*International Journal For Technological Research In Engineering*
*Volume 3, Issue 9, May-2016* *ISSN (Online): 2347 - 4718*

# UNIFIED POWER QUALITY CONDITIONER FOR POWER QUALITY IMPROVEMENT USING FUZZY LOGIC AND NEURAL NETWORK

Shahezad Shaikh[1], Mandar Oza[2], Smit Padhiar[3], Dharmistha Makwana[4]
[1,2,3]Research scholar K.I.R.C-Kalol-Gujarat
[4]Asst Prof, Electrical Engineering Department,K.I.R.C.-Kalol-Gujarat

***ABSTRACT: Voltage disturbance problems are in distribution systems are not new but customer alertness of these problems increased recently. It is very important to maintained the voltage and reduce the power quality problems because new generation load that uses microprocessor and microcontroller based controls and power electronics devices which are more sensitive to power quality variations. Using UPQC we should reduce both series and shunt power quality problem in this paper we should studied out how to solve that power quality problems like voltage Sag and Voltage Swell by using UPQC with fuzzy logic controller (FLC) and Neural Network Controller.***
***Key word: UPQC, Voltage Sag, Voltage Swell, PI controller, Fuzzy logic controller And Neuro-Fuzzy Controller***

## I. INTRODUCTION

When the increment of non-linear load power quality problems like voltage sag, swell, flicker are increased. LC passive filter are use to solve that type of problems. However, this kind of filter cannot solve random Variations in the load current waveform and voltage waveform. Active filters can resolve this problem, however the cost of active filters is high, and they are difficult to implement in large scale. as well, they also present lower efficiency than shunt passive filters. FACTS device are use to solve the Power quality problems like sag, swell, harmonics etc.There are many types of FACTS device some of the device include active power filter, surge arrestor, battery storage system, SVR, SVC, DSTATCOM,UPS and UPQC. DVR is the series connected Power quality improvement device and it response time is quick and it is very reliable device for power quality improvement. DSTATCOM is the shunt connected device which is use to solve out power quality problems. It is use to eliminate current distortion problem and harmonic so it is normally connected in parallel to eliminate this type of problems. The UPQC is one of the APF family members which solve both shunt and series power quality problems. The UPQC is a combination of series and shunt active filters connected through a common DC link capacitor. The main purpose of a UPQC is to solve supply voltage power quality issues such as, sags, swells, unbalance, flicker, harmonics, and for load current power quality problems such as, harmonics, unbalance, reactive current and neutral current.

### 1.1Basic configuration of UPQC

A unified power-quality conditioner (UPQC) is the advanced form of unified power-flow controller (UPFC) concept at the distribution level. It consists of combined series and shunt converters for simultaneous compensation of voltage and current imperfection in a supply feeder However, a UPFC only needs to provide balance shunt and/or series compensation, since a power transmission system generally operates under a balanced and distortion free environment.

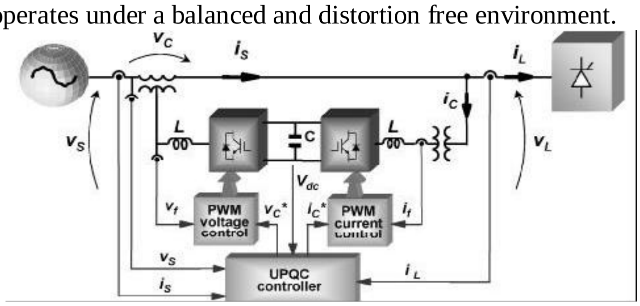


Fig-1.1.1Basic configuration of UPQC

The main use of a UPQC is to balance for supply voltage power quality issues, such as, sags, swells, unbalance, flicker, harmonics, and for load current power quality problems, such as, harmonics, unbalance, reactive current, and neutral current. There are two methods which are used to control the UPQC time domain method and frequency domain method. Time domain method is P-Q or d-q-0 based method. This type of method is quite faster than the frequency domain method. Frequency domain method is more flexible but their dynamical response is slower.

