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Design Simulation of Improved Power Quality Conditioner System for Enhancement of Power Quality

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Abstract: The increased usage of power-sensitive electronic devices has prompted interest in power conditioning solutions, which is no surprise. As a result, some type of compensation must be supplied if power output remains below the standards' prescribed limitations. The UPQC (Unified Power Quality Controller) is one of numerous AC Transmission System families that can control voltage, impedance, and phase angle among other factors (FACTS). This study focuses on modern UPFC systems that have increased power quality efficiency to help utilities reduce voltage concerns. One of the FACTS controls for lowering stress sales effects is a unified power quality conditioner (UPQC). The quadrature voltage is specified using the UPQC series compensator. As a result, the compensator series never utilizes active power in a continuous scenario. As mentioned in the approach, a low power rating compensator injects voltage to remedy the system's power quality problem. The voltage is decreased and the power factor is raised when the fluid logic controller is used in conjunction with traditional UPQC. Furthermore, the load factor has been improved. The circuit is then imitated in MATLAB / SIMULINK using a fluctuating logo controller.

***Keywords:** UPQC, Power System, Power Quality, Total Harmonic Distortion, Efficiency, Sag, Swell, Active Power Filter*

INTRODUCION

Most voltage fluctuations of customers are triggered by power supply faults often caused by overhead power lines such as lightning, wind and ice [5, 13]. Individual consumers may also suffer higher financial losses arising from these short-term incidents than the expense of interruptions. Thisprocess need to keep the equipment in service is extremely necessary to prevent large financial losses in automated installation operations. Disruption of production, income and profits will lead directly to downtimes.

Voltage decreases are most common [4] due to various power quality disruptions and contribute to the highest financial losses, as voltage decreases also cause equipment malfunction [5]. The voltage sag occurrence is much more than the number of power breaks. Consequently, financial losses incurred by tension-sag incidents for individual customers can also be greater than the expense of power interruptions. The increased sensitivity and high cost of such incidents are the driving force behind an increased study interest and a reduction of the impacts of conflict sales on customer operations. As voltage sales are important for consumers, the character of voltage sales encountered in their network should be taken into account by power distribution companies.

In addition, the Electric Power Companies should be evaluated to mitigate the disadvantages caused by voltage slips by the impact of alternative device configuration [3].If such changes are made on the network as well as on the customer side, the voltage drop effect is expected to change.

The effect of the voltage slopes can be seen in terms of financial losses resulting from customer downtime using the methods outlined in this study. Accurate estimates of the loss of voltage drops will encourage power distributors to make their systems more redundant by changing their switching schemes so that the voltage drops would have a less effect on customers connected to their networks. This will help electricity distributors to boost network efficiency and cope

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with the growing demands of the electricity companies and the consumers that are more demanding.

