Design of UPQC for the Improvement of Power Quality

K.N.Kasat M.S.Ali M.D.Bobade

***Abstract*— Today, Power quality is the major concerns in electricity industry. Power quality is an interaction of electrical power and electrical equipment. If electrical equipment operates correctly without any damage then we would say that the electrical power is of good quality. Because of conventional filters, power quality problems such as voltage sags, voltage swells, voltage flickers, harmonics, interruption etc cannot be eliminated. To eliminate these problems we have distribution static compensator, dynamic voltage restorer and unified power quality conditioner. So, nowadays power electronic based active power filter is used. The distribution static compensator, dynamic voltage restorer and unified power quality conditioner are used for improvement of power quality. UPQC combines a series active filter as well as a shunt active filter in back to back configuration. This device is modern solution that deals with load current and supply voltage imperfection.. The results are analyzed using MATLAB/Simulink software.**

Index Terms- power quality; UPQC; DSTATCOM; DVR

I. INTRODUCTION

POWER QUALITY

Power quality is the set of limits of electrical properties that allows electrical system to function in proper manner without significant loss of performance such as, the term custom power use for distribution system flexible ac transmission system [1].Power quality is an interaction of electrical power and electrical equipment. If electrical equipment operates correctly without any damage then we would say that the electrical power is of good qua Unified Power Quality Conditioner (UPQC), Distribution Static Synchronous Compensator (D-STATCOM) and Dynamic Voltage Restorer (DVR) etc. are many custom power devices. The devices are either connected in shunt or in series or a combination of both [1]. The APFs are of two types; the shunt APF and the series APF. To compensate current related problems, like load unbalance compensation, reactive power compensation, current harmonic filtering, etc. the shunt APFs are used[18]. To compensate voltage related problems, like voltage sag, voltage swell, distortion, harmonics etc [1-4]. In distribution system, Custom Power devices are a better solution for these Power Quality related issues[4].

As the power quality problems are originated from customer and utility side, the solutions should come

from customer and utility side and are named as customer based solutions and utility based solutions respectively. An examples for those two types of solutions are devices and Custom power devices. FACTS devices and Custom power devices are based on solid state power electronic components. Whereas, Custom power devices are maintained, operated and controlled by the customer itself and FACTS devices are those controlled by the utility [10,14].

II. POWER QUALITY PROBLEMS

The power quality problems are voltage sag, distortion, voltage swell, harmonics etc. But we have considered here voltage sag and voltage swell, because voltage sag and voltage sag and voltage swell are commonly used.

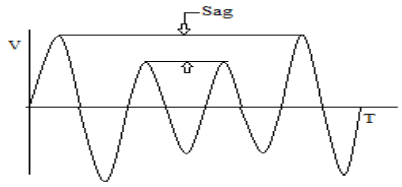
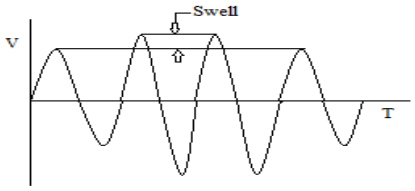


Figure1.Voltage sag



1)

Figure2.Voltage swell

III. UNIFIED POWER QUALITY CONDITIONER

UPQC consists of a four leg current controlled VSI used as a shunt active filter and a three leg voltage controlled VSI used as a series active filter. The dc link of both active filters is connected to a common dc capacitor.The series filter is connected between the supply and load terminals using three single phase transformers. The primary windings of these transformers are star connected and the secondary windings are connected in series with the three-phase supply.

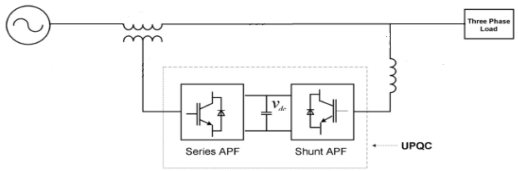


Figure3.Configuration of UPQC

A small capacity rated RC filter is connected across the secondary of each series transformer to eliminate the high switching ripple content in the series active filter injected voltage. In order to inject the voltage, these transformers are used to filter the switching ripple of the series active filter.Number of IGBT(Insulated Gate Bipolar Transistors) are used for the voltage source inverters for both the active filters. The four leg shunt active filter is connected through a small capacity rated inductive filter. This four leg VSI based shunt active filter is capable of suppressing the harmonic currents both in the neutral conductor of the unbalanced three phase, four wire electrical distribution system and in the three phases.

The aims of unified power quality conditioner (UPQC) are that, to integrate both shunt and series APFs through a common DC link capacitor. The UPQC and unified power flow controller (UPFC) both are similar in construction [3]. The unified power quality conditioner is used in a power distribution system whereas the UPFC is used in power transmission system. For controlling the flow of power at fundamental frequency is the primary UPFC objective. Also, the unbalance in distortion and voltage due to harmonics in addition to control of flow of power at the fundamental frequency is achieved by the UPQC controls [3]. The (UPQC) unified power quality conditioner is used for the elimination of the disturbances that critically affect the performance of the load in power system.