## II. CONTROLLERS

### *2.1 PI controller*

For the operation of UPQC PI controller is used. To control the gate pulse signal of IGBT controller are used. Overall bloke diagram of controller is shown in below Fig 2.1.

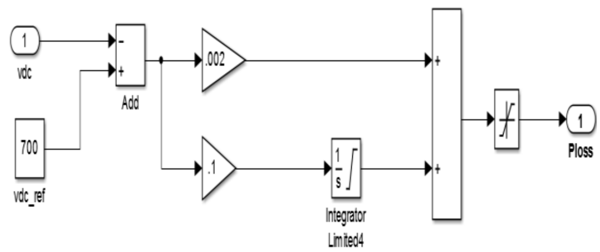


Fig-2.1 PI Controller

P-I controller is mainly used to eliminate the steady state error resulting from P controller.However in terms of the speed of the response and overall stability of the system,it has a negative impact.This controller is mostly used in areas where speed of the system is not an issue.

  

*International Journal For Technological Research In Engineering*
*Volume 3, Issue 9, May-2016* *ISSN (Online): 2347 - 4718*

PLL (Phase Locked Loop)

PLL is used to generate output signal which is in phase with the input signal. It is used for the check of synchronism. PLL is a closed loop system. Input signal is Vabc which is taken from the PCC. Than input signal Vabc converted into Vdq form with the usage of park's transformation. Further calculation convert voltage signal into phase checking signal.

*2.2 Fuzzy Logic*

A fuzzy control system is a control system based on fuzzy logic—a mathematical system that analyzes analog input values in terms of logical variables that take on continuous values between 0 and 1, in contrast to classical or digital logic, which operates on discrete values of either 1 or 0 (true or false, respectively).

Overview

Fuzzy logic is widely used in machine control. The term "fuzzy" refers to the fact that the logic involved can deal with concepts that cannot be expressed as the "true" or "false" but rather as "partially true". Although alternative approaches such as genetic algorithms and neural networks can perform just as well as fuzzy logic in many cases, fuzzy logic has the advantage that the solution to the problem can be cast in terms that human operators can understand, so that their experience can be used in the design of the controller. This makes it easier to mechanize tasks that are already successfully performed by humans.

*Fuzzy sets*

The input variables in a fuzzy control system are in general mapped by sets of membership functions similar to this, known as "fuzzy sets". The process of converting a crisp input value to a fuzzy value is called "fuzzification".

A control system may also have various types of switch, or "ON-OFF", inputs along with its analog inputs, and such switch inputs of course will always have a truth value equal to either 1 or 0, but the scheme can deal with them as simplified fuzzy functions that happen to be either one value or another. Given "mappings" of input variables into membership functions and truth values, the microcontroller then makes decisions for what action to take, based on a set of "rules", each of the form:

IF break temperature is warm and speed is not very fast. Than brake pressure is slightly decreased Here one example is discussed. When break temperature is warm and speed is low than condition is satisfy otherwise controller check second condition weather brake pressure is decrease or not. This rule by itself is very puzzling since it looks like it could be used without bothering with fuzzy logic, but remembers that the decision is based on a set of rules:

All the rules that apply are invoked, using the membership functions and truth values obtained from the inputs, to determine the result of the rule.

- This result in turn will be mapped into a membership function and truth value controlling the output variable.
- These results are combined to give a specific ("crisp") answer, the actual brake pressure, a procedure known as "defuzzification."

Fuzzy control in detail

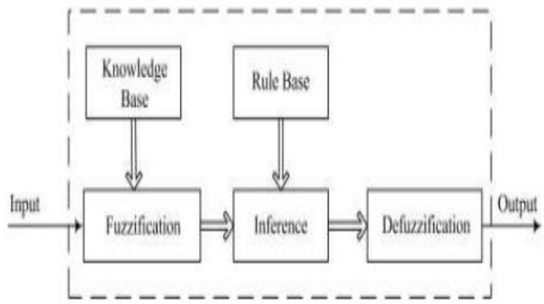


Fig 2.2 Schematic representation of Fuzzy logic controller

FLC has been widely used in systems with complex structure because it doesn't need mathematical model of controlled system. Figure 2.2 shows schematic representation of FLC. As shown in Figure 2.2, FLC consists of five main parts. These are fuzzification, knowledge base, rule base, inference and defuzzification.