In Present Scenario, most of the DVR projects are based on compensation for voltage sag. There is growing demand worldwide for power quality and tensile offsetting devices every day. DVR has become increasingly common because the industry is increasingly vulnerable to voltage slumps. Conception and regulation of the complex voltage restorer integrated with emphasis on voltage dip mitigation in the LV or HV delivery or utilities.The solution intended should be a solution provided to consumers who are willing to pay for value-added electricity by distributor companies is a relatively new product and has not yet done much work. In addition to these global factors, the power quality problems and custom power devices have little context. A clear context of simulation model and DVR analysis for voltage compensation, Shunt APF for harmonics mitigation will be given by this report.Conventional voltage control devices such as on-charge and off-charge tap changers control only RMS voltage value and not the slope when the value occurs. The primitive UPFC that employs shunt and serial converters in order to minimise voltage drop has a high THD inconvenience, complex current regulation, inadequate real and reactive power simultaneous regulation (abido 2009). Mihalic&Zunko's (1996) mathematical model of the UPFC only increases transient stability. In their work, other problems of power quality were not discussed. Schaulder et al. (1998) published a study that devoted itself only to the basic control, sequence and security of UPFC operations. In introducing UPFC over a long transmission line to control its power and voltage, SaminaElyasMubbeenetal (2008)[8] has made no suggestions for improving the quality of power. Schoder's (2000) scheme deals with the UPFC 's success against significant disruptions. Only the dynamics of power systems change with the approach proposed by Noroozian et al .(1997). Zhengyu Huang 's latest power frequency model (2000) is an alternative to the Noroozi system. In addition to substantially increasing power system dynamics, the Zhengyu Huang model has a reasonably good control over real and reactive power.However, his model did not discuss the aspects of power efficiency. Manoj Kumar et al .(2010) addressed power quality improvement through the DSTATCOM. In his work Murali&Rajaram (2010) UPFC's power quality improvement has not been seen in comparison to static UPFC results, and the poor quality of electricity causes huge loss of income for end user. The utilities must therefore explore all economically and technically feasible ways of improving the quality of electricity, apart from increasing the transmission power transfer of existing transmission lines up to their thermal limit. Many schemes with numerous FACTS devices have so far suggested only boost capacity for power transfer and stability. FACTS devices in power systems are yet to be studied on the aspects of power efficiency. The use of the UPFC method with five stage inverters to increase electricity efficiency decreases tensile slope and THD.

LITERATURE REVIEW

ToshifiimiIse et al. [1] provides numerous examples of power quality definitions based on this description. Power quality can be divided into three groups: reliability of voltage, consistency of delivery and value of voltage.

Such schemes may provide their customers with an interrupted degree of energy stream subject to the contractual scale, frequency and power delivery schedules; the distribution systems have a number of non-linear charges which significantly affect supply quality [2-5].

Dixon Juan et al. [11] gives the Active Power Filters sequences and act as a sinusoidal current source during the power supply process. An error signal regulates the range of the simple current in the series filter. A reference between load voltages has been developed. The quest provides an effective correction of the power factor, harmonic distortion and load voltage regulation.

Rajan and Parag [16] are the focus of improved power performance. DSTATCOM induction engine feeders drive radial, not linear and DTC feeders. The effectiveness of DSTATCOM in distribution networks is compensated in this article. Present load harmonics are discussed and discussed under various conditions of operation and failure Implemented. The IGBT switch pulses are calculated through a PWM current controller based on dqo transformation. The efficiency of DSTATCOM has been established. Present harmonic framework for enhancing reactive power and distribution power.

Ankush and parag [21] were developed in the field of UPQC, which was tested for various loads and single lines to the field. Complete Harmonic Distortion is compared with and without the UPQC compensation in order to measure voltage and current. UPQC is realised with an IGBT based PWM-VSI DC bus capacitor. The pulses for the IGBT switch gate are derived from a dqo PWM current controller. UPQC offset current, harmonic power, reactive power and improves the power efficiency of the distribution system.

Rao and Dash et al. [35] have been suggested several factors affecting the efficient strength, including non-linear and harmonic contamination as high thyristor arc in arc furnaces, swell and flake converters, rectifiers, etc. A combination of a Shunt system solution and active sequence filters, such as the UPQC, is the combination of an active Shunt filter with an

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active back-to-back filter. Return configuration to offset the power and power supply current or to mitigate any voltage and current variations and power supply network correction.

METHODOLOGY

Figure 1 presents a standard single-line UPQC delivery system compensated diagram. It uses two inverters connected to a standard DC power storage condenser. One of these two VSIs is connected with the feeder in sequence and the other is connected with the same feeder in parallel.