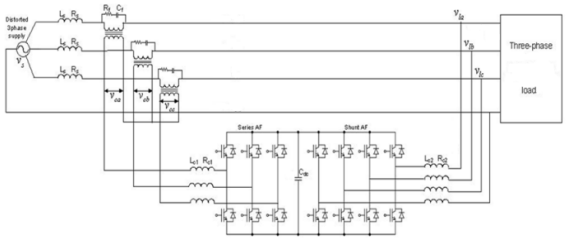


Figure4.Detailed configuration of UPQC

Application of each custom power device:

- D –STATCOM
  -Load current balancing
  -Power factor improvement
  -Current Harmonic compensation
  -Flicker effect compensation

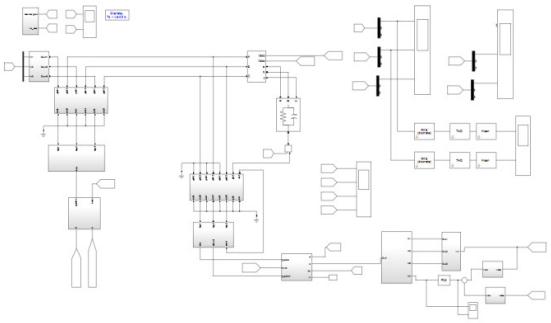
- DVR
  -Voltage balancing
  -Voltage regulation
  -Voltage sag and swell protection
  -Flicker attenuation
- UPQC
  -Voltage balancing
  -Voltage regulation
  -Flicker attenuation
  -Voltage sag and swell correction
  -VAR compensation
  -Harmonic suppression
  -Current balancing

IV. Related Work

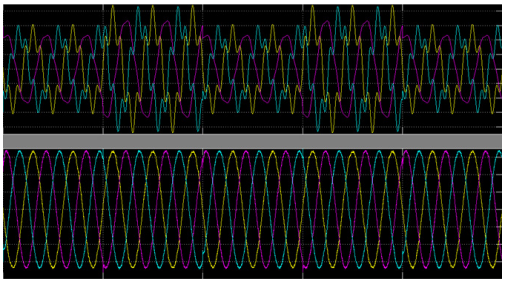
In this paper fuzzy logic controller (FLC) based UPQC for a 3 phase 4 wire distribution system is proposed[2].
The UPQC is able to compensate the unbalance in source voltage, load current[6]. Using the UPQC device the voltage sag and swell can be mitigated successfully In distribution system power Quality problem is a major issue. Out of the custom power devices UPQC is the most effective device for mitigating these issues[7]. This paper presents a review on the UPQC to improve the electric power quality at distribution level[12]. This paper proposes a novel reference signal generation method for the unified power quality conditioner UPQC adopted to compensate current and voltage-quality problems of sensitive loads[15]. Different aspects of UPQC and up to date developments in this area of research have been briefly addressed[14]. The UPQC is studied and its advantages over conventional APFs and UPQC are discussed[11]. In this paper a new control algorithm for the UPQC system is optimized[5]. In this paper, the ANN-based controller is designed for the current control of the shunt active power filter. Performance using the conventional PI controller is not satisfactory especially with respect to transient conditions[13]. The discharging time of DC link capacitor is very high, and so it is the main problem in UPQC device. To eliminate this problem, an enhanced neuro-fuzzy controller (NFC) based UPQC is proposed in this paper[10]. In this paper, a new unified power-quality conditioning system (MC-UPQC), capable of simultaneous compensation for voltage and current in multibus systems[8]. A unified power quality controller (UPQC) using a aritifical neural network (ANN) has been proposed[3].In this paper, the ANN-based controller is designed and the performances of ANN and PI controller are studied[9]. The main concern in this paper is to introduce a new concept of UPQC for mitigating different power system problems[4]. Neural network based controller have great advantage of flexibility[1].

V. Simulation Results And Discussions

From the simulation model, It is clear that we have disturbed supply which is connected to UPQC where UPQC involves series active power filter and shunt active power filter. Series and shunt APF consists of inverter and hysteresis controller. Whereas hysteresis controller has two control schemes ie control scheme for series active filter and shunt active filter.



From the graph shown below, We came to know that input is disturb. Disturb means there is voltage sag, voltage swell in the waveform. And in the output we have sine wave. This shows the difference between input and output.



VI. CONCLUSION

This work is related to the study of power quality problems and UPQC. This study provide useful information regarding the behavior of UPQC used for improvement of power quality. From this we conclude that among custom power device UPQC is the most effective device as well as it compensates both voltage related problems and current related problems. The model of UPQC is designed. The developed graphic facilities available in MATLAB/Simulink were used. From this, it is clear thatby using UPQC we can improve the power quality.Proposed model of UPQC is to compensate load side and also source side problems.

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