In fuzzification part, crisp values of input are converted into fuzzy values, so that these values are compatible with the fuzzy set representation in the rule base. The choice of fuzzification strategy is dependent on the interference engine. The knowledge base consists of a database of the plant. It provides all the necessary definitions for the fuzzification process. Rule base is essentially the control strategy of the system. It is usually obtained from expert knowledge or heuristic as a set of IF-THEN rules.

The rules are based on the fuzzy inference. Inference called fuzzy model applies fuzzy reason to rule base to obtain a proper output. Mamdani and Takagi-Sugeno fuzzy systems are the most commonly used fuzzy inference mechanisms.

Mamdani is suitable for the systems with slow-changing dynamic while Takagi-Sugeno is suitable for the systems with fastchanging dynamic. Results obtained from fuzzy process are converted into crisp values by using any defuzzification method such as maxima methods and centre of area.

The structure of the Fuzzy-PI controller is shown Figure 2.3. It has two inputs and one output.

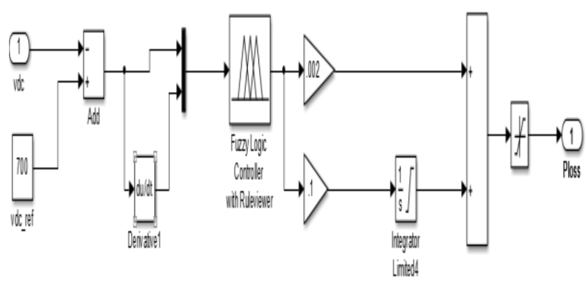


Fig 2.3 Structure of Fuzzy-PI controller

In this study, normalized triangular membership functions are preferred for input variables and output variable as shown in Fig 2.3. Rule base for Fuzzy-PI controller consists of 25 rules and shown in Table 2.1.

  

