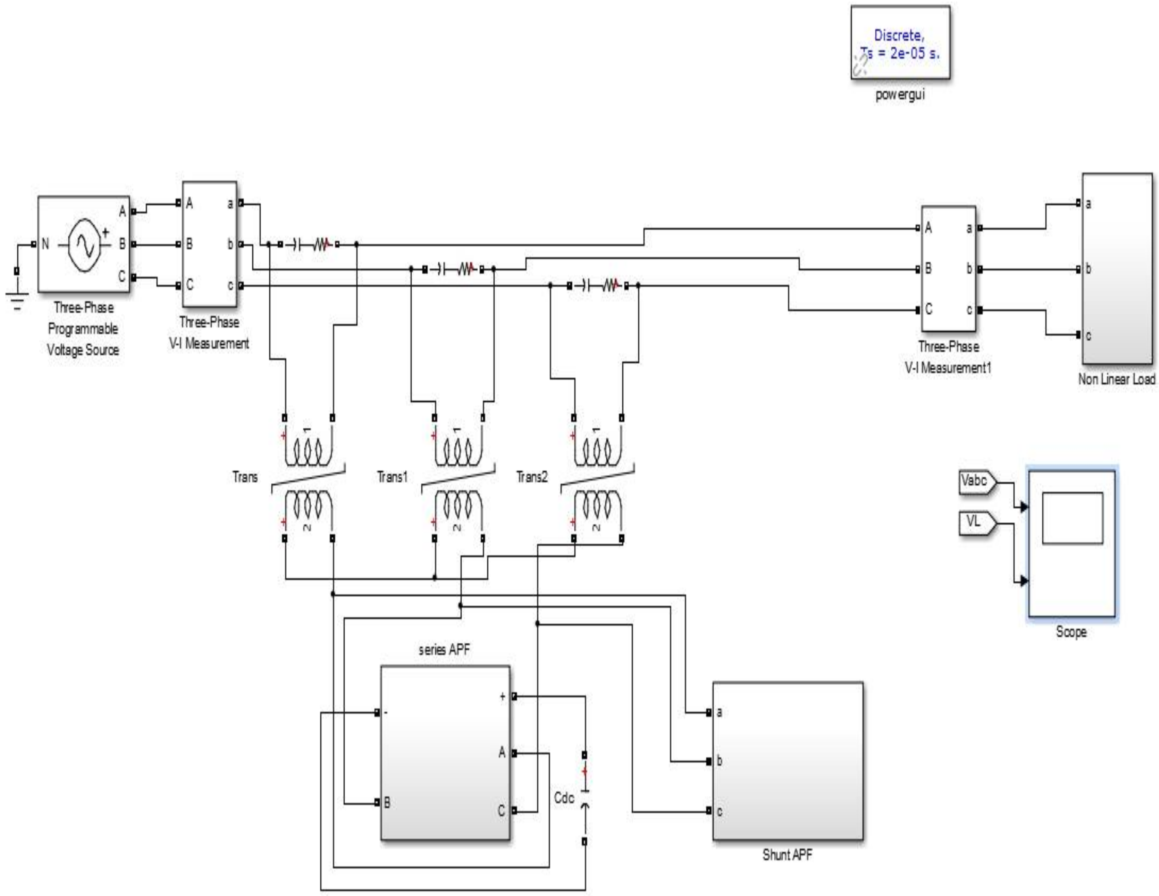

Fig 3: Simulink Model Using PID controller

The above figure shows the simulink model of PID controller. Model is same as that of fuzzy logic controller only PID controller is used instead of fuzzy controller

The without UPQC system is taken, and then we can add the UPQC system with PI controller is connected to this without UPQC circuit. The actual signal is taken from the source side, this signal is transformed abc to dqo form. Then this signal is compared with reference signal it then the error signal. The error signal is given to the PI-controller; the controller gives signal the corresponding switch will be turned on. Depending upon the controller gain value the output will be varied.

