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Power Quality Improvement with Combined Operation of UPQC and Solar System in Power System Distribution Network

N.Ambika

Assistant Professor, Saraswathy College of Engineering and Technology, Tindivanam, India

ABSTRACT: The quality of the power is affected by factors such as harmonic contamination, non-linear loads, voltage sag and swell due to the switching of the loads etc. Recent times due to increased usage of loads, maintaining the quality of power is major challenging for power engineer for efficient optimization of power problem. Combined operation of Unified Power Quality Conditioner (UPQC) and Solar system can be used for effectively improving the power quality of an electrical power system. The UPQC having shunt APF (Active Power Filter) and series APF (Active Power Filter) and it solves voltage related and current related power quality problems in distribution network with different controller such as PI, Fuzzy Logic PI controller (FPI). The generated solar power is connect to common DC link point. Particle Swarm Optimization technique used for Maximum Power Point Tracking (MPPT) algorithm for solar panel. In this paper presents PI based fuzzy logic controller is designed for this work for reduction for THD, maintaining load side voltage level constant and current rating improved to the load side. From the MATLAB software results, It is shows the performance of the FPI controller is best.

KEYWORDS: UPQC, Power quality, PI, Fuzzy Logic PI Controller.

I. INTRODUCTION

Nowadays Power quality is the major issue in the power system area. E.W.Gunther, et al., developed a new power quality monitoring instrument. This can be used to monitor the steady state quantities and disturbances [1]. In UPQC the active power filters to compensate current and reactive power for voltage compensation [2]. The power electronics based equipment’s are used to improve the power quality issues and power enhancement [3]. In [4, 5] UPQC SCR controlled capacitor banks achieving load compensation by current control method. A new method proposed [6] for power quality improvement and it needs actual sinusoidal power supply. In this paper [7] the universal power quality conditioning system with various compensation are discussed with recent development. The ANN with hysteresis control give assurance for power quality issues like swell, sags etc. [8, 9].Artificial intelligence based 3ϕ UPQC implemented for control purpose [10]. The improvement of power quality issues are discussed in [11, 12]. The authors presented PI based power quality improvement system [13] to improve the THD level. Various control schemes are discussed and applied for synchronous rotating frame to maintain the constant voltage [14].The authors describing about connection between photovoltaic generation system and load [15].The work deals with MPPT algorithm and fractional short circuit methods [16]. The authors have clearly explained about suddenly changes weather condition problem for their work [17] [18]. The paper discussed about different sample taking in the work [19]. The authors demonstrated various control methods for UPQC [20].In this paper deals with power quality improvement with UPQC by different controller [21]. In this proposed paper discuss about soft controller taking for UPQC.

