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Enhancement of Power Quality Using UPQC

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ABSTRACT:Power quality issue is one of the major challenges of power system some power quality issues including electrical harmonics, poor power factor, voltage instability and imbalance are the impact on the efficiency So to improve the power quality the present system is provided with active filter and semiconductor devices. The grater switching frequency as well as non linearity in the characteristic of power electronics equipment is mostly for the power quality issue. In order to overcome this issue active filter are implemented .With rapid development of power system various power conditioner are invented to maintain the good quality of power .This paper provides one of the recent invention of power quality conditioner called Unified Power Quality Conditioner (UPQC). It is an multi functioning device that compensates various voltage disturbances of the power supply, reduce the voltage fluctuations and prevent the harmonic load current from entering into the power system This conditioner consists of two active power filter called by shunt and series this two filter together operated with their control signals used to maintain the power quality in an excellent way. Shunt active filter is used for the load current, harmonics issue and for reactive power compensating and Series active filter is used for voltage compensation. There are many control techniques are used for the operation of UPQC but the most excellent technique is Instantaneous reactive power theory (α-β). Instantaneous reactive power theory which extract power line data such as voltage, current etc in the form of abc parameter and converted into α-β parameters based on these calculation the required the reference current and voltage signals are generated and these generated pulse are provided through Hysteresis current controller and PI controller. A sperate DC source is provided with back to back connection of active power filter of the UPQC in order to supply the active and reactive power based on the operation of active power filters. UPQC implementation is quite simple and efficient to improve the power quality. In this work the simulation has been worked and harmonic compensation results were analysed.

KEYWORDS: Power Quality, Clerks Transformation, Total Harmonic Distrotion,Unified Power Quality Conditioner, Voltage source inveter, Voltage source conveter

I.INTRODUCTION

Power quality is one of the major challenges of grid [1]. The term electric power quality (PQ) is generally used to assess and to maintain the good quality of puissance at the caliber of generation, transmission, distribution, and utilization of AC electrical potency. Since the pollution of electric power supply systems is much astringent at the utilization level, it is paramount to study at the terminals of end users in distribution systems. There are a number of reasons for the pollution of the AC supply systems, including natural ones such as lightening, flashover, equipment failure, and faults (around 60%) and coerced ones such as voltage distortions and notches (about 40%). A number of customer's equipment additionally pollute the supply system as they draw non sinusoidal current and comport as nonlinear loads. Ergo power quality is quantified terms of voltage, current or frequency deviation of the supply system, which may result in failure or mal-operation of customer's equipment. Typically, some power quality quandaries cognate to the voltage at the point of prevalent coupling (PCC) [2] where sundry loads are connected are the presence of voltage harmonics, surge, spikes, notches, sag/dip, swell, unbalance, fluctuations, glitches, flickers, outages, and so on. These quandaries are present in the supply system due to sundry perturbances in the system or due to the presence of sundry nonlinear loads such as furnaces, uninterruptible power supplies (UPSs), and adjustable speed drives (ASDs). However, some power quality quandaries cognate to the current drawn from the AC mains are impecunious power factor, reactive power burden, harmonic currents, unbalanced currents, and an exorbitant neutral current in polyphase systems due to unbalancing and harmonic currents engendered by some nonlinear loads. These power quality quandaries cause failure of capacitor banks, incremented losses in the distribution system and electric machines, noise,

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vibrations, over voltages and exorbitant current due to resonance, negative sequence currents in engenderers and motors, especially rotor heating, derating of cables, dielectric breakdown, interference with communication systems, signal interference and relay and breaker malfunctions, erroneous metering, interferences to the motor controllers and digital controllers, and so on.Nowadays more number of non linear are utilizing in distribution system. It requires more flexible and high speed of operation. For this situation, power quality amelioration contrivances are utilized. The main custom power contrivance which are utilized in distribution systems for power quality amelioration are D-STATCOM, AF, UPQC etc. Electrical equipment susceptible to power quality or more congruously to lack of potency quality would fall within a ostensibly abysmal domain. Mundane issues cognate to power quality are such as voltage sag, voltage swell, voltage unbalance, harmonics, voltage fluctuations. In this paper, the instantaneous reactive power theory is presented, and its emolument strategy is applied to a three phase three-wire power system

II. UNIFIED POWER QUALITY CONDITIONER

UPQC (unified power quality conditioner) is a equipment which is utilized for compensate for voltage distortion and voltage unbalance in a puissance system so that the voltage at load side is thoroughly balance and sinusoidal and impeccably regulated and additionally it is utilized to compensate for load current harmonics so that the current at the source side is impeccably sinusoidal and liberate from distortions and harmonics. UPQC is a coalescence of a shunt active power filter and series active power filter. here shunt active power filter (APF) is utilized to compensate for load current harmonics and make the source current thoroughly sinusoidal and liberate from harmonics and distortions. shunt APF is connected parallel to transmission line. here series APF is utilized to mitigate for voltage distortions and unbalance which is present in supply side and make the voltage at load side impeccably balanced, regulated and sinusoidal. series APF is connected in series with transmission line.