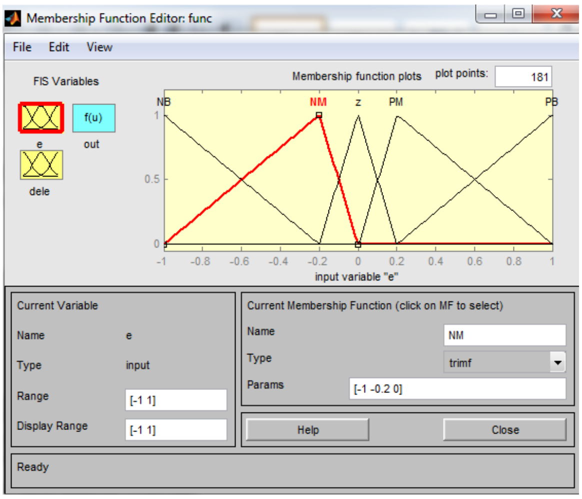


Fig 2.4 Membership function for input 1 for fuzzy logic

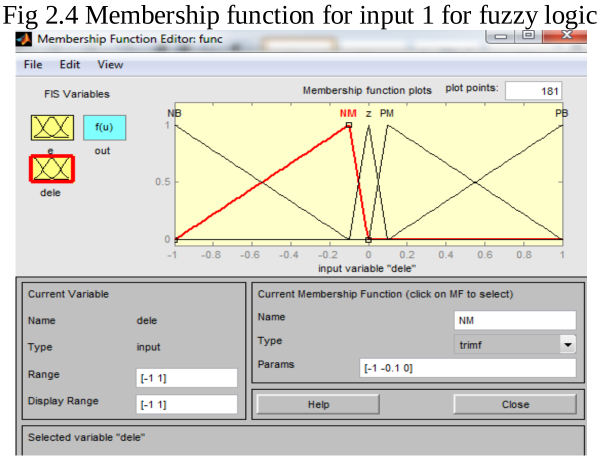


Fig 2.5 Membership function for input 2 for fuzzy logic

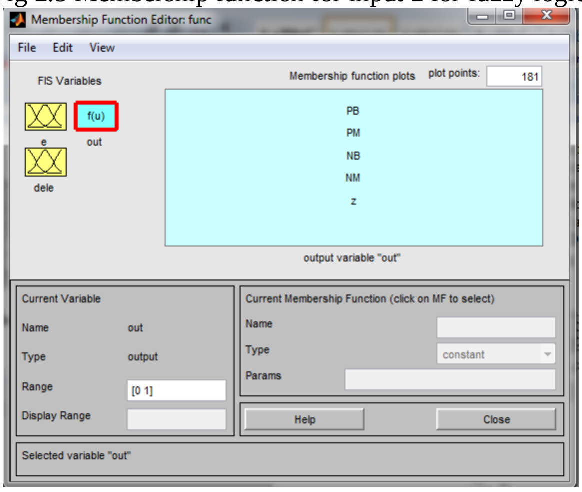


Fig 2.6 Membership function for output for fuzzy logic

| $e/delay$ | NB | NM | Z | PM | PB |
|---|---|---|---|---|---|
| NB | NB | NB | NB | NM | Z |
| NM | NB | NB | NM | Z | PM |
| Z | NB | NM | Z | PM | PB |
| PM | NM | Z | PM | PB | PB |
| PB | Z | PM | PB | PB | PB |

Table 2.1 Rule base for Fuzzy PI controller

*2.3 Neuro-Fuzzy controller*

Artificial Neural Networks are relatively crude electronic models based on the neural structure of the brain. The brain basically learns from experience. It is natural proof that is beyond the scope of current computers are indeed solvable by small energy efficient packages. This brain modeling also promises a less technical way to develop machine solutions. Now, advance in biological research promise an initial understanding of the natural thinking mechanism. This research shows that brain stores information, as patterns. Some of these patterns are very complicated and allow us the ability to recognize individual faces from any different angles. This process of storing information as patterns, utilizing those patterns, and then solving problems encompasses a new field in computing. A one-layer network with R input elements and S neurons follow. In this network, each element of the input vector p is connected to each neuron input through the weight matrix W. The ith neuron has a summer that gathers its weighted inputs and bias to form its own scalar output n(i). The various n(i) taken together form an S-element net input vector n.

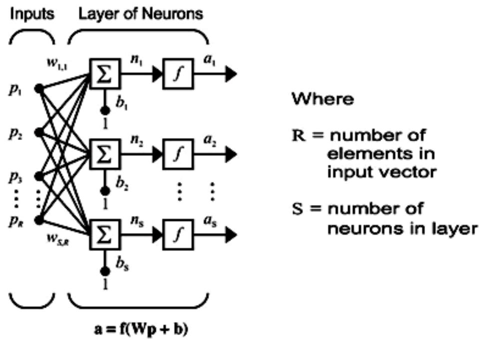


Fig 2.7 Single layer neural network

The structure of the Neuro-Fuzzy controller is shown Figure 2.7.

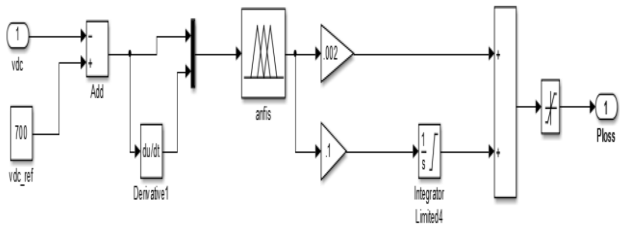


Fig 2.8 Neuro-Fuzzy controller

## III. VOLTAGE SAG

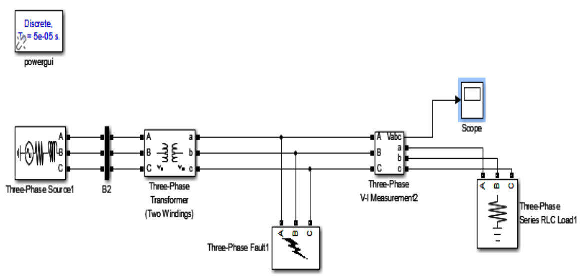


Fig-3.1 Voltage Sag

  

Here 3-phase 220kv source is used in this system this supply is fed to step down transformer. The rating is 100MVA, 220KV/ 11KV. This power is given to the load and in this system three phase fault is joint into the system so voltage sag is generate into the result. In this result voltage sag is generate between 0.3 to 0.4 sec.