II. PROPOSED SYSTEM (UPQC AND SOLAR SYSYTEM)

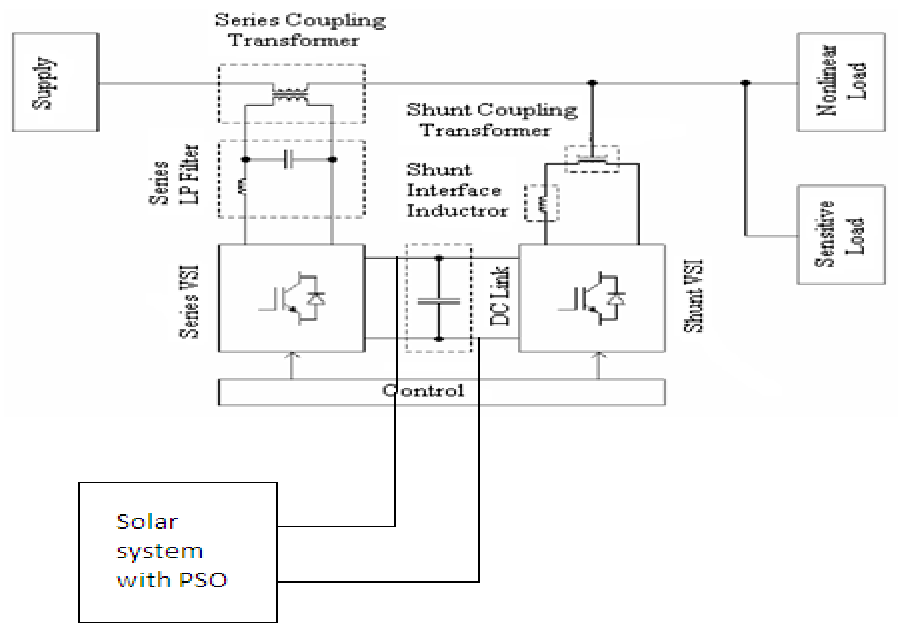

Fig.1. Configuration of UPQC with Solar system

UPQC has shunt and series voltage source inverters which are 3-phase 3-wire shunt inverter connected back to back DC link capacitor. This DC link capacitor voltage is regulated by using different controllers (PI and FPI). This various controller output signals are convert to pulse signal to drive the converter switches. The series active filter used to regulate the dc voltage with distortion harmonics. The harmonics is compensated with dc link to reduce the ripple factor and the stabilized in dc link capacitor. The shunt active filter to maintain the linear voltage to overcome with non-linear load. The linear voltages is maintained by control techniques such as PI and FPI and also control the bypass filter for to reduce the harmonics using this filter. From the proposed system the solar system is connected across the DC link capacitor to boost the power level as shown in fig.1. In this solar system PSO based MPPT control is used to boost the power level. In this proposed system output power is improved by adding the solar system.

III. FUZZY LOGIC CONTROLLER

The active power which is necessary to keep dc voltage constant in steady state or transient condition. The voltage fluctuations of the dc capacitor are affected by three principle factors; to compensate the alternating power, imbalance during transient and active power absorbed. The block diagram of the FLC is shown in figure.2.

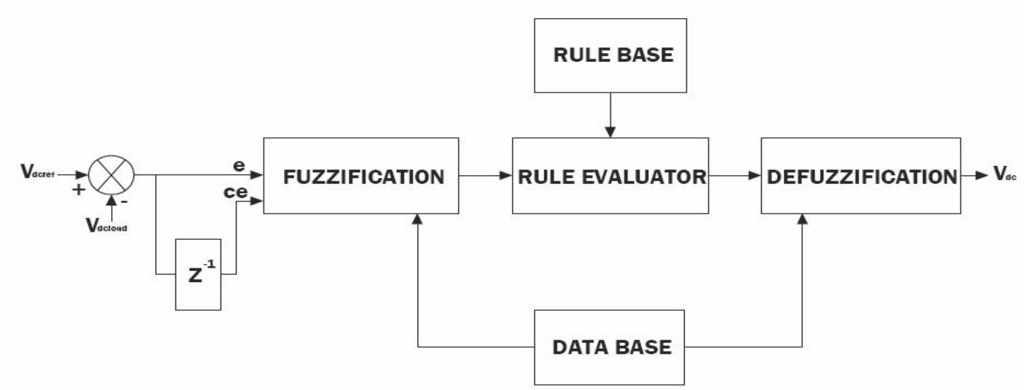

Fig.2. dc voltage control using fuzzy logic

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The numerical values of the variables are converted into linguistic variables in the fuzzification stage. For every input and output variable seven linguistic variables are assigned. The FLC structure is shown in figure.2. In this fuzzification, defuzzification and rule evaluator is there. In this work 7 membership functions is used as it is Table.1. All the membership functions are from using triangular membership. The linguistic variables assigned for the system are as follows, they are NB(negativebig),NM(negativemedium),NS(negativesmall),ZE(zero),PS(positivesmall),PM(positivemedium), and PB(positive big). For fuzzy implementation normalized values are used. A membership function value between zero and one will be assigned to each of the numerical values in the membership function graph. Max min inference method to get implied fuzzy set of the turning Rules.