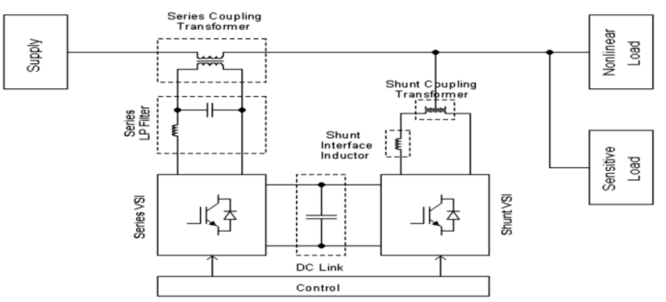

Figure 1 Single Line Diagram of UPQC

Model Equation of UPQC

(1) Computation of control Quantities of Shunt Inverter

In the three step sensed values the amplitude of the supply voltage is determined as:

$$V_{sm} = [2/3\ (v_{sa}^2 + v_{sb}^2 + v_{sc}^2)]^{1/2} \quad (1)$$

The current vectors of the three-phase unit are calculated as:

$$u_{sa} = v_{sa} / v_{sm};\ u_{sb} = v_{sb}/v_{sm};\ u_{sc} = v_{sc}/v_{sm} \quad (2)$$

The multiplication with the amplitude of the supply current (isp) of three phase vectors (USA, USB and USC) results in a three phase supply reference currents as follows:

$$i_{sa}^* = i_{sp}.u_{sa};\ \ i_{sb}^* = i_{sp}.u_{sb};\ \ i_{sc}^* = i_{sp}.u_{sc} \quad (3)$$

Three phase load currents are removed from three phase reference currents in order to obtain reference currents:

$$i_{sha}^* = i_{sa}^* - i_{la};\ i_{shb}^* = i_{sb}^* - i_{lb}$$

$$ishc^* = isc^* - ilc \quad (4)$$

This i_{ref} is the guiding principle for shunt inverter direct control technology. In order to obtain the commutation signals for the devices used in the inverter, the IRAF is compared to the IC in the PWM current controller.

(2) Inverter Series Control Quantity Computation

The voltage of supply and the voltage of charge are sensed, and the desired injected voltage is calculated accordingly:

$$v_{inj} = v_s - v_l \quad (5)$$

The size of the voltage injected is as follows:

$$v_{inj} = |v_{inj}| \quad (6)$$

The injected tension step is indicated as:

$$_{inj} = \tan(Re[v_{pq}]/Im[v_{pq}]) \quad (7)$$

The following inequalities are followed for the purpose of compensating harmonics in load voltage:

a) $v_{inj} < v_{inj}max$; control of magnitude;

b) $0 <_{inj} < 360$ °; control phase;

The injected voltages express three phase reference values as:

$$v_{la}^* = 2v_{inj} \sin(wt + {}_{inj})$$

$$v_{lb}^* = 2v_{inj} \sin(wt + 2\ /3 + {}_{inj})$$

$$v_{lc}^* = 2v_{inj} \sin(wt - 2\ /3 + {}_{inj}) \quad (8)$$

The three stage benchmarks (i_{ref}) of the inverter series are determined as follows:

$$i_{sea}^* = v_{la}^*/z_{se}; \quad (9)$$

$$i_{seb}^* = v_{lb}^*/z_{se}; \quad (10)$$

$$i_{sec}^* = v_{lc}^*/z_{se}; \quad (11)$$

The z^{se}impedance requires the insertion transformer impedance. The currents (i^{sea} *, i_{seb} * and i_{sec} *) are the best current to hold through the secondary winding of the insertion transformer to inject tension (v_{la}, v_{lb} and v_{lc}) to compensate for the voltage sag that is needed. The i_{ref}currents (i_{sea}*, i_{seb}* and i_{sec}*) in PWM current controller are compared to iakt (i_{sea}, i_{seb} and i_{sec}*), resulting in six switching signals for series inverter IGBTs.

Design of Fuzzy Logic Controller

Nowadays it has become possible to find floated logic-based control systems (FLCs) in an increasing number of items, including washing machines, speed boats, air conditioners, handheld car focal cameras and others. The inference motor is central to a fluid controller and the application of fluid rules. Its current operation was divided into three stages, as shown in fig 2.

i) Fuzzification – The inputs in actual system are fuzzified.

ii) Processing of fuzzy inputs – Processing in compliance with rules and generating fuzzy outputs.

iii) Defuzzification – Creates a crisp actual fuzzy output value.