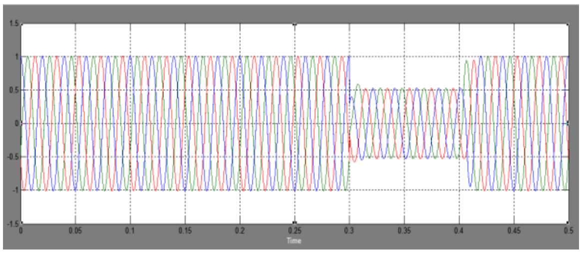

Fig-3.2 Voltage Sag

Further to mitigate this issue PI based UPQC is used as shown as below Fig 3.3. Output of Fig 3.3 is shown in Fig 3.4.

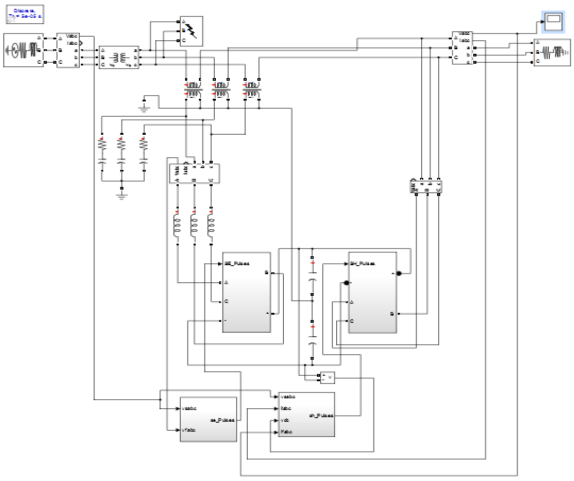

Fig 3.3- PI based UPQC

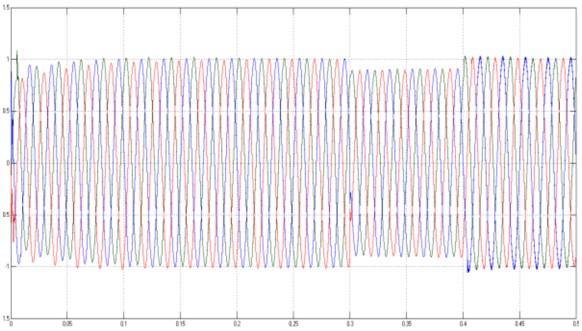

Fig-3.4 PI based UPQC output for voltage sag

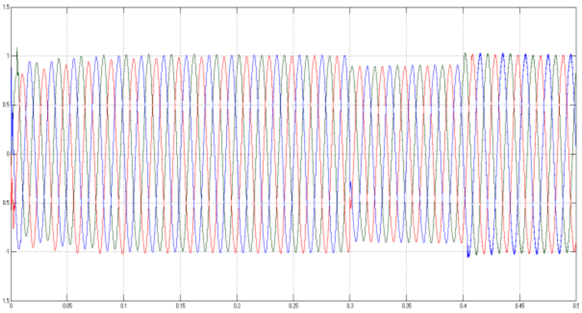

Fig-3.5 Fuzzy based UPQC output for voltage sag

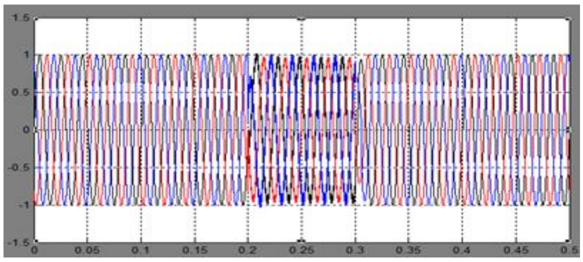

Fig-3.6 Neuro-Fuzzy based UPQC output for Voltage sag

## IV. VOLTAGE SWELLS

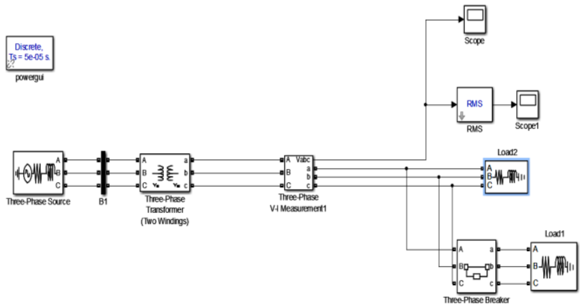


Fig-4.1 Voltage Swell

