Generalized UPQC System with an Improved Control Method under Distorted and Unbalanced Load Conditions

Shraddha Bele[1], Pratik Ghutke[2]

[1]PG Student, Department of Electrical Engineering, TGPCET, Nagpur, Maharashtra, India
[2]Asst. Professor, Department of Electrical Engineering, TGPCET, Nagpur, Maharashtra, India

---***---

Abstract - *Whenever we consider unified power quality conditioner [UPQC], we ae to consider two things (1) voltage sag, (2) voltage swell on the power network. The power remains an important factor while considering its application. The important factor that provides poor power factor are harmonic current, supply voltage variations etc. here in our project we will be using UPQC which will diminish voltage and current related power quality problems. It also improves the harmonics ad correct the power factor of the load. The UPQC is designed by using MATLAB/SIMULINK based simulation for the working of the UPQC.*

***Key Words*: UPQC, power factor, voltage sag and voltage swell.**

1. INTRODUCTION

In today's era, due to many fluctuations in the transmission and distribution lines, power quality remains an important factor with respect to greater need of electrical engineering. In addition to this, load characteristics are becoming very sensitive to the voltage supplied to them. The power electronic devices have been used to overcome the major problems.

Before long time ago, conventional methods have been used to overcome the power quality problems but due to the increased demand in the load Characteristics it was merely possible to transmit the power without distortion. Thus, giving rise to modern concept that deals with load current and voltage fluctuations in the power quality. UPQC is the combination of series and shunt APF (active power filter), with a combination of dc capacitor link. The main objective of the shunt APF is to compensate the load reactive power and to eliminate the harmonic supply current. It uses a pair of 3-phase controllable bridges to produce current that is injected in the transmission line using series transformer.

2. Structure of UPQC

A UPQC consists of a superiority level of electronic devices which can compensate the power Loss. The distribution is not always the same and is variable. It is not such so that consumers want reliable power but want excess power too. The main power quality problems are voltage sag, voltage swell, and harmonic distortion. The voltage sag is a brief decrease in the RMS line voltage of 10 to 90% of the normal line voltage; whereas the duration of sag is 0.5 to 1 min. The swell is the brief increase in the RMS voltage of 10-70% of the normal line voltage with a duration off 0.5 to 1 min. An interruption in the transmission line is defined as the normal reduction in the line voltage which occurs for 10% of the nominal value. Voltage fluctuations are normally very small (less than 5%) but distort the power factor. The harmonic distortion originates in the non-linear characteristics of the devices connected to the load side of the power system. Thus higher quality power factor remains an issue for increasing demand of the consumers.

3. Basic design of UPQC

UPQC are the best compensating devices that are designed to ensure that the power meets all required standards and specifications. The UPQC is basically a power device that connects the series and shunt APF connected back to back on dc side sharing a common dc capacitor as shown in fig. 1.

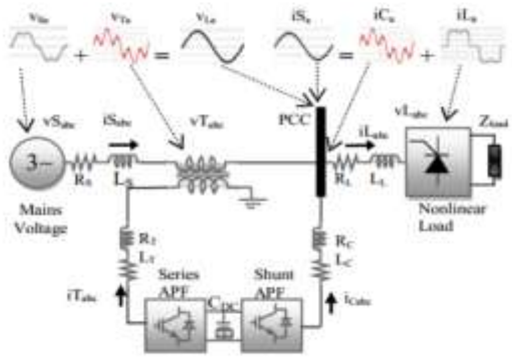

Fig - 1: Structure of UPQC

UPQC consists of two IGBT based VSC (voltage source converter) that are connected to the dc capacitor which consists of two filter banks. One of these two VSC is connected in series with the feeder and other is connected in parallel. The series converter/ compensator is operated in PWM (pulse width modulation) voltage control mode. When the supply voltage undergo sag then series converter injects suitable voltage with supply. The series filter suppresses and cancels the distortion of the voltage whereas shunt filter cancels the distortion of the current.