Table.1. Fuzzy set rules of inference for the dc voltage

E \ CE	NL	NM	NS	EZ	PM	PS	PL
NL	NL	NL	NL	NL	NM	NS	EZ
NM	NL	NL	NL	NM	NS	EZ	PS
NS	NL	NL	NM	NS	EZ	PS	PM
EZ	NL	NM	NS	EZ	PS	PM	PL
PM	NM	NS	EZ	PS	PM	PL	PL
PS	NS	EZ	PS	PM	PL	PL	PL
PL	EZ	PS	PM	PL	PL	PL	PL

IV. SIMULATION RESULT

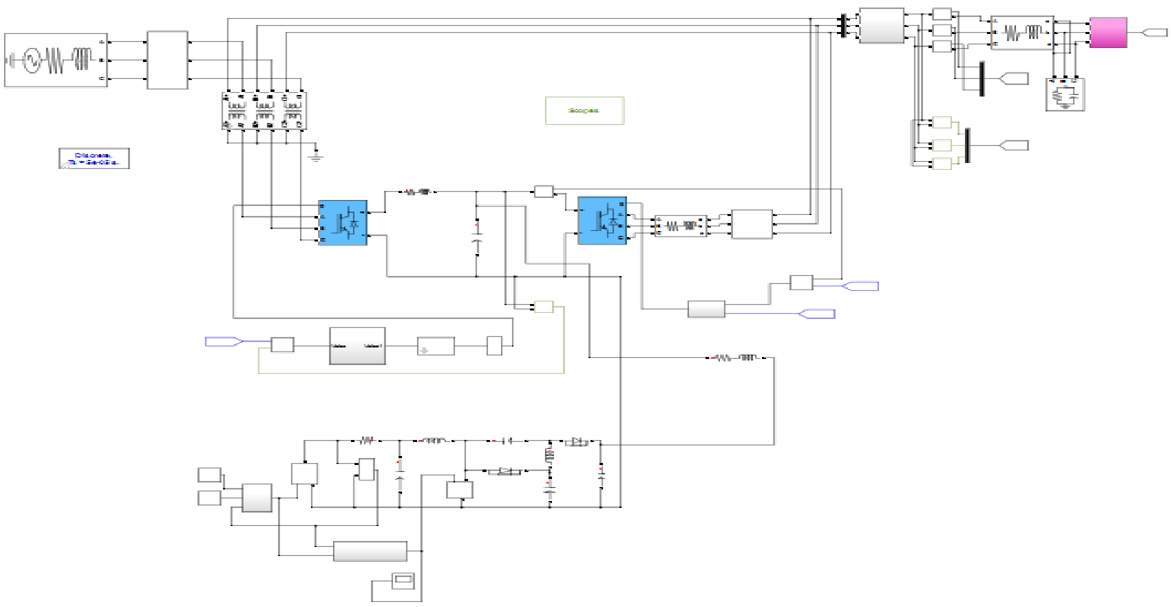

Fig.3. MATLAB Simulation Diagram for proposed system

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1.1. FUZZY PI BASED WITH SOLAR SYSTEM

The figure.3 shows the MATLAB simulation diagram for proposed system. The figure.4 shows the source side voltage waveform from in this work the input voltage is V_{rms}=1.098X10^{+4} for all the phases and the current is for phase-A 594.2 A, phase-B 620.9 A and phase-C 592.9 A. From the figure.5 structure load voltage is maintained constant V_{rms}=1.098X10^{+4} and the current is same for all the phases 547.1 A. Figure.6 shows the waveform of load side real and reactive power is improved P_{load}=1.764X10^{+5} and Q_{load}=3.667X10^{+4} from source side real and reactive power P_{source}=1.229X10^{+5} and Q_{source}=1.477X10^{+5}. From Table.2 it is inferred that it will give better results for THD level.