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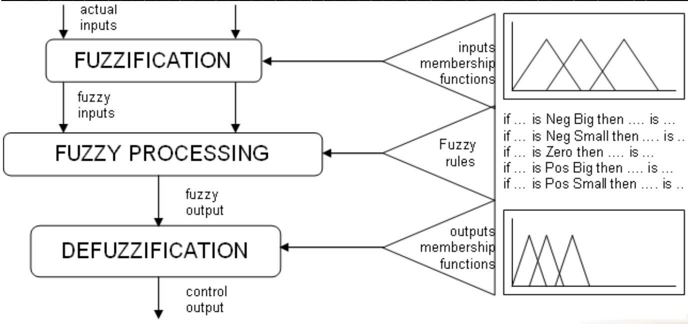

Figure 2 Design of Fuzzy Logic Operational Parameters

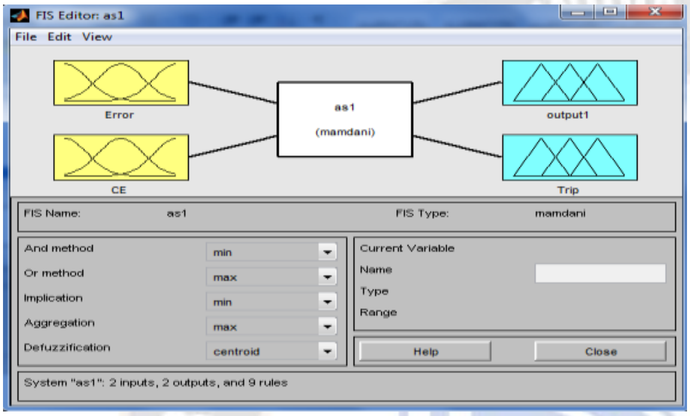

Figure 3 Design of Fuzzy Inference System

MATLAB and Simulink software simulated the proposed algorithm. Interference for the fuzzy rule input is shown by fig. 3. The simulation model should be balanced and sinusoidal for the three-phase source voltage. For load compensation a load with highly nonlinear features is considered. Fig. 4 shows the structure of Fuzzy controller.

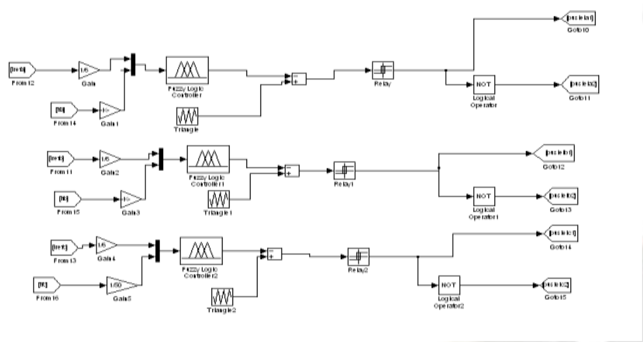

Figure 4 Structure of Fuzzy Based Controller for APF Control

The standard of electrical energy supplied to consumers has come up with a challenge. This is because non-linear loads are increasingly present in a network. It constitutes a harmonic network emission source, causing many disruptions and disturbing the optimum functioning of electrical systems.

The FLC has three components: flushing, interruption, and defusing. The FLC is designated as;

i. Each input and output has seven fuzzy sets.
ii. Simplicity works for triangular membership.
iii. The inflammation of the world of constant discourse.
iv. Implication of the 'min' operator of Mamdani.
v. The 'height' type of defuzzification.