Here 3-phase 220kv source is used in this system this supply is fed to step down transformer. The rating is 100MVA, 220KV/ 11KV.This power is given to the load and in this system three phase breaker is joint into the system so voltage swell is generate into the result.

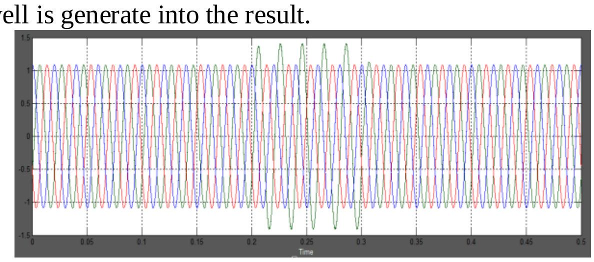

Fig-4.2 Voltage Swell

Further to mitigate this issue PI based UPQC is used as shown as below Fig 4.3. Output of Fig 4.3 is shown in Fig 4.4.

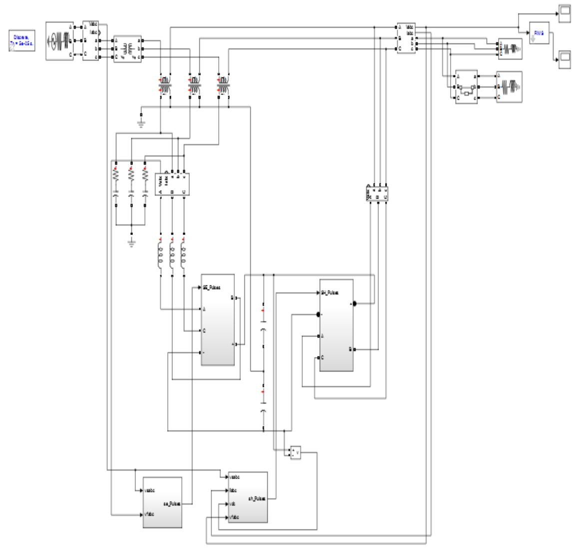

Fig-4.3 Voltage Swell

  

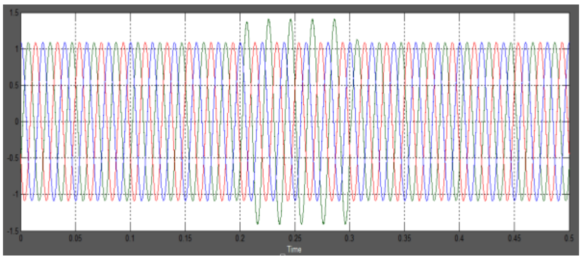
Fig-4.4 PI based UPQC output for voltage swell

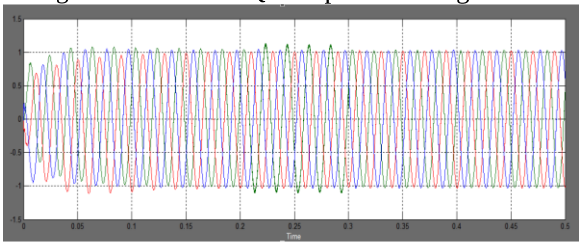
Fig-4.5 Fuzzy based UPQC output for voltage swell