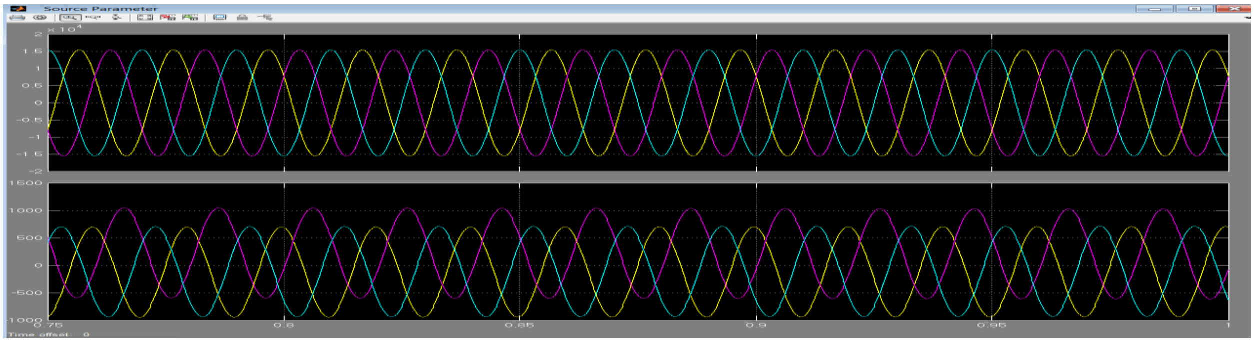

Figure.4. Waveform for source voltage and current

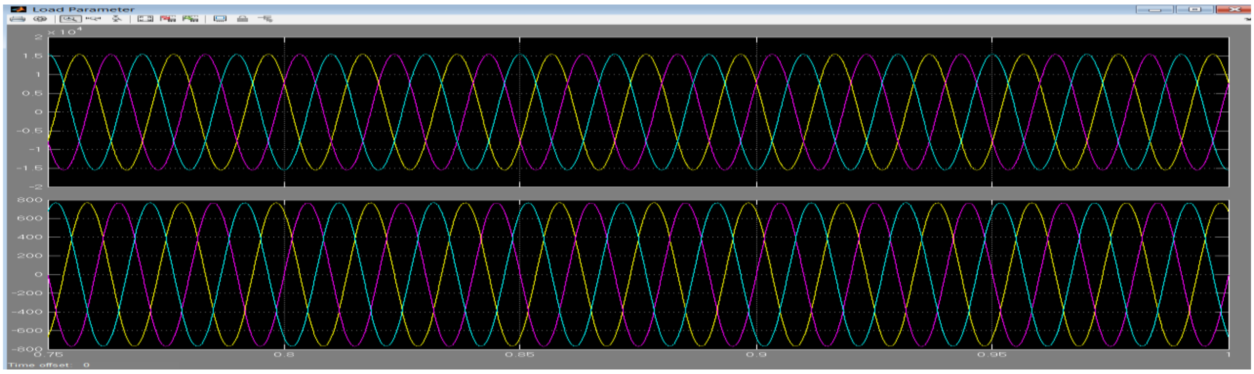

Figure.5. Waveform for load voltage and current

Figiure.6. Waveform for real and reactive power for source side and load side

Table.2. Comparison of Harmonics result with different controller

Phase / Controller	VOLTAGE HARMONICS (%)			CURRENT HARMONICS (%)		
	Phase A	Phase B	Phase C	Phase A	Phase B	Phase C
PI with solar PSO	3.01	2.33	2.98	4.86	4.02	4.56
FUZZY PI with solar PSO	2.28	2.22	2.29	2.86	2.97	1.59

V. CONCLUSION

The simulation results show that UPQC with solar system can be used for effectively improving the power quality of an electrical power system. The shunt APF has been used for compensating the load current harmonics. The series APF has been used for compensating the load voltage harmonics. The solar system is connected across the DC capacitor link that can improve the power. By using different controller combination (UPQC with PI, FPI based with solar PSO) with the FFT analysis to get the reduced Total Harmonic Distortion (THD) level, Load side voltage can be maintained at constant level and improve the real and reactive power of the system. Hence it is proved that the combination of UPQC with FPI with based solar PSO is superior when compare to PI.

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