The main purpose of UPQC is to balance the unbalanced load and improve the power factor problem. The voltage injected by the UPQC to preserve the load end voltage, is taken from the dc link. These dual functionality of UPQC makes it more reliable that can solve any power quality problems and distortions, as we have taken fundamental frequency of 50 to 60 Hz. The harmonic distortions are sinusoidal voltage or current having frequency at which the supply system is to be designed.

4. Configuration of UPQC

The UPQC has been designed to mitigate the disturbances that occur due to critical. It is only the device which can handle both voltage and current simultaneously with respect to power quality problems. UPQC is capable of having steady state as well as dynamic series active and reactive power compensation at fundamental and harmonic frequency. It consist of various harmonics which can be eliminated with the help of active filters. Control of series converter is generally maintained by the PWM as the shunt converter is connected in parallel with the load. The gate pulses required for the converter are generated by the fundamental input reference signals.

4.1 System parameter

We have taken into consideration the various parameters depending upon the system quantities and the values.

Table -1:

System quantities	Values
Source	3-phase, 415v 50 Hz
Input RC load	Active power= 5MW Capacitor power= 2 MW
Output RL load	Active power= 1 GW Inductor power= 1 KW
Power factor	0.0039
Transformer 1	Y/Δ 25kv/600V
Transformer 2	Δ/Y 600/600 V
Shunt VSI parameter	Voltage=600V, Lsh=1mH, Csh=1mF
Series VSI parameter	Voltage=600V, Lse=1mH, Cse=1mF

By taking these values we have designed a MATLAB simulation and the performance of UPQC has been analyzed under different condition.

4.2 Proposed simulation model of UPQC

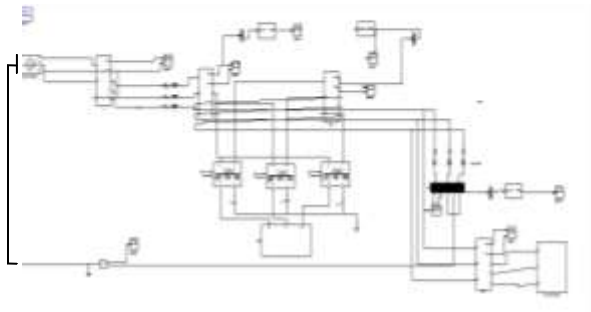

Fig - 2: Simulation model of UPQC

The simulation model sown in fig. 2 consists of one series and one shunt APF connected to each other and also contains capacitor and transformer for desirable voltage. The system is tested under different condition.

4.3 Model of UPQC

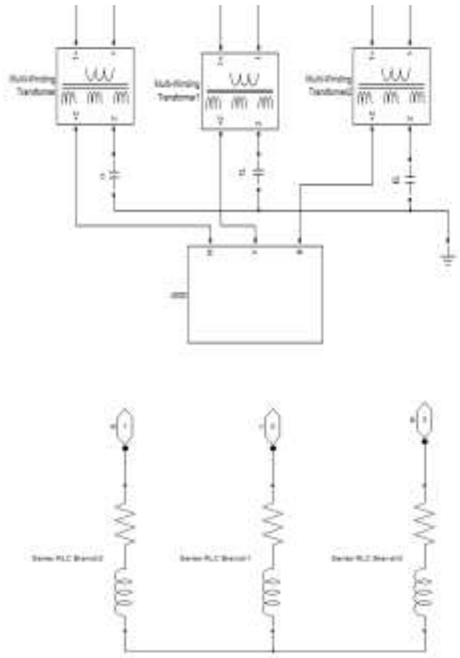

Fig - 3: Model of UPQC.

5. Results

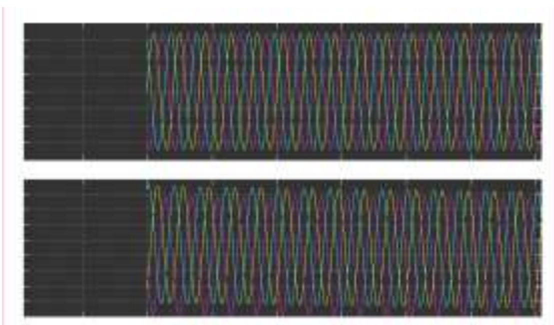

Fig. (i)