The knowledge bases have been built to obtain a good dynamic response in unclear process parameters and DC voltage control with Fuzzy Logic external disturbances. In our application the fuzzy controller is based upon the processing of the voltage error and its derivation. It can be used with a 50% overlap to allow a smooth and progressive control change. As there are seven input and output variables, there are 7 x 7 = 49 input output choices, as shown in Table 1 rule chart is explained which has been used in fuzzy logic controller. Each numerical value of the membership feature in the membership function is assigned to a value between zero and one. We used max-min inference to implicitly set the rules of change in this chapter.

Current Hysterical Controller for Adaptive Fuzzy Controller

The active filter core is the control section that must allow the reference waveform, which corresponds with the harmonic content of the line current, to be extracted and the inverter must faithfully track the reference current.

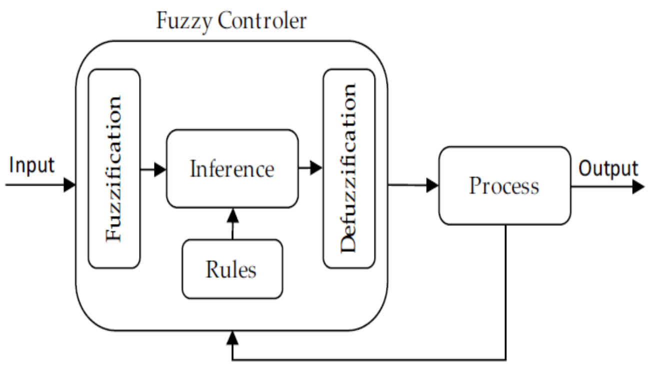

Figure 5 Building Blocks of Fuzzy Based System

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Table 1: Rule Base

Change in error	Error						
	PL	PM	PS	Z	NS	NM	NL
NL	PL	PL	PL	PM	PM	PS	Z
NM	PL	PL	PM	PM	PS	Z	ZS
NS	PL	PM	PS	Z	NS	NM	NL
Z	PL	PM	PS	Z	NS	NM	NL
PS	PM	PS	Z	NS	NM	NL	NL
PM	PS	Z	NS	NM	NM	NL	NL
PL	Z	NS	NM	NM	NL	NL	NL

In this paper, the harmonics introduced by nonlinear loads were eliminated. This design simulates the harmonics and reactive power produced by nonlinear charge in steady and temporal conditions. Matlab / Simulink use to create modern fluid logic controllers based operation filters to demonstrate the usefulness of the APF simulation approach**.**

RESULTS ANALYSIS

In this paper, Simulation design and performance assessment of unified power quality controller based on fuzzy logic controller has been discussed and simulated for harmonic mitigation and power quality improvement.