Basic configuration of UPQC

Basic configuration of Unified power quality conditioner has been shown

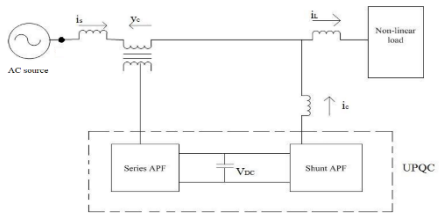

Fig 1 Basic Configuration of UPQC

UPQC is a potency electronic contrivance which consists of two voltage source inverters (VSI) connected through a prevalent dc-link capacitor. it is utilized to mitigate both load current as well as supply voltage imperfections. the main components of a UPQC are series converter and shunt converter, dc capacitors, lowpass and high-pass passive filters, and series and shunt injecting transformers. the purport of a UPQC is to compensate for supply voltage power quality issues, such as sags, swells, unbalance, flicker and harmonics. the model of UPQC is shown in figure1 the series part of UPQC is kenned as dynamic voltage restorer (DVR). it is utilized to maintain constant and balanced voltage at the load. the series compensator injects a voltage, in such away that the voltage at the load end remains impervious to any voltage perturbance. whenever there is sag in the supply voltage then series converter injects opportune voltage to supply. the series inverter of the UPQC injects a voltage represented by the following equation

$V_c=V_l-V_s$……..……..(1)

in order to rescind the harmonics engendered by nonlinear load, the shunt inverter should inject the current by the following equation

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$I_c=I_l-I_s$……..……(2)

here dc link connected with capacitor utilized. the inverter circuit in UPQC will convert the dc voltage to ac voltage. this inverter will engender the harmonics. the harmonics engendered by these inverters are filtered by utilizing passive filters. It has been concluded from this, we have discussed about active filter and its one of the type called amalgamated power quality conditioner and discussed about UPQC is how designed and how it has been used to compensate the voltage imbalances and reduce the harmonic distortion.

III. INSTANTANEOUS REACTIVE POWER THEORY

The instantaneous reactive power theory, withal designated p–q formulation is predicated on the Clarke coordinates transformation, which, applied to the voltage and current vectors in phase coordinates, gives those vectors in 0αβ coordinates In instantaneous power theory, the instantaneous three phase currents and voltages are calculated as given in following equations 3 and 4

$$\begin{bmatrix} V_0 \\ V_\alpha \\ V_\beta \end{bmatrix} = \frac{\sqrt{2}}{3} \begin{bmatrix} 1/\sqrt{2} & 1/\sqrt{2} & 1/\sqrt{2} \\ 1 & -1/2 & -1/2 \\ 0 & \sqrt{3}/2 & -\sqrt{3}/2 \end{bmatrix} \begin{bmatrix} V_a \\ V_b \\ V_c \end{bmatrix}$$

……..(3)

$$\begin{bmatrix} i_0 \\ i_\alpha \\ i_\beta \end{bmatrix} = \frac{\sqrt{2}}{3} \begin{bmatrix} 1/\sqrt{2} & 1/\sqrt{2} & 1/\sqrt{2} \\ 1 & -1/2 & -1/2 \\ 0 & \sqrt{3}/2 & -\sqrt{3}/2 \end{bmatrix} \begin{bmatrix} i_a \\ i_b \\ i_c \end{bmatrix}$$

……..(4)

The $\alpha - \beta$ theory is one of several methods that can be utilized in the control active filters. It presents some intriguing features, namely,

- It is inherently a three-phase system theory
- It predicates the instantaneous values, sanctioning excellent dynamic replication
- It can be applied to any three-phase system (balanced or unbalanced, with or without harmonics in both voltages and currents)
- Its calculations are relatively simple (it only includes algebraic expressions that can be implemented utilizing standard processors)
- It sanctions two control strategies: constant instantaneous supply power and sinusoidal supply current

The instantaneous active and reactive power in the $\alpha - \beta - 0$ coordinates are calculated with the following expressions

$$P_0=V_0*I_0 \quad \text{……(5)}$$

$$P=V\alpha*I\alpha+V\beta*I\beta \quad \text{……(6)}$$

$$Q=V\alpha*I\alpha-V\beta*I\beta \quad \text{……(7)}$$

where

Po = instantaneous zero sequence power
P = instantaneous real power
Q = instantaneous imaginary power

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V α I α and V β I β are instantaneous real and imaginary powers respectively. Since these equations are products of instantaneous currents and voltages in the same axis, in three-phase circuits, instantaneous authentic power is p and its unit is watt.

