Conditioning of Power Quality in Transmission Network Using UPQC

Mr. Suhas M. Shembekar[1], Mr. Sidhhant N. Patil[2]
Department Name: Electrical, Position: Assistant Professor[1], M.E. Student[2]
SSBT's College of Engineering & Technology[1,2], Bambhori, Jalgaon (India-425001)
Email:smshembekar@gmail.com[1], sidhhantpatil@gmail.com[2]

Abstract-Electricity supply plays an important role in the economic development and technology advancement throughout the world. The quality and reliability of power supplies relates closely to the economic growth of a country. The main task of the utility system is to provide the power to load with proper sinusoidal wave of the voltage and current, with fixed frequency and magnitude with less total harmonic distortion (THD) as possible according to **IEEE 519-1992 standard**. Our power system contains many non-linear loads like electric arc furnaces, power electronic convertors etc. which introduce current and voltage harmonics. Also the loads like computers, micro-controllers are sensitive loads; their proper functioning depends upon the quality of power supplied. However, power quality disturbances such as sags, swells, flicker, harmonics, voltage imbalance etc., create a lot of problems in achieving a reliable and quality power supply. To mitigate these problems, power electronics based FACTS devices are used in distribution systems. Reliability of supply and power quality are two most important faces of any power delivery system today. For providing reliable and efficient power, proposed UPQC based improvement in Power Quality is the dissertation topic. UPQC is effective in compensating current, harmonics, reactive power and improving the power quality of the distribution system.

Keywords: Transmission Network, UPQC, Power Quality, FACTS, Reliability, THD.

1. INTRODUCTION

Quality of power supply has become an important issue with the increasing demand of distributed generation systems either connected to the conventional grid, smart grid or micro-grid. Power quality has become a research topic in power distribution system due to a significant increase of harmonic pollution caused by proliferation of nonlinear loads, rectifiers, switching power supplies and other line connected power converters. So to improve the voltage profile, stability of system, enhancement of power quality, reduction in THD and reliability of power, etc. the various flexible alternating current transmission system (FACTS) are come in electrical network. The FACTS based application of power electronic devices effective for the power distribution systems to enhance the quality and the reliability of power delivered to the consumers. The core of FACTS technology contains high power electronics, a variety of thyristor devices, micro-electronics, communications and advanced control actions. By FACTS, operator governs the phase angle, the voltage profile at certain buses and line impedance. Power flow is controlled and it flows by the control actions using FACTS devices, which include (i) Static VAR Compensators (SVC), (ii) Thyristor Controlled Series Capacitors (TCSC), (iii) Static Compensators (STATCOM), (iv) Static Series Synchronous Compensators (SSSC), (v) Unified Power Flow Controllers (UPFC) and (vi) Unified Power Quality Conditioner (UPQC), etc.

According to the basic idea of UPQC, it consists of back-to-back connection of two three-phase active filters (AFs) with a common dc link. UPQC is to minimize grid voltage and load current disturbances along with reactive and harmonic power compensation. UPQC is a versatile device that can compensate almost all power quality problems such as voltage harmonics, voltage unbalance, voltage flickers, voltage sags & swells, current harmonics, current unbalance, reactive current, etc.

2. UNIFIED POWER QUALITY CONDITIONER

Unified Power Quality Conditioner (UPQC) mainly consists of two parameters: (i) Shunt Active Power Filter (Shunt APF) and (ii) Series Active Power Filter (Series APF). UPQC is the integration of series and shunt active power filters, connected back-to-back on the dc side, sharing a common DC capacitor as shown in Fig. 3. The series component of the UPQC is used to overcome or mitigation of the supply side disturbances such as voltage sags/swells, flicker, voltage unbalance and harmonics. It inserts voltages so as to maintain the load voltages at a desired level with balanced and distortion free. The shunt component is used to overcome or mitigating the current quality problems caused by the consumer such as poor power factor, load harmonic currents, load unbalance etc. It injects currents in the ac system such that the source currents become balanced sinusoidal and in phase withthe source voltages.

