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REVIEW ON POWER QUALITY IMPROVEMENT BY USING UPQC

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ABSTRACT:

Today with increase in demand of electricity it is essential to have a good quality of power. As most of the load and power electronics equipment are nonlinear in nature many power quality problems like voltage sag ,voltage swell ,Harmonics, Voltage fluctuation, Flicker, gets introduced in System. UPQC(Unified Power Quality Conditioner)is one of the compensating device which consist of Shunt& Series Active Power Filter Cascaded with dc link capacitor. This paper present review of UPQC to enhance Quality of Power at distribution level Along with overview of different types of UPQC.

INTRODUCTION:

Nowadays, use of electronic and power electronics equipment such as thyristor, IGBT, power converter has been increasing tremendously. As power electronics equipments are nonlinear in nature. So with the increase in use of nonlinear load in power system, power quality problems voltage & current related problem arises in system. These problems are solved by LC passive filters. However, these kinds of filters are unable to solve waveforms related problems. Active filters are able to solve this problem, but its cost is high, and difficult to implement in bulk scale. Also, their lower efficiency is low.

UPQC is the compensating device in power distribution network. The UPQC belongs to APF family where shunt and series APF are integrated together to achieve better-quality control on several power quality problems simultaneously. The UPQC consist of arrangement of series and shunt active filters connected by DC link capacitor. The main aim of a UPQC is to compensate for voltage and current related problems.

In this paper, UPQC is used to resolve power quality problems. The series and shunt active power filters of UPQC operate as a voltage and current source converters which are controlled by the PWM signals which are generated by the controllers.

POWER QUALITY:

A constant amplitude and one constant frequency sinusoidal signal is considered as desirable and ideal current or voltage signal. Quality of voltage taken from the utility or that distributed to the end user is referred as voltage or current quality. The fluctuation of voltage, current and frequency from its most favorable worth that may prevent mal-function of the equipment can be considered as power quality problem.

Power quality can have various different meanings and significances. In the view of manufacturer, power quality can be described as the way in which there should be no voltage variety and no noise generation in the system of grounding. In view of utility designer, it can be considered as voltage availability. Whereas for the end users power quality can be considered as the feasibility of utilizing the accessible power for operation of various types of loads. Distribution system is worst affected because of the power quality problems. Power quality becomes poor at the position where loads are connected with the distribution system. So here we'll try to upgrade the quality of power of the distribution system.

POWER QUALITY PROBLEMS:

Power quality problems generally observed in distribution network are as follows

I] SHORT DURATION VOLTAGE VARIATION

It's duration very less i.e. less than 1min.The cause for this are-large load energisation, fault conditions etc. Short duration voltage variation includes voltage sag, voltage swell and interruption.

a) VOLTAGE SWELL:

It is increased in the line-voltage (rms) to 1.1-1.8% of the nominal line-voltage for a small period of half cycle to 1 min. Main cause for this is Swells can be switch off a large load.

b) VOLTAGE SAG:

It is a decrease of line voltage (rms) to 10 to 90 % of the standard line-voltage for the period of half cycle to a min. It is also referred as "dip". The main cause for this voltage sag is starting of induction motors.

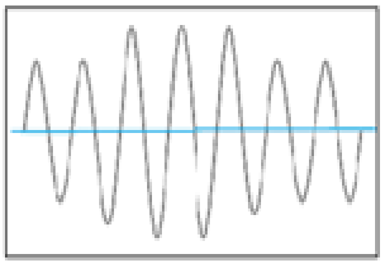

Fig.1 .Voltage Swell

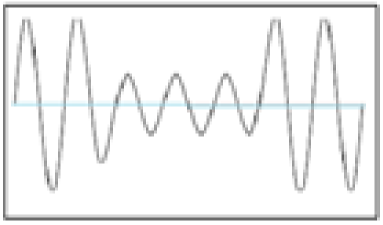

Fig. 2. Voltage Sag

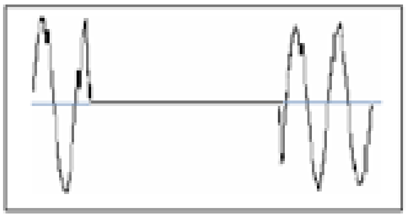

Fig.3.intruption

c) INTERRUPTION:

It is the reduction in current or line-voltage to a value which is less than 0.1 pu for a duration not more than 1 min. Main causes for this are failure of equipment, faults etc.

Complete loss of voltage or current for a time period. Interruptions is the result of power system faults, equipment failures, and control malfunction.

II . LONG-DURATION VOLTAGE VARIATION

a) UNDER VOLTAGE:

A reduction in the RMS ac voltage to a value less than even 90 %. Its span is little more than a min.

b) OVERVOLTAGE:

It's a rise in the RMS ac voltage to a value more than 110 %. Its san is also greater than a min. Main cause for this overvoltage are load switching.

C) SUSTAINED INTERRUPTION:

It is the situation when supply voltage is zero for a timeframe surpassing a minute.