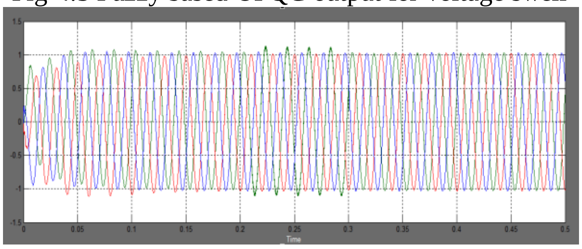
Fig- 4.6 Neuro Fuzzy Based UPQC for voltage swell

## V. CONCLUSION

Using UPQC we should reduce both series and shunt power quality problem in this paper we should studied out how to solve that power quality problems like voltage Sag and Voltage Swell. PI based UPQC is capable for the remove issue like voltage sag and swell. Further voltage sag and swell is also mitigated by Fuzzy based UPQC. Here fuzzy logic controller has Mainer advantage than PI controller. The advantages are response of fuzzy logic controller is fast. Also Neuro Fuzzy is best controller compare to PI and Fuzzy Logic controller advantages of Neuro Fuzzy controller are,
Learning capacity
Generalization Capacity
Robustness in relation to disturbances.
Response time is faster.

| Voltage sag | With PI Improvement | With PI-Fuzzy Improvement | With Neuro Fuzzy Improvement |
|---|---|---|---|
| 0.6 | 0.85 | 0.912 | 0.95 |

| Voltage swell | With PI Improvement | With PI-Fuzzy Improvement | With Neuro Fuzzy Improvement |
|---|---|---|---|
| 1.4 | 1.21 | 1.115 | 1.04 |

Acknowledgment
It is a privilege for me to have been associated with Asst. Prof. Dharmishtha makwana, Electrical Engineering Department, K.I.R.C.-Kalol, during this paper work. She always gives me a valuable suggestions and ideas for this work. It is with great pleasure that we express our deep sense of gratitude to her for her valuable guidance and constant encouragement throughout this work.

## REFERENCES

[1] B.Gopal, Pannala Krishna Murthy and G.N. Sreenivas “A Review on UPQC for power Quality Improvement in Distribution System” Global Journal Of Researches In Engineering volume 13 issue 7 versions 1.0 year 2013.
[2] Swapnil. Y. Kamble and Madhukar.M. Waware “Unified Power Quality Conditioner for Power Quality Improvement With Advanced Control Strategy “ ISSN 978-1-4673-5090-7/13,IEEE Press year 2013.
[3] Yash Pal, A. Swarup , Senior member IEEE and Bhim Singh Senior Member IEEE “Performance of UPQC for Power Quality Improvement” ISSSN: 978-1-4244-7781-4/10 IEEE Press Year 2010.
[4] MR. Shaktisinh N. Gohil and Prof M.V. Makwana “ A Comparative Analysis of UPQC for Power Quality Improvement” ISSSN:0975-6736 Nov To Oct 2013 Volume-02, Issue-02.
[5] K.S.Srikanth, Krishna Mohan and P Vishnuvardhan “Improvement of Power Quality For Microgride using Fuzzy based UPQC Controller” by IEEE press Year 2015.
[6] K. R. Suja and I. Jacob Raglend “ Fuzzy Based UPQC for Power Quality Improvement” ICCPCT-2013 978-1-4673-4922-2/ 2013 IEEE Press
[7] K.S.Ravi Kumar and S.V.A.R Sastry “ Application of PI, Fuzzy Logic and ANN in Improvement of Power Quality using UPQC” Chennai and Dr.MGR University Second International Conference on Sustainable Energy and Intelligent System (SEISCON 2011) july 20-22,2011 pp-316to319.
[8] RVD Rama Rao and Dr. Subhransu Sekhar.Dash “power Quality Enhancement by Unified Power Quality Conditioner Using ANN with Hysteresis Control” International Journal of Computer Application volume 6- No 1 september 2010
[9] A.Kazemi, R. Rezaaeipour “Introducing a New Method for UPQC Control to Solve the Power Quality Problems” 978-1-4244-1718-6/08 IEEE press 2008
[10] Anu Shukla “Application of PI, Fuzzy Logic and ANN for Improvement of Power Quality Using UPQC” Transactions on Engineering and Sciences ISSN: 2347-1964 Online 2347-1875 Print Vol. 2, Issue 7, July 2014

  