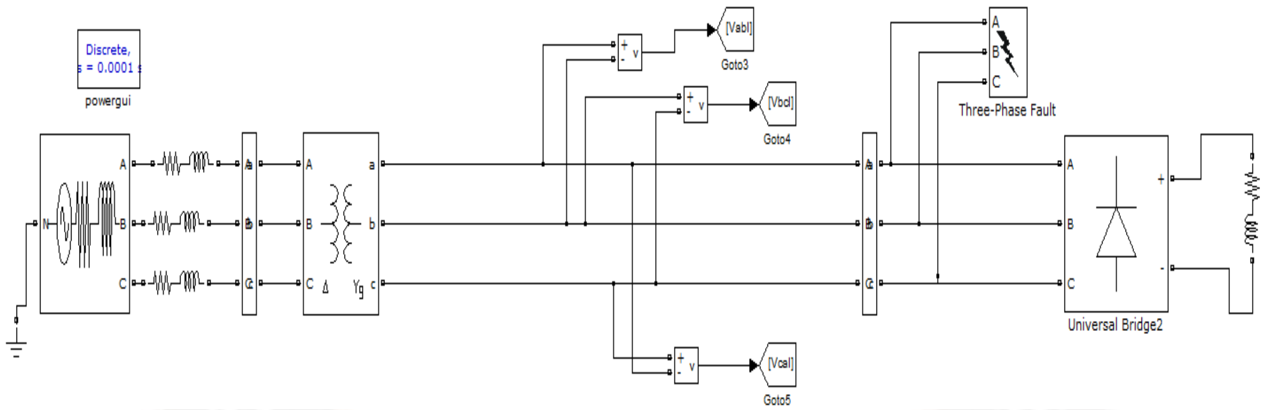

Figure 6 Simulink Model of Grid with Fault without UPQC

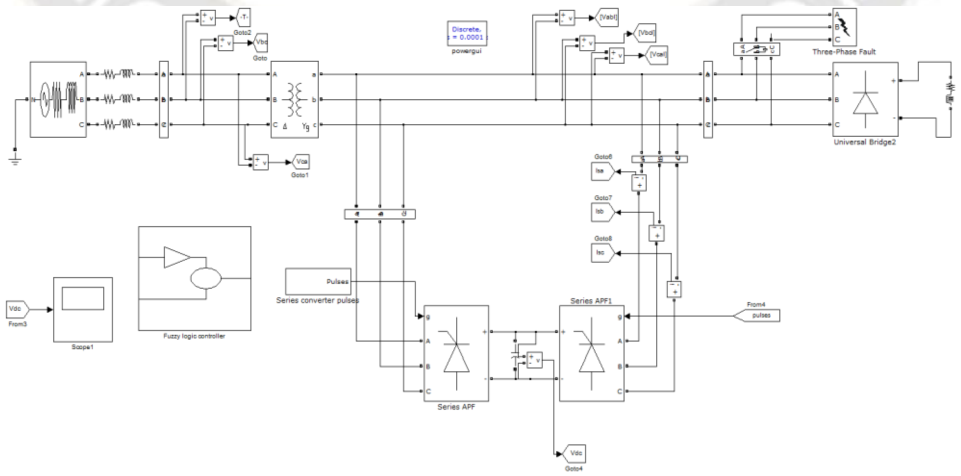

Figure 7 Simulink Model of Grid with UPQC Using Fuzzy Logic Controller

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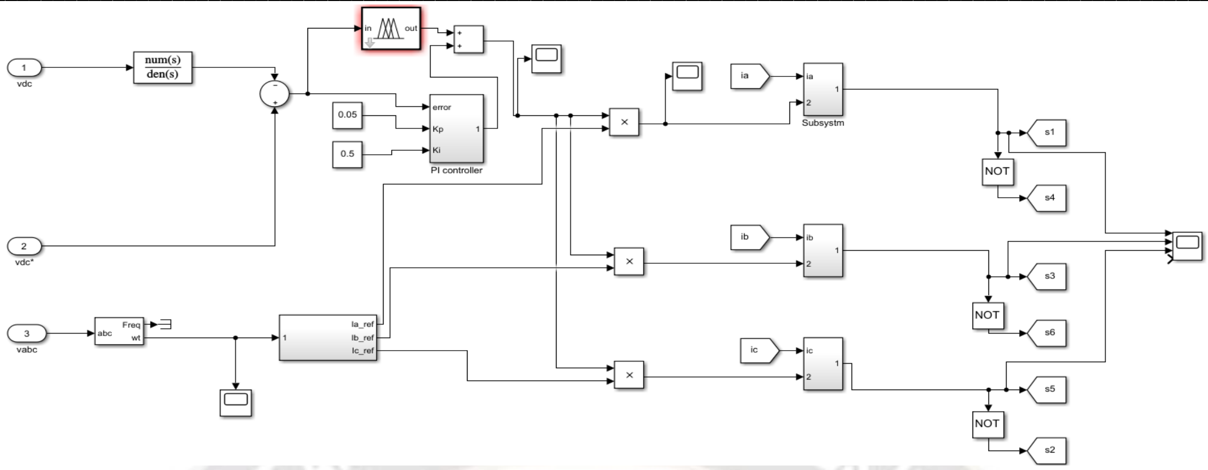

