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Study of Unified Power Quality Conditioner for Power Quality Improvement

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Abstract: ***These In a powers system network there are many problems related to power quality. So to improve power quality of a system we use different devices such as active power filters. Active power filters are classified into two types that is Shunt Active Power Filter (APF) and Series Active Power Filter (APF) and combination of both is known as UPQC (Unified Power Quality Conditioner). Here we have done simulation of Shunt Active Power Filter, Series Active Power Filter and Unified Power Quality Conditioner. Shunt APF is used to mitigate the problems due to current harmonics which is because of non-linear load and make source current sinusoidal and distortion free. The control scheme used is hysteresis current controller using "p-q theory". Series APF is used to mitigate problems caused due to voltage distortion and unbalance present in source voltage and make load voltage perfectly balanced and regulated. The control scheme used is Hysteresis voltage controller by using a-b-c to d-q transformations. Then Shunt APF and Series APF is combined for designing UPQC and by this current harmonics in load current and voltage unbalances in source voltage both are removed and source current becomes sinusoidal and load voltage becomes perfectly balanced.***

Keywords: UPQC, Active Power Filter, Harmonics.

1. Introduction

Due to power electronics devices there is serious effect on quality and continuousness of electric supply. Because of power electronics devices there is uninterrupted power supply, flicker, harmonics, voltage fluctuations e.tc. There is also PQ problems such as voltage rise/dip due to network faults, lightning, switching of capacitor banks. With the excessive uses of non-linear load (computer, lasers, printers, rectifiers) there is reactive power disturbances and harmonics in power distribution system. It is very essential to overcome this type of problems as its effect may increase in future and cause adverse effect.

In today's world there is great importance of electrical energy as it is the most famous from of energy and all are massively relying on it. Without supply of electricity life cannot be imagined. At the same time the quality and continuousness of the electric power supplied is also very important for the efficient functioning of the end user equipment. Many of the commercial and industrial loads require high quality undisturbed and constant power. Thus maintaining the qualitative power is topmost important in today's world.

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Traditionally passive filters were used for reactive power disturbances and harmonics generation but there is many problems with them like they are large in size, resonance problem, effect of source impedance on performance.

Active Power Filters are used for power quality enhancement. Active power filters can be classified according to system configuration. Active power filters are of two types series and shunt. Combining both series APF & shunt APF we get a device known as UPQC. UPQC eliminates the voltage and current based distortions together.

A Shunt APF eliminates all kind of current problems like current harmonic compensation, reactive power compensation, power factor enhancement. A Series APF compensates voltage dip/rise so that voltage at load side is perfectly regulated. The Shunt APF is connected in parallel with transmission line and series APF is connected in series with transmission line. UPQC is formed by combining both series APF and shunt APF connected back to back on DC side.

In this controlling techniques used is hysteresis band controller using "p-q theory" for shunt APF and hysteresis band controller using Park's transformation or dq0 transformation for series APF. UPQC is made by combining both shunt APF and series APF. UPQC is used to eliminate all problems due to current harmonics and voltage unbalances & distortions and improve power quality of a system. UPQC is a very versatile device as at same time it mitigates the problem both 3

due to current and voltage harmonics. In this thesis power quality of system was improved by using UPQC. First simulation of shunt APF was done after that series APF was done. And after that combining both device simulation of UPQC was done.

2. UPQC

Basically UPQC (Unified Power Quality conditioner) is a equipment which is used for compensate for voltage distortion and voltage unbalance in a power system so that the voltage at load side is completely balance and sinusoidal & perfectly regulated and also it is used to compensate for load current harmonics so that the current at the source side is perfectly

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sinusoidal and free from distortions and harmonics. UPQC is a combination of a Shunt Active power filter and Series Active power filter. Here Shunt Active power filter (APF) is used to compensate for load current harmonics and make the source current completely sinusoidal and free from harmonics and distortions.

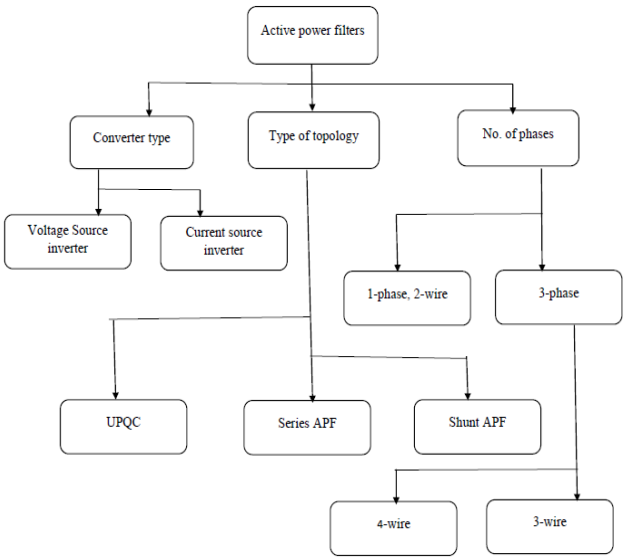

Fig 2.1 Active power filter classification

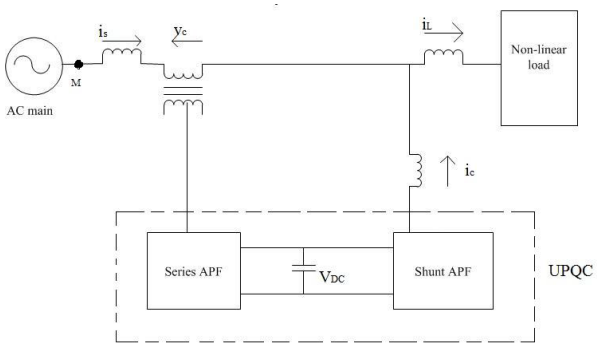

Fig 2.2 Operation of UPQC

3 Basic configuration of UPQC

3.1 Series APF:- In a transmission line series APF is generally connected in series. It is connected to the transmission line with the transformer. Series APF is a voltage source inverter connected in series with transmission line. It is used to compensate or mitigate the problems which comes due to voltage distortions and voltage unbalances. The series APF injects a compensating voltage so that load voltage will be perfectly balanced and regulated. Controlling of series inverter is done by PWM (pulse width modulation) techniques. Here we used Hysteresis band PWM techniques as it implementation is easy. Also its response is fast. Its details are explained in subsequent sections.