IV.CONTROL SCHEMES OF ACTIVE POWER FILTER

A. CONTROL SCHEME OF SHUNT ACTIVE POWER FILTER

The shunt active power filter can be controlled by Generation of reference compensating current and Generation of gating signal by hysteresis current controller as shown fig 2.The source voltages and load currents are taken and it is converted from $a-b-c$ phases to $\alpha-\beta-0$ cordinate. This conversion is kenned as Clarke's transformation. After that power calculation is authentic power and imaginary power is calculated. After that power which is to be compensated is ascertained. This currents in $\alpha-\beta$ coordinates are transformed into $a-b-c$ axis by inverse Clarke's transformation. This is the reference compensating current. It is given to hysteresis current controller along with shunt APF authentic output current. In current calculation low pass filter is utilized to abstract higher order harmonics of power Hysteresis controller is utilized as it is simple, it has expeditious transient replication, it enhances stability,& has good precision. Hysteresis

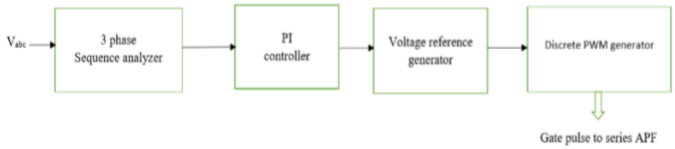

Fig 2 Control Scheme of Shunt Active Power Filter

current controller is utilized for engendering switching signal by comparing the error present in the current in a fine-tuned tolerance band. Here comparison is done between the authentic current & reference current within a fine-tuned tolerance band. It is different for different phases. Hysteresis current controller is utilized to compare current so to engender switching signals for Shunt APF. Here the reference current ic is compared with genuine current ic of shunt APF within a given hysteresis band.

B. CONTROL SCHEME OF SERIES ACTIVE POWER FILTER

By the Generation of reference compensating voltage and Comparing reference compensating voltage as shown in fig 3 with real compensating voltage in voltage controller and engendering PWM signal for voltage source inverter

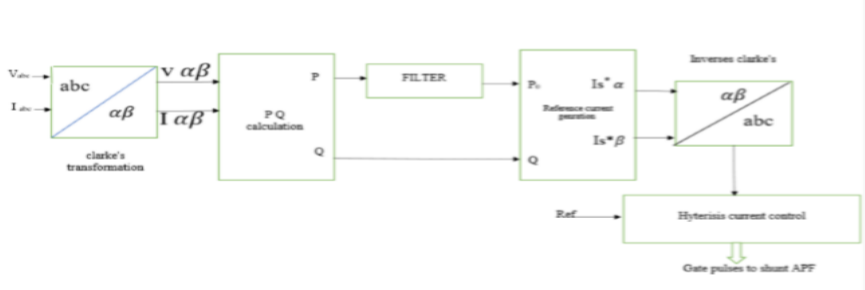

Fig 3 Control Scheme of Series Active Power Filter

PI controller is mainly used to reduce the steady state error. The puissance loss across DC capacitor should withal be ascertained. It is found with the avail of PI controller. Gain of PI controller is kept congruous. Power which is to be compensated are harmonic component of authentic power and whole imaginary power

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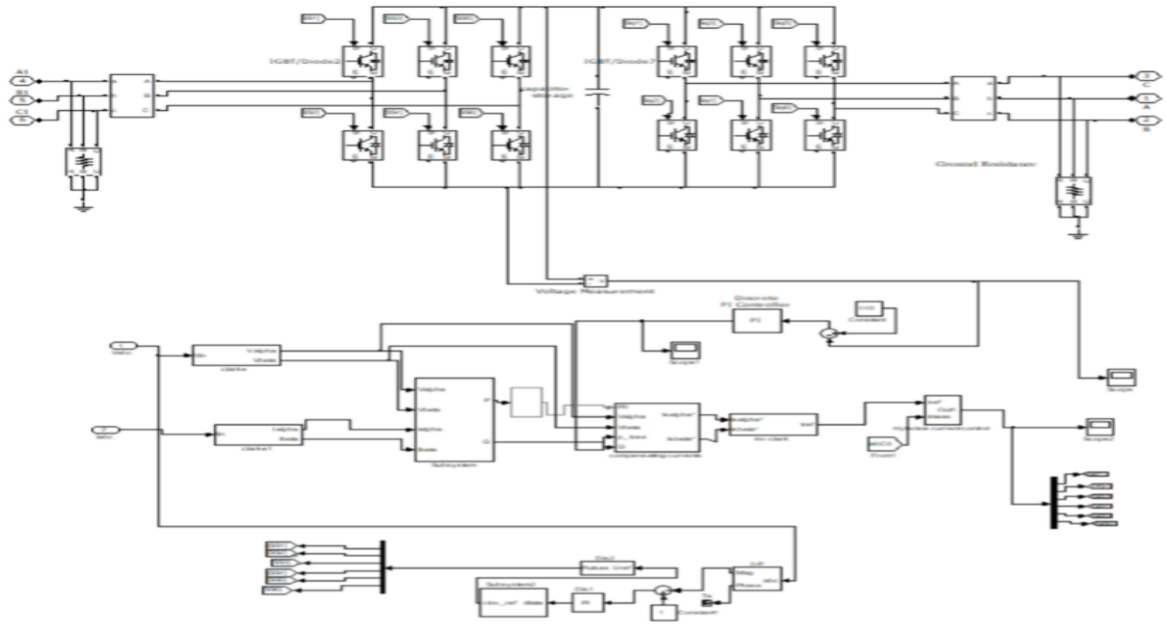