The without UPQC system contain Sag, Swell, Active and Reactive power output by using this with UPQC system we can eliminate this Sag, Swell, Active and Reactive power for the use of proper Proportional Integral (PI) controller.

III. RESULT AND DISCUSSION

A PI-based control strategy used in the UPQC, which mainly compensates the reactive power along with voltage and current harmonics under non-ideal mains voltage and unbalanced load-current conditions. The without UPQC contain sag, swell, active and reactive power distortion. So we can mitigate this problem UPQC system is proposed, to mitigate this problem by the use of PI control and Pulse Width Modulation (PWM) technique. The simulation results show that, when under sag, swell, active and reactive power distortion under fault condition, the PI control algorithm eliminates the impact of distortion on supply voltage and unbalance of load current on the power line, making the power factor unity. Meanwhile, the series APF isolates the loads and source voltage in unbalanced and

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijareeie.com

Vol. 6, Issue 4, April 2017

distorted load conditions, and the shunt APF compensates reactive power, and provides three-phase balanced and rated currents for the mains. Simulation results obtained by the use of Matlab/simulink software to mitigate the power quality problems effectively by the use proper PI controller of UPQC.

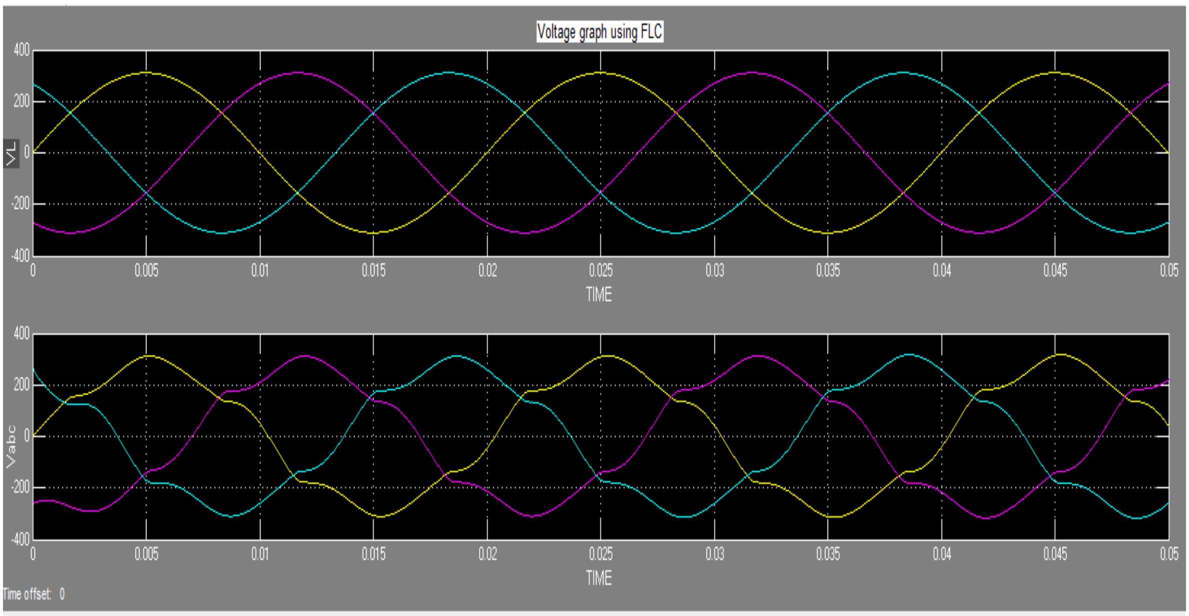

Fig 4 :Graph of source supply voltage $V_{abc}$and load voltage V_L of Fuzzy logic controller.