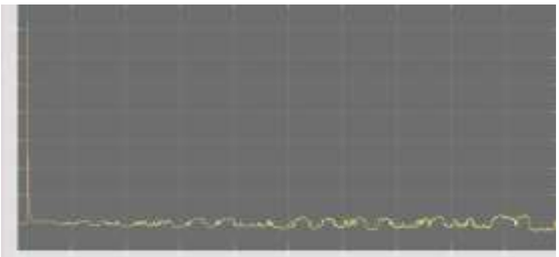

Fig. (ii)

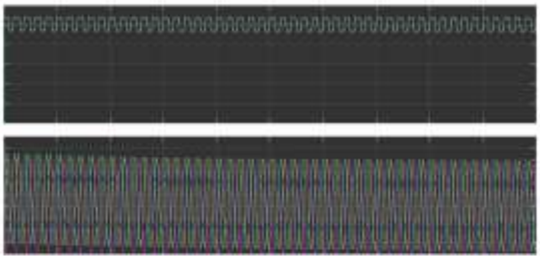

Fig. (iii)

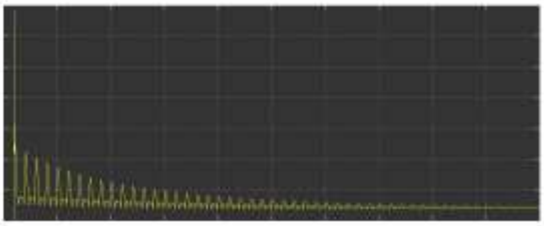

Fig. (iv)

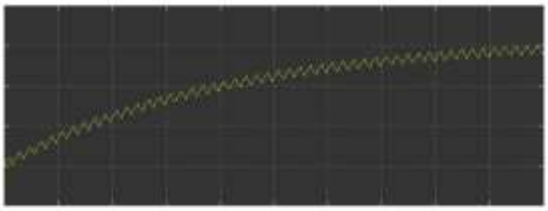

Fig. (v)

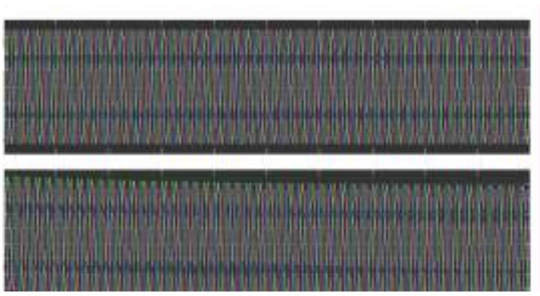

Fig. (vi)

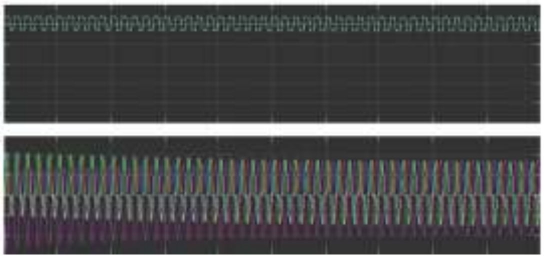

Fig. (vii)

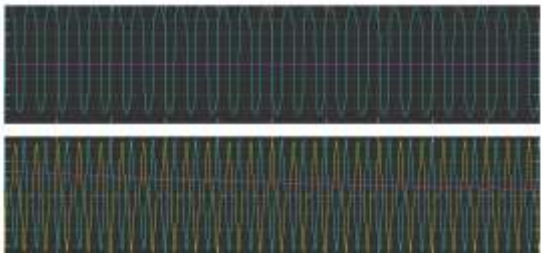

Fig. (viii)

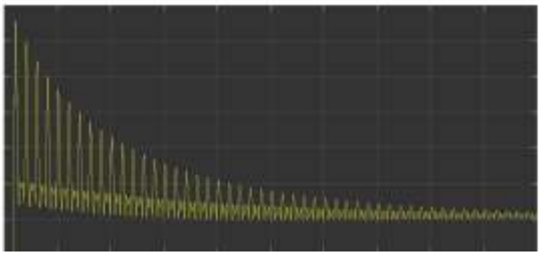

Fig. (ix)

6. CONCLUSION

In this paper, we have provided a quality approach method for designing and removing the distortion of the load side. This paper deals with the effective strategy of the use of UPQC for power quality improvements and implementation of flexible control strategy to enhance the criteria of UPQC. In order to protect critical load from voltage distortion, UPQC is suitable and satisfactory.