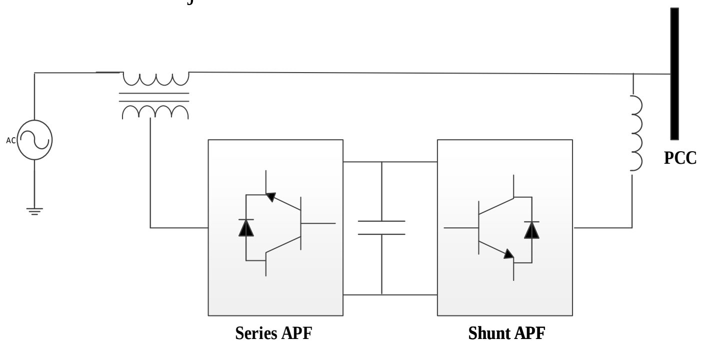

Fig. 1: Multi-level Converter based UPQC Structure

3. CONTROLLER OF UPQC:

A multi-level converter is proposed to increase the converter operation voltage, avoiding the series connection of switching elements. However, the multilevel converter is complex to form The output voltage and requires an excessive number of back-connection diodes or flying capacitors or cascade converter. A basic form of multi-level UPQC is shown in Fig. 1 and the controller strategies are shown in Fig. 2 and Fig. 3.

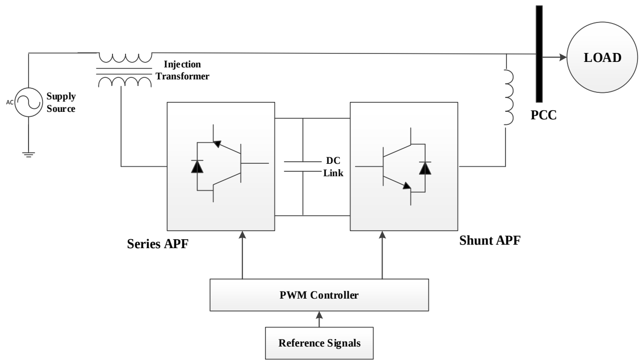

Fig. 2: UPQC with controller arrangement

The multi converter UPQC consists of two VSC's. The two voltage source converters are connected with a commutation reactor and high-pass output filter to prevent the flow of switching harmonics in to the supply. The voltage source converters are controlled by pulse width modulation (PWM) techniques. Fig. 3 shows the control scheme algorithm for sinusoidal pulse width modulation (SPWM) Technique. In this reference signals are compare with carrier signals to generate gate pulses for multi-level inverter. Fig. 4 shows a waveform of SPWM control scheme with Phase Disposition (PD) carrier waves.