III. VOLTAGE FLUCTUATIONS

It's a comparatively very small variation in the line voltage (rms).The variation is even less than 5%.The main culprits for this are arc furnaces, Cyclo-converters etc. This is also referred as "flicker".

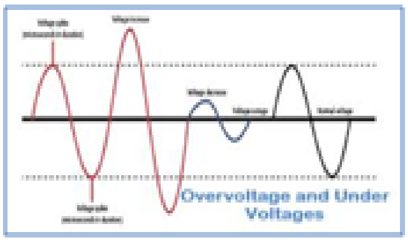

Fig.4. Overvoltage & Undervoltage

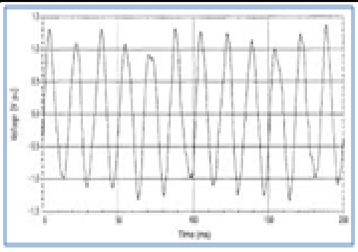

fig.5.Voltage fluctuation

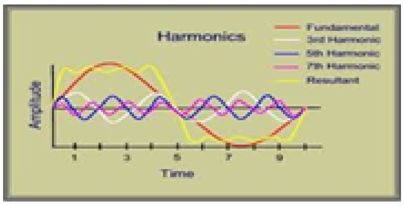

Fig.6.Harmonics

IV. TRANSIENTS:

a) IMPULSIVE TRANSIENT:

It is the unidirectional change in current or voltage on a power line. The main reasons for this are inductive load switching and lightning strikes.

Figure 1.2 Impulsive transient

b) OSCILLATORY TRANSIENT:

It's a bidirectional change in current, voltage on a power line. The cause for this is the switching of capacitors for power factor corrections.

Figure 1.3 Oscillatory transient 8

V. WAVEFORM DISTORTION:

HARMONICS:

While supplying of a nonlinear load from a supply voltage at the power frequency, thee nonlinear load draws currents at more than a particular frequency that finally leads to a distorted current waveform. These are current or voltage signals having frequencies in terms of integral multiples of fundamental frequency. Total harmonic voltage distortion (THD) is utilized for measurement of the harmonic present in any waveform

UPQC:

Now a days, solutions on power quality problems based on flexible ac transmission systems (FACTS) have increases. The use of FACTS concepts in distribution systems has resulted in a new generation of compensating devices. A unified power-quality conditioner (UPQC) belongs to one of these devices which is the modification of the unified power-flow controller (UPFC) concept at the distribution level.. The aim of a UPQC is to compensate for supply voltage power quality problems like, sags, swells, unbalance, flicker, harmonics, and for load current power quality problems, such as, current unbalance, reactive current, harmonics, and neutral current. Fig.7 shows a single-line diagram of the UPQC.

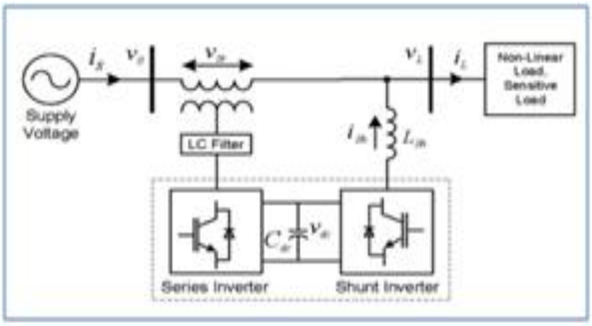

Fig.7.Single Line Diagram of UPQC

UPQC contains two inverters one connected parallel to the load and other connected in series with the line. Shunt Inverter act as a Shunt APF whereas Series inverter act as a Series APF.

A common dc link is formed by using a Capacitor. In Fig. 7, the dc link is obtained using a capacitor which interconnects the two inverters and also maintains a constant self supporting dc bus voltage across it. Coupling inductor Lsh is used for connecting the shunt inverter with network. It also helps in smoothing the current wave shape. Sometimes an isolation transformer is used to electrically isolate the inverter from the network.

An LC filter used as a passive low-pass active filter (LPF) which helps in removing high- frequency switching ripples on generated inverter output voltage. Series transformer is for connecting the series inverter with network. The integrated controller of the series APF and shunt APF of the UPQC is to provide the compensating voltage reference VC* and compensating current reference IC * to be evaluated by PWM converters. The shunt active power filter of the UPQC can compensate all undesirable current components, including harmonics, imbalances due to negative and zero sequence components at the fundamental frequency of supply system. In order to reduce the harmonics generated by a nonlinear load, the shunt inverter should insert a current as governed by the following equation:

IC(ωt)=I*L(ωt)-IS(ωt)…………….. (1)

Where IC(ωt), I*L(ωt), and IS(ωt) represent the shunt inverter current, reference load current, and actual source current, respectively.

The series active power filter of the UPQC can compensate the supply voltage related problems by injecting voltage in series with line to achieve distortion free voltage at the load terminal. The series inverter of the UPQC can be represented by following equation:

VC(ωt)=V*L(ωt)-VS(ωt) …………(2)

Where VC(ωt),V*L(ωt),and VS(ωt) represent the series inverter voltage, reference load voltage, and actual source voltage, respectively.