REFERENCES

1) Nikita Hari, K.Vijayakumar and Subhranshu Sekhar Dash, "A Versatile Control Scheme for UPQC for Power Quality Improvement", Proceedings of the International Conference on Emerging Trends in Electrical and Computer Technology (ICETECT), pp 453-458, 23-24 March 2011.

2) Srinivas Bhaskar Karanki, Mahesh K. Mishra and B. Kalyan Kumar, "Comparison of Various Voltage Source Inverter based UPQC Topologies", Proceedings of the International Conference on Power and Energy Systems (ICPS), pp 1-7, December 2011.

3) Vinod Khadkikar, "Enhancing Electric Power Quality Using UPQC: A Comprehensive Overview", IEEE Transactions on Power Electronics, Vol. 27, No. 5, pp 2284-2297, May 2012.

4) Malabika Basu, S. P. Das and Gopal K. Dubey, "Performance Study of UPQC-Q for Load Compensation and Voltage Sag Mitigation", Proceedings of the IEEE 28th Annual Conference of the Industrial Electronics Society (IECON 02), Vol. 1, pp 698-703, November, 2002.

5) V. Khadkikar, A. Chandra, A. O. Barry and T. D. Nguyen, "Application of UPQC to Protect a Sensitive Load on a Polluted Distribution Network", IEEE Power Engineering Society General Meeting, 2006.

6) A.Jeraldine Viji and M.Sudhakaran, "Generalized UPQC system with an improved Control Method under Distorted and Unbalanced Load Conditions", Proceedings of the International Conference on Computing, Electronics and Electrical Technologies (ICCEET), pp 193-197, 2012

7) Morris Brenna, Roberto Faranda and Enrico Tironi, "A New Proposal for Power Quality and Custom Power Improvement: OPEN UPQC", IEEE Transactions on Power Delivery, Vol. 24, No. 4, pp 2107-2116, October 2009.

8) Vinod Khadkikar and Ambrish Chandra, "A New Control Philosophy for a Unified Power Quality Conditioner (UPQC) to Coordinate Load-Reactive Power Demand Between Shunt and Series Inverters" IEEE Transactions On Power Delivery, Vol. 23, No. 4, October 2008.

9) V. Khadkikar,A. Chandra, A. O. Barry and T. D. Nguyen, "Application of UPQC to Protect a Sensitive Load on a Polluted Distribution Network", IEEE Power Engineering Society, General Meeting, 2006.

10) B. S. Mohammed, K. S. Rama Rao and P. A. Nallagownden, "Improvement of Power Quality of a Two Feeder System using Unified Power Quality Conditioner", Proceedings of the National Postgraduate Conference (NPC), pp 1-6, September 2011

11) K. Palanisamy, J Sukumar Mishra, I. Jacob Raglend and D. P. Kothari, "Instantaneous Power Theory Based Unified Power Quality Conditioner (UPQC)", 2010 Joint International Conference on Power Electronics, Drives and Energy Systems (PEDES), pp 1-5, 20-23 December 2010.

12) G. Siva Kumar, B. Kalyan Kumar and Mahesh K. Mishra, "Mitigation of Voltage Sags with Phase Jumps by UPQC with PSO-Based ANFIS", IEEE Transactions on Power Delivery, Vol. 26, No. 4, pp 2761-2773, October 2011.

13) V. Khadkikar, A. Chandra, A. 0. Barry and T. D. Nguyen, "Conceptual Study of Unified Power Quality Conditioner (UPQC)", Proceedings of the IEEE International Symposium on Industrial Electronics 2006, Canada, Vol. 2, pp 1088- 1093, July 2006.

14) Subramanian Muthu and Jonathan M. Kim "Steady-State Operating Characteristics of Unified Active Power Filters", twelfth annual Applied Power Electronics Conference and Exposition (APEC), Vol. 1, pp 199 – 205, February 1997.