3.2 Shunt APF: - In a transmission line shunt APF is generally connected in parallel. Shunt APF is used to compensate for distortions & harmonics which are produced due to current. Due to non- linear load there is harmonics in load current, so to keep source current completely sinusoidal and distortion free we uses Shunt APF. Shunt APF injects compensating current so that the source current is completely sinusoidal and free from distortions. Controlling of Shunt APF is done by hysteresis band PWM techniques. In hysteresis band PWM techniques output current follows the reference and current and is within the fixed hysteresis band.

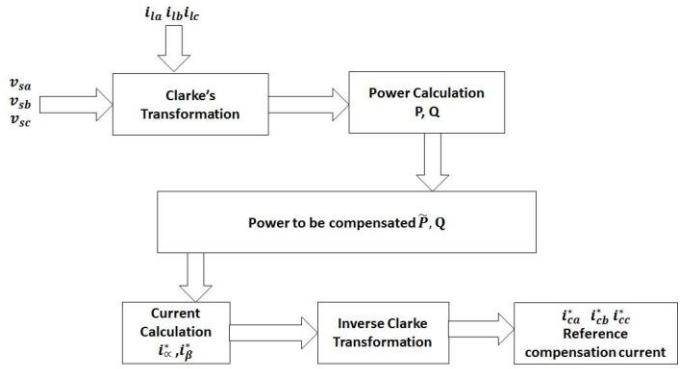

Fig 3.2 Flow chart of Shunt APF control technique

4 Simulation Result:

Current harmonic compensation and voltage sag mitigation

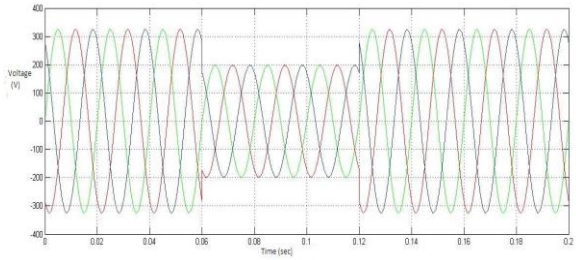

Fig 4.1 Source voltage during sag of UPQC

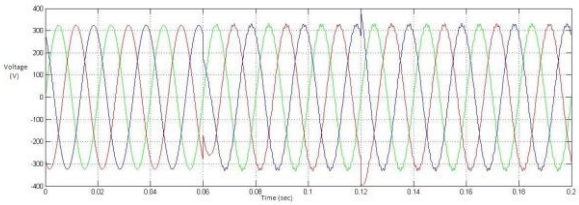

Fig 4.2 Load voltage during sag after application of UPQC

4.1 Current Harmonics compensation and voltage swell mitigation

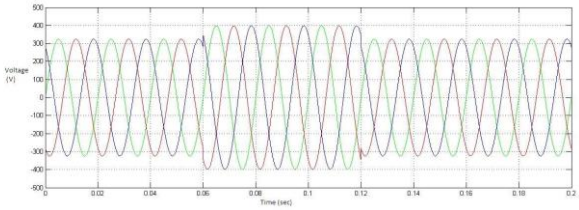

Fig 4.1.1 Source voltage of UPQC during swell

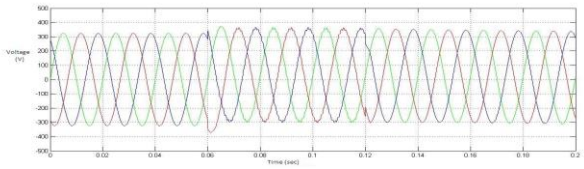

Fig 4.1.2 Load voltage of UPQC during swell

Conclusion :

Unified quality conditioner was studied and investigated in this thesis for power quality enrichement. UPQC is a type of advance hybrid filter which uses series APF for removal of voltage realted problmes like voltage dip/rise, fluctutaion, imbalance and shunt APF for removal of harmonics in current harmonics.What type of problems are there in power quality was studied and discussed. UPQC system is developed and discussed in detail.

The simulink models of Shunt APF , Series APF, UPQC are developed.

Shunt APF model is developed using "p-q Theory" and control techniques used here is hystersis current controller. The simulation is done and current harmonics are eliminated and current drawn from source is completely sinusoidal. The THD of source current is within the limit that is 5%.

Series APF model is developed using Park's transformation and controlling techniques used are hystersis voltage controller. The simulation is done and source voltage dip/rise are mitigated and load voltage is made comletely balanced.

UPQC model was developed by joining Shunt APF and series APF back to back using DC capacitor. The controlling techniques used here are hystersis band controller. The simuation is done and current harmonics are removed and source current is complerely sinusoidal. And the voltage dip/rise in supply side is mitigated and load voltage is perfectly balanced. The THD of source current is within the limit that is lees than 5%.

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