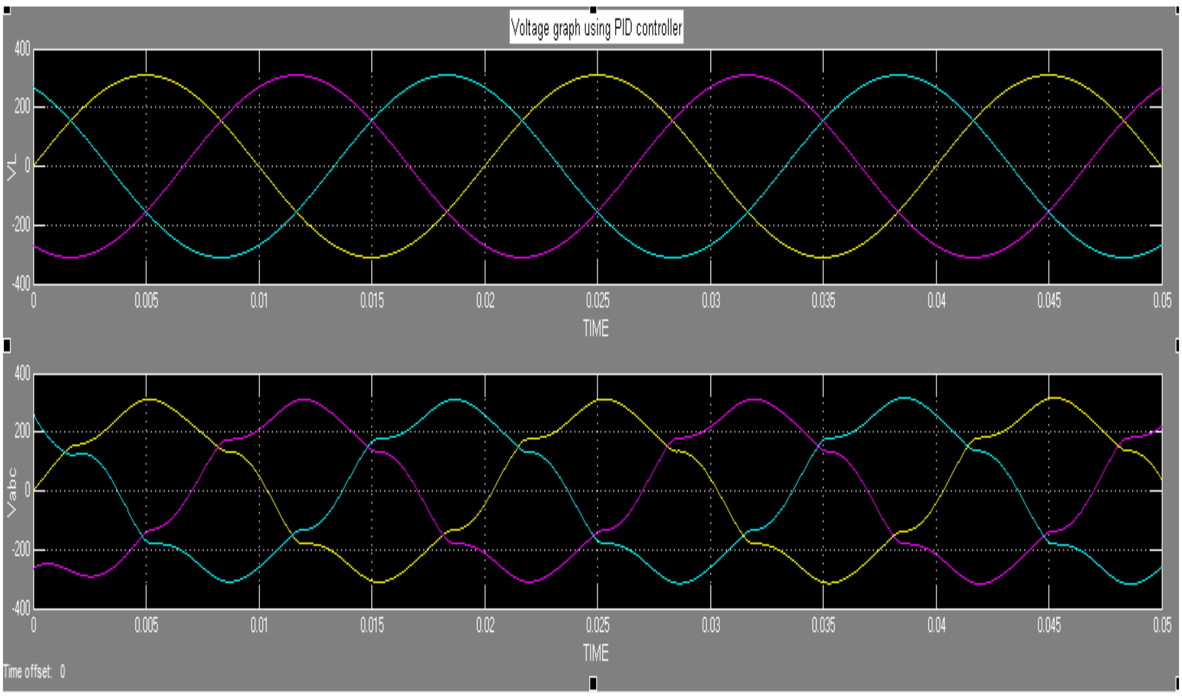

Fig 5: Graph of source supply voltage $V_{abc,}$ load voltage V_L of PID controller

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijareeie.com

Vol. 6, Issue 4, April 2017

The graph of supply voltage Vabc and the load voltage V_L are shown below. This graph represents both the voltages with the use of PID controller.
The response graph using Fuzzy controller is shown below. The x-axis represents the time whereas the y-axis shows the response of the system using Fuzzy logic controller.