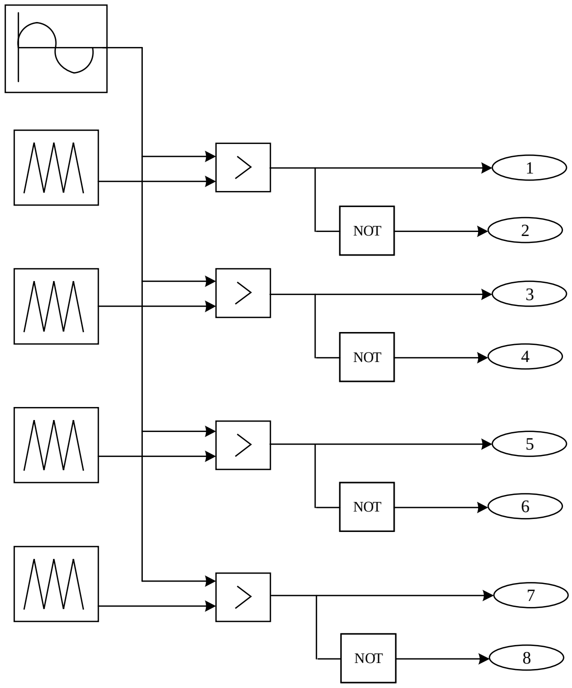

Fig. 3: Control Scheme Algorithm for SPWM

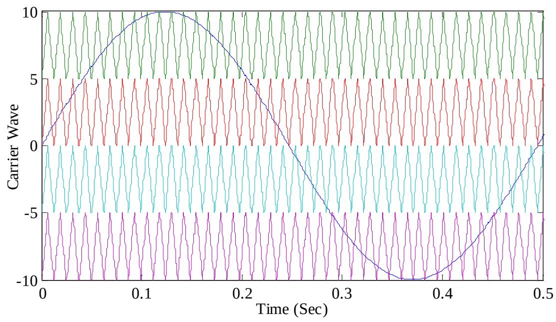

Fig. 4: SPWM PD Control Scheme

4. MODELLING FOR TRANSMISSION NETWORK WITH UPQC:

The modeling of UPQC in mat lab environment for electrical network is shown in Fig. 5. In which a one feeder of Power transmission is considered and simulated. The simulation results are presented on basis of that network for the performance of UPQC. The fault is created manually for some period and various results during such conditions are carried out.

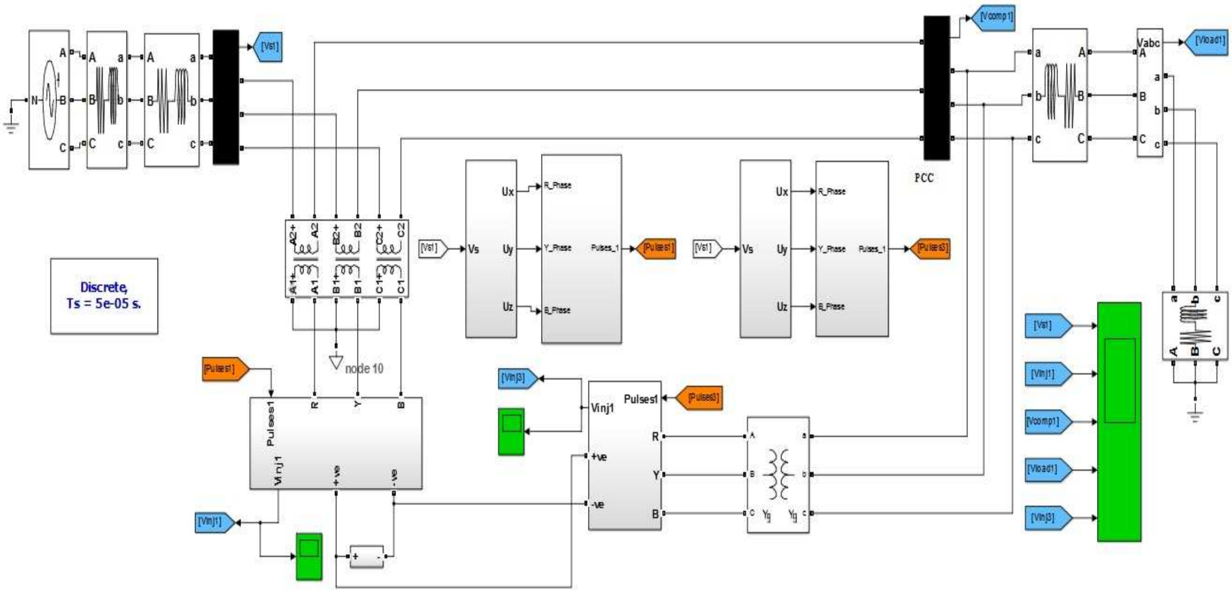

Fig. 5: Matlab simulation model of upqc in transmission network

5. SIMULATIONRESULTS

For the verification of the performance of UPQC the system was simulated using Simulink Power System Blockset in Matlab-Simulink.