Fig 4 Simulink Model of UPQC

V. MATLAB SIMULATION AND RESULT

MATLAB is an interactive system for numerical computation. The simulation diagram of unified Power Quality Conditioner is shown below in fig 4

Table 1 System Parameters

Types	Range
Three phase source	110Kv
Three phase transformer	110/33 Kv
Inductor	4e-3H
Series transformer	250e-6KVA
Non liner RL load	--

The UPQC has simulated utilizing the instantaneous reactive power theory. The source voltage and current waveform afore and after connecting the UPQC are analysed. It has descried that the source voltage is distorted afore connecting the UPQC and the distorted is reduce after connecting the UPQC.

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A.Without UPQC

The system is simulated at the intervals of 0.8 to 1.6 during this sag and swell are crated and waveform is obtained

Fig 5 Voltage and Current Wave Form Without UPQC

B.With UPQC

The voltage and current waveform is obtained and it has been conclude that the emolument is done during the duration of 0.85 to 1.6 sec and 0.05 sec in wave form has uncompensated sag,swell as shown below.

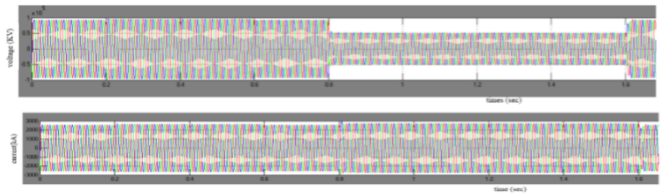

Fig 6 Voltage and Current Wave Form With UPQC

C. HARMONIC DISTORTION

The Harmonic distortion in the system is analysed in source side. The THD in source side afore connecting UPQC is9.56% at the time of 0.84 sec and 3.13% at the time of 0.83 sec and THD is analysed in source side after connecting UPQC is 0.4% at the time of 0.86 sec as shown below

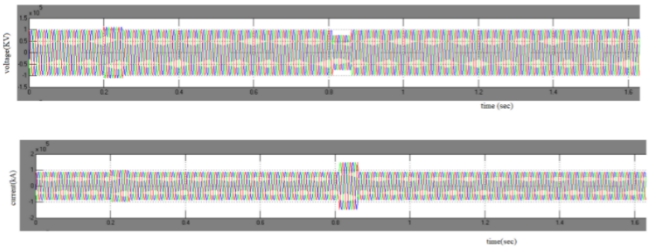

Fig 7 THD Without UPQC **Fig 8** THD With UPQC

VI.CONCLUSION AND FEATURE SCOPE

In this paper the incrementation in commercial and industrial load has results in rigorous power quality quandary in the transmission and distribution side. The consumption of electrical energy is incremented desultorily due to increment in consumers. The major perturbance in the distribution side cause losses of equipment, damage equipment. This major perturbance in the distribution side is minimized by the proposed method to a great extent. To solve these quandaries several solutions have been developed and cumulated power quality conditioner is the one of the most popular solution used nowadays. The UPQC can perform the function of both DSTATCOM and DVR. In these work it has been

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conclude that , an amended control strategy for the operation of UPQC system. Several control strategy is studied like p-q theory, SRF predicated approach, for the APF operation. The UPQC model is simulated in MATLAB utilizing instantaneous power theory. Shunt part of UPQC abstracts all the current cognate harmonic quandaries in the system and series connected APF of UPQC system abstracts all voltage harmonics which comes up due to the utilization of nonlinear load. The overall THD is now ameliorated in the system which is pellucidly observed from the waveforms afore and after UPQC operation.Furtherly this work can be elongate in the controller performance of active filter may further be ameliorated by other perspicacious control techniques like Neural, Fuzzy and Genetic algorithm. These control techniques which reduce the uncompensated part and amend the puissance quality.

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