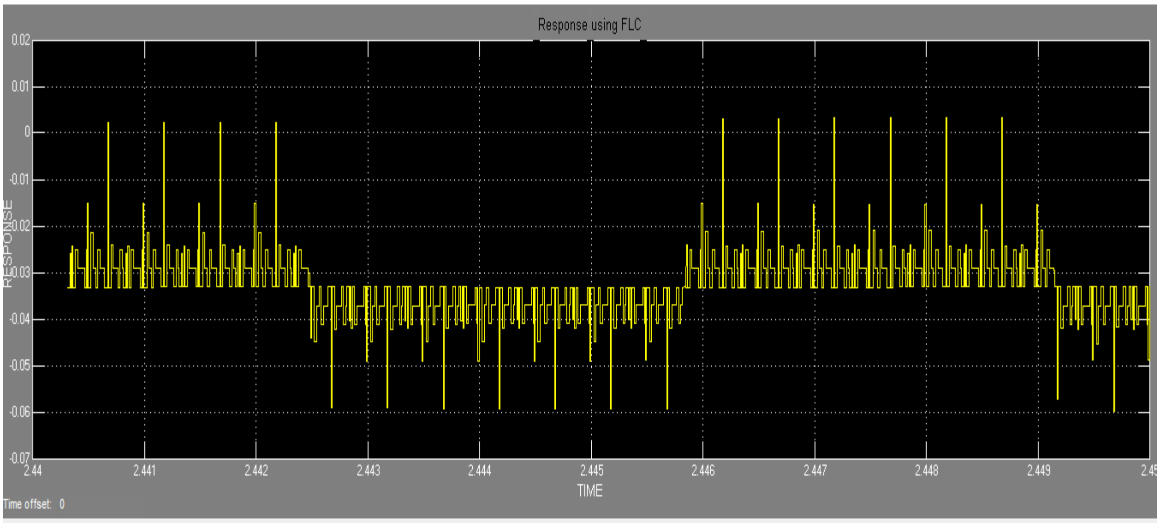

Fig 6:Response of Fuzzy Controller

The response graph obtained with the use of Fuzzy logic controller which is more linear in nature in comparison with the graph obtained by PID controller.

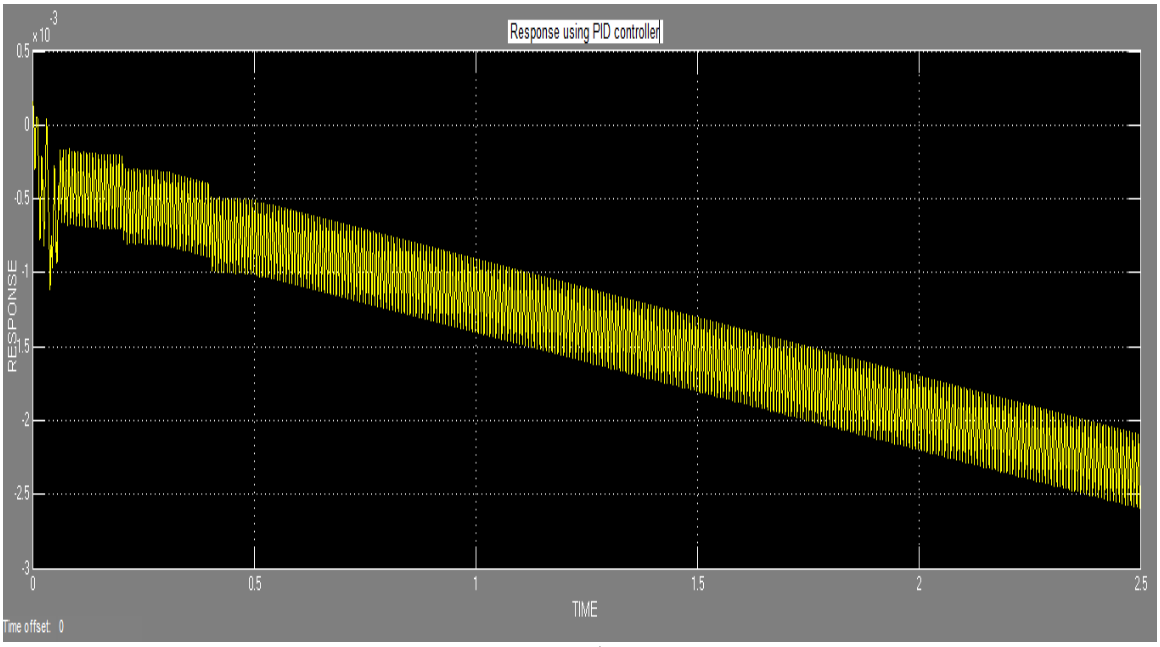

Fig 7: Response Of PID controller

The above figure shows the graph obtained with the use of PID controller.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijareeie.com