CONTROLLING OF UPQC:

I. CONTROL OBJECTIVES:

Following are the objective of UPQC. The shunt converter has the following objectives:

1) To counterbalance the source currents by inserting negative and zero sequence components required by the load.

2) To compensate the harmonic contenting the load current by injecting the required compensating Harmonic currents.

3) For controlling the power factor by inserting the required reactive current.

4) For regulating the DC bus voltage.

The series connected converter has the following control objectives

1) To Counterbalance the voltages at the load bus by injecting negative and zero sequence voltages to compensate for those present in the source.

2) To isolate the load bus from harmonics in the source voltages, by injecting the harmonic voltages.

3) For regulating the magnitude of the load bus voltage by injecting the required active and reactive components.

4) To control the power factor at the input of the UPQC.

II. CONTROL STRATEGIES:

The control strategy of UPQC is as follows

1. Sensing the Voltage & Current Signal & therefore obtaining compensating command.
2. PWM based Hysteresis or fuzzy logic control techniques are used for generating gate signal for switches of converter.
3. In first stage voltage and current signal are sensed by Voltage sensor or Power transformer & Current sensor or Current transformer. Next Stage is to derive compensative command. For compensating command two methods are used i) Frequency Domain Method ii) Time Domain Method

In frequency domain method FFT tool is used. But FFT has some drawbacks like large computation time, delay etc. So this method is not too popular.

In time-domain are based on instantaneous derivation of compensating commands in the form of either voltage or current signals. There are mainly two control techniques of UPQC which are: i) The instantaneous active and reactive power or p-q theory, & ii) Synchronous reference frame method or d-q theory. In p-q based theory instantaneous active and reactive powers are calculated, while, the d-q theory deals with the current independent of the supply voltage. Both methods transforms voltages and currents from abc frame to stationary reference frame (p-q theory) or synchronously rotating frame (d-q theory) to separate the fundamental and harmonic quantities. In third stage the gate signals for semiconducting switches of UPQC based on derive compensating commands in terms of voltage or current. Then, these compensating signals are given to PWM, hysteresis or fuzzy logic based control techniques.

CLASSIFICATION OF UPQC:

A .INVERTER BASED CLASSIFICATION:

i. VSI (voltage source Inverter)

ii. ii. CSI (current source Inverter)

B. SUPPLY SYSTEM BASED CLASSIFICATION:

Single -phase	Three-Phase
i) Two H-bridge (total 8 switches) ii)3-Leg topology (total 6 switches) iii) Half Bridge (total 4 switches)	i) Three-wire ii) Four- wire

C. CONFIGURATION BASED CLASSIFICATION:

i) UPQC-R (Right Shunt) ii) UPQC-L (Left Shunt) iii) UPQC-I (Interline) iv) UPQC-MC (Multi-Converter) v)) UPQC-MD (Modular) vi) UPQC-ML (Multilevel) vii) UPQC-D (Distributed) viii) UPQC-DG (Distributed Generator integrated).

Following Tables shows difference between different UPQCs

Sr. No	VSI Based UPQC	CSI Based UPQC
1	Voltage Source Inverter is used	Current Source Inverter is Used
2	Capacitor is Used to couple Series and shunt inverter	Inductor is Used to couple Series and shunt inverter
3	It is advantages in following manner low cost, small size, light weight etc.	It is advantages in following manner It gives high efficiency for low load ,power
4	It consist of following Disadvantages Low Efficiency ,Limited life time for capacitor	It has following Disadvantages like High cost large size high weight. Multilevel operation is not possible.

Sr.No	Single Phase UPQC	Three Phase UPQC
1	It Consist of single phase 2 wire systm	It may consist of three phase three wire or three phase four wire system
2	It can be further classified as i) Two H-bridge (total 8 switches) ii) 3-Leg topology (total 6 switches) iii) Half Bridge (total 4 switches)	It can be further classified as i) Four leg ii) Split capacitor iii) Three H Bridge
3	Current Unbalance is not problem in single phase UPQC so unbalance compensation is not required in single phase	Current Unbalance is one of the problems in three phase system. It require Unbalance System
4	Load current & harmonics are major problem in Single phase	Along with load current , harmonics neutral current is also major problem in three phase four wire UPQC

Sr.No	Interline UPQC	Multi converter UPQC
1	Two Inverter are connected in between two Distribution feeder	Along with two inverter third converter is added to support dc bus
2	It can control flow of power between only two feeder	It control flow of power between multi feeder
3	Here one Inverter in connected in series called series inverter other in parallel called as shunt inverter.	Third Inverter used here is either in series or in parallel

CONCLUSION:

Today Power Quality becomes an important concern in power system. To maintain power quality within acceptable range is a challenging task for power system engineer. UPQC plays an important role in improving quality of power at distribution side. UPQC deals with both voltage and current compensation along with power factor improvement. UPQC Compensate voltage quality problem like voltage sag, Swell, Unbalance, Flicker, Harmonics. It also compensate Current quality problem like harmonics, unbalance, reactive current and neutral current. So with the help of UPQC we can improve power quality and hence can reduce losses in power system.

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