Figure 8 Simulink Model of Fuzzy Logic Controller and its System

Table 2: Analysis of Proposed Methodology

Methods	%THD		
	Phase-A	**Phase-B**	**Phase-C**
Uncompensated	47.15%	44.78%	43.29%,
UPQC	6.1 %	5.12 %	4.9 %
Proposed-UPQC	4.4 %	4.06 %	3.1 %

Table 3: Comparative Analysis of Proposed Methodology

Methods	%THD
Uncompensated	47.5%
Compensation with DSTATCOM	14.69%
DVR	12.19%
UPQC- FUZZY	4.06%

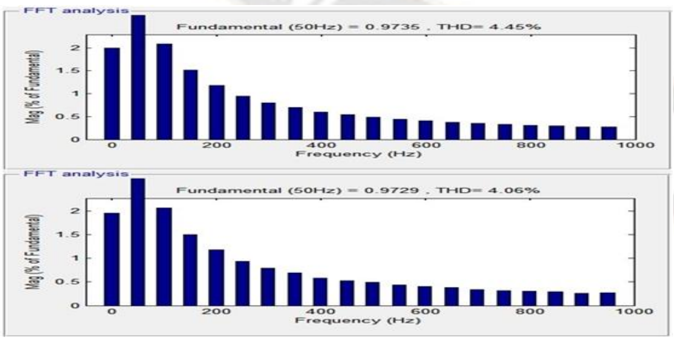

Figure 9 Spectrum Analysis of Proposed UPQC

The implementation of the proposed approach in the application of lowering harmonics using the fuzzy logic driven UPQC is illustrated in the figure of merits outlined above. The approach has been effectively implemented for the elimination of harmonics in unbalanced load conditions, and its analysis and enhancement have been compared to traditional methods, uncompensated research, and current research. Table 2 and 3 also shows a harmonic analysis of the proposed methodology.

CONCLUSION & FUTURE SCOPE

Conclusion

In this thesis, the UPQC based on the concept of a novel management strategy for 3-phase-four wire

i. Active and reactive theory of power instantly,
ii. Symmetric theory of the instantaneous component and
iii. Band controls for fuzzy hysteresis are seen.

This work aimed primarily to build UPQC performance enhanced control algorithms. Instant symmetrical theory of components is simple to implement and has a dynamic solution. This controllers such that the source-side currents and load-side tensions become sinusoidal and balance under different power quality specifications, as well as the voltages of the active series filters. The neutral current flowing to the neutral point of the transformer is essentially compensated such that the neutral point of the transformer is still virtually null potential. A suitable UPQC mathematical model has been developed based on instantaneous active and reactive power theory. Using the instantaneous power method based on zero transform and fundamental positive sequence detection, the UPQC controller was developed. The findings are evaluated and simulated using this technique for monitoring, harmonic detection, reactive power compensation.

We examined UPQC operation, which combines DSTATCOM and DVR operations. The UPQC 's serial part inserts voltage to keep the PCC tension balance and distortion free. At the same time a.c. is injected with the shunt portion of UPQC. System that balanced sinusoids are the streams entering the bus that the UPQC disconnected from. The goals must be accomplished in both source and load parties , regardless of any unbalance or distortion. Simulations have shown the feasibility of the suggested control strategies. It can be recommended that a Control Strategy based on Fuzzy hysteresis band controller, based on simulation studies and degree of THD, is sufficient for all problems in power quality with very strong transient and steady state operations.

Future Scope

In the following fields the work presented can be extended:

i. Custom power devices can be checked for different loads.
ii. More sophisticated controllers including the fugitive interface, the artificial neutral network, AUPF, ISCT, AGCT, IGCT, and UPQC can also be used for more efficiency in the system.
iii. Multi-level converters will examine the efficiency of UPQC.
iv. The effect of Z-source inverters on different Custom Power devices can be examined.

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