Vol. 6, Issue 4, April 2017

VI.CONCLUSION

This paper is based upon fuzzy logic and is meant to overcome the various power quality problems which our power system is facing now-a-days. The various power qualitywhich our power system is facing now a days. The various power quality problems that our power system is facing these days are voltage sag, voltage swell, harmonics, flicker etc. Here we tried to overcome the voltage and current related problems to improve the quality of power. This system is used in the distribution system as we are using the UPQC which is unified power quality conditioner which is the combination of series and shunt active filter connected with a back to back dc link. If series APF and shunt APF are connected differently then the system architecture becomes complicated, so UPQC is the solution which is the combination of series and shunt APF. Series APF is used to overcome the voltage related problems and whereas shunt APF is used to overcome the current related problems. Various methods can be used to compensate the error which is the difference between reference quantity and practical quantity. These various methods are trial and error, PID controller, fuzzy logic controller etc. Out of which we found Fuzzy Logic to be the most efficient and hence used in our system. The results using FL are more accurate as compared to any other system and the FL has the advantage to give more efficient output in less time. Hence, it is found to be more accurate and its response is fast. So FL is suitable for this system. The results obtained through FLC are good in terms of dynamic response because of the fact that FLC is based on linguistic variable set theory and does not require a mathematical model of the system. The tedious method of tuning PI controllers is not required in case of FLC.

This paper is then executed using the MATLAB software and findings have been studied. Hence this system is found to be more efficient as compared to the other ones. The response for this system has been proved and hence the objectives for this project have been satisfied.

REFERENCES

[1] Sathakkathulla S and Kumarasabapathy, "Power Quality Improvement using Fuzzy Logic based UPQC", International Conference and Computing and Control Engineering (ICCCE 2012), 12&13 April,2012
[2] Vinod Khadkikar, Member IEEE, " Enhancing Electric Power Quality Using UPQC: A Comprehensive Overview", IEEE transactions on power electronics, vol. 27,No.5,May 2012
[3]Sumeet Singh and MukulChanakya, "A Review on Power Quality Improvement by UPQC", International Journal of Enhanced Research in Science Technology & Engineering., Vol. 4 Issue3, March-2015
[4]M.D.Bobade and K.N.Kasat, "Design of UPQC using Fuzzy Logic and Neural Network for the Improvement of Power Quality: A Review",International Journal of Scientific Engineering and Technology Research.,Vol.04, Issue.05 February-2015.
[5]Chandrashekhar Reddy S, "Power Quality Improvement Using UPQC", Proceedingsof The Intl. Conf. on Information, Engineering, Management and Security 2014 [ICIEMS 2014].
[6]Chirag Patel and R. Mahanty, "Fuzzy Logic Controlled Unified Power Quality Conditioner for Power Quality Improvement",16th NATIONAL POWER SYSTEMS CONFERENCE, 15th-17th DECEMBER, 2010.
[7] MekriFatiha, Machmoum Mohamed and Ait Ahmed Nadia," High Performance of An Unified Power Quality Conditioner Based on a Fuzzy Logic"
[8] N. SUNIL KUMAR, C. VISWANATH ,"Design and implement of Fuzzy based system with Unified Power Quality Conditioner (UPQC) to Improve the Power Quality Problems",International Journal of Scientific Engineering and Technology Research,ISSN 2319-8885 Vol.04,Issue.26, July-2015, Pages:4979-4986.
[9] Rojin R.K, Ajay Amrit Raj," An Efficient Design of UPQC Using Fuzzy Logic Controller for a 3 Phase 4 Wire Distribution System", International Journal of Advanced Research in Electrical,Electronics and Instrumentation Engineering Vol. 3, Issue 5, May 2014.
[10] G.Venkata Prasad, S.Muqthiar Ali, M. Padma Lalitha," Power quality improvement using ANN logic based UPQC for harmonic distortion."