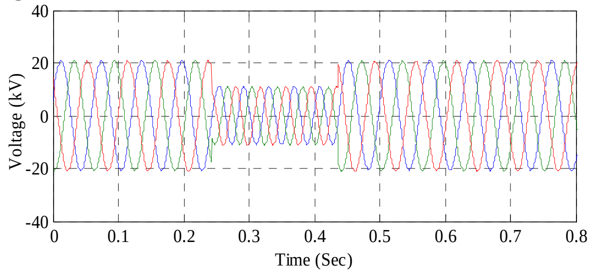

Fig. 6: Uncompensated voltage waveform

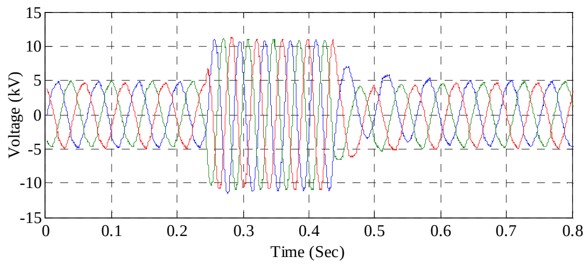

Fig. 7: Injected voltage waveform

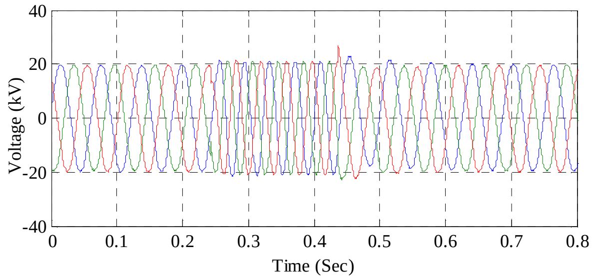

Fig. 8: Compensated voltage waveform

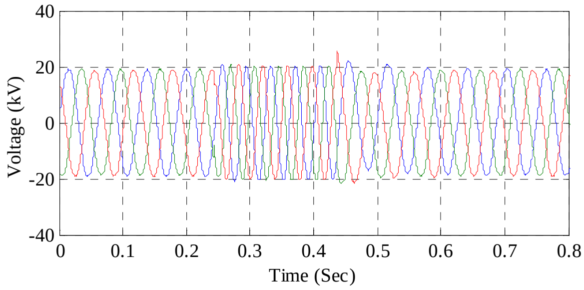

Fig. 9: Voltage waveform across load

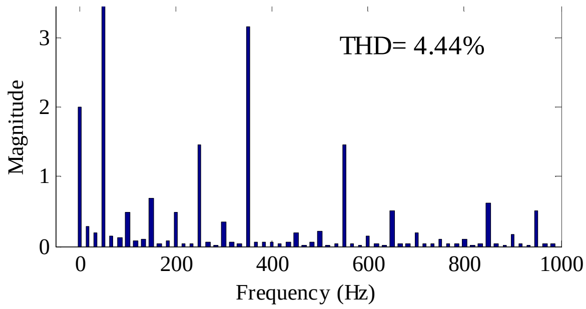

Fig. 10: Injected Shunt VSC Voltage THD

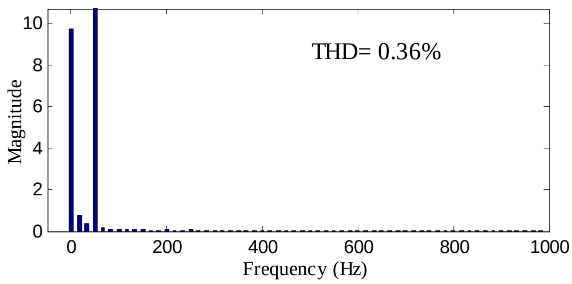

Fig. 11: Injected Shunt VSC Current THD

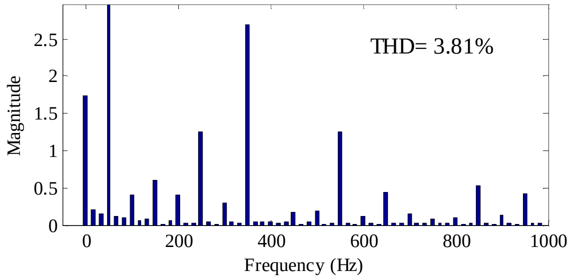

Fig. 12: Injected Series VSC Voltage THD

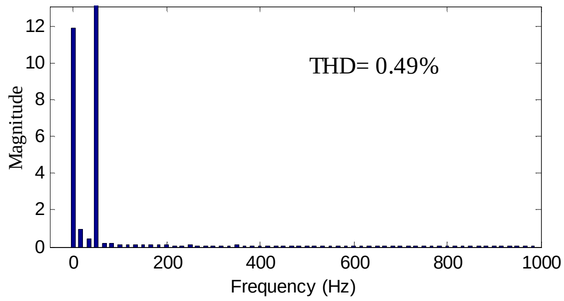

Fig. 13: Injected Series VSC Current THD

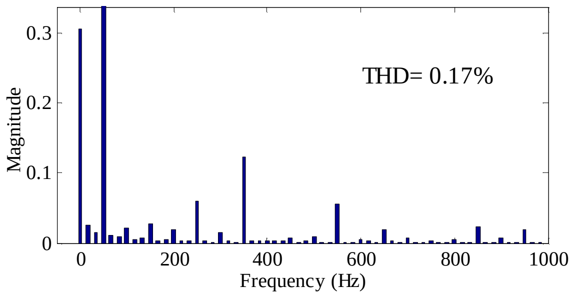

Fig. 14: Source Side Voltage THD

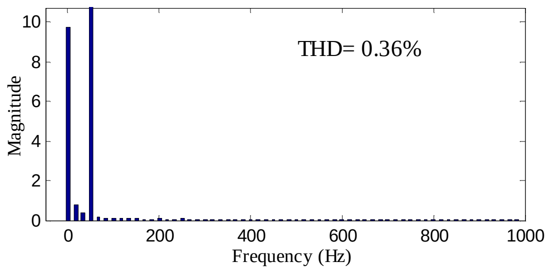

Fig. 15: Source Side Current THD

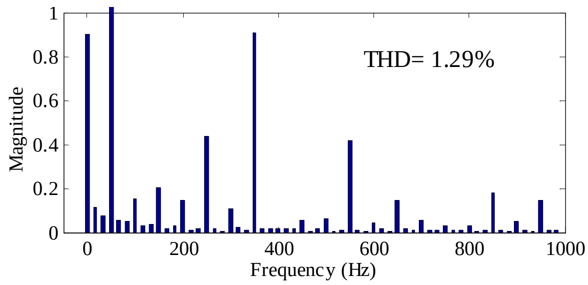

Fig. 16: Load Side Voltage THD

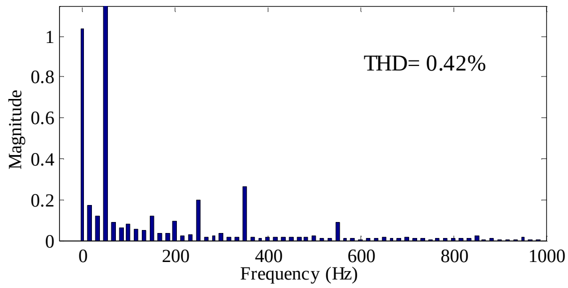

Fig. 17: Load Side Current THD

Table 1: Overall THD Comparison of System

PWM Technique		SPWM
Carrier Technique		**PD**
Filter Configuration		**VSC Based**
Total Harmonic Distortion (THD) in %		
Type of THD	Current	Voltage
Source Side	0.36	0.17
Injected Shunt VSC	0.36	4.44
Injected Series VSC	0.49	3.81
Load Side	0.42	1.29

6. CONCLUSION:

The power quality problems in distribuation system are not new but customer awarenessof these problems increased recently.It is very diffcult to maintain electric power quality at acceptable limits. One modern and very promising soluation that deals with both load current and supply voltage imperfection is the unified power quality conditioner(UPQC). The objective of this paper is to improve the power quality in an electrical network using UPQC FACTS device. The simulation is carried out by SPWM control technique. From this paper and simulation results it is clear that the performance in the voltage profile or waveform get improved using UPQC.

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