POWER QUALITY IMPROVEMENT USING INTELLIGENT FUZZY CONTROLLER

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ABSTRACT

Due to increasing complexity in the power system, voltage sag is becoming one of the most significant power quality problems. In this paper, the distribution static synchronous compensator (DSTATCOM) is used for compensation of the reactive power concerned in an electrical distribution network. DSTATCOM is based on a five level Voltage Source Inverter (VSI) and is controlled to compensate reactive power and correcting power factor. Fuzzy logic controller known by its speed and its simplicity of implementation carried out the control of this device.The compensation performance of any active filter depends on the voltage rating of dc-link capacitor. In general, the dc-link voltage has much higher value than the peak value of the line-to-neutral voltages. This is done in order to ensure a proper compensation at the peak of the source voltage. A new DSTATCOM topology with reduced dc link voltage is proposed. The topology consists of two capacitors: one is in series with the interfacing inductor of the active filter and the other is in shunt with the active filter. A simulation study of the proposed topology has been carried out using MATLAB/SIMULINK. Finally a fuzzy logic controller is applied for further reduction of harmonics on source side
Keywords: DSTATCOM, multilevel SVM, reactive power compensation, fuzzy logic controller

INTRODUCTION

Non-sinusoidal components in power system is mainly due to non-linear behavior of devices such as transformer tap-changer, adjustable speed drive, switch mode power supply, renewable energy source, HVDC system and other non-linear loads. In most of cases, non-linear loads are interpreted either as harmonic current source or a harmonic voltage source in practice [1]. Power healing is required for improvement of power quality which includes harmonic elimination, reactive power compensation, voltage regulation, load balancing etc. Enhancement in features of the active filter used in distribution system is known as Custom Power Device. An improved version of a shunt active filter named as DSTATCOM is used for degradation of current related power quality issues. The major advantages of DSTATCOM are better response and capacity for transient overload even at voltage sag. IEEE 519 and IEC are used as guideline of harmonic limits at point of common coupling [2]. Efficient utilization of voltage source converter (VSC) used as a DSTATCOM depends upon the control algorithm used for finding reference currents and switching pattern. Many time-domain control algorithms are available based on phase-dictated sinusoidal tracking, extraction of non stationary sinusoidal and non-linear time frequency analysis, direct power control and other soft computing algorithms etc for extracting reference signals [3-5]. The field of adaptive control has been made for control algorithms, design techniques and analytic tools. It is closed loop system that can adjust system behavior during any kind of disturbances. Based on this control theory, many control algorithms are also reported in available content such as improved adaptive detection algorithm for selective harmonics detection, adaptive filter for synchronous extraction etc [6,7].

Usually the term power quality refers to maintaining a sinusoidal waveform of bus voltages at rated voltage and frequency. Otherwise PQ Problems like voltage flickers, poor power factor and harmonics are occurred. These problems are due to large amount of induction motors, adjustable speed drives, Switching Power supplies, Arc furnaces, Non- linear loads and power electronic devices used in DG Systems. The characteristics of load have become more complex due to the increased use of power electronic equipment, which results in a deviation of voltage and current from its sinusoidal waveform. Also, the restructuring of power systems and with shifting trend towards distributed generation and deregulation, the issue of power quality is going to take newer dimensions. In developing countries, Where the variation of power frequency and many such other determinates of power quality are themselves a serious question, it is very vital to take positive steps in this direction. The evolving nature of distribution system operations and end-use equipment performance presents a mixed bag of tasks that will need to be well executed for utilities to succeed in the new highly competitive marketplace. A growing number of loads are sensitive to customer's critical processes, which have costly consequences if disturbed by poor power quality. Industries are very sensitive to PQ problems. So, for all types of power quality solutions at the transmission & also in distribution system voltage level FACTS also called as Custom Power Devices are introduced to improve Power Quality. Harmonics and poor power factor will produce effects like reactive power burden, unbalance and excessive neutral current which in turn produce overheating. To compensate harmonics conventional Passive Filters are used for specific number of harmonics. After development of power electronics SVC, Which is composition of Passive LC filters and fixed compensating devices with some degree of variation were employed to improve the power factor of ac loads. Such devices have the demerits of fixed compensation, large size, ageing and resonance. The increased severity of harmonic pollution in power networks has attracted the attention of power electronics and power system engineers to develop dynamic and adjustable solutions to the power quality problems. So, now to compress total harmonic content, power factor improving & for power quality Active Power Filters (APFs) are used. In APFs, DSTATCOM or Shunt APF is popular now.

SYSTEM DESCRIPTION

The proposed system consists of RES connected to the dc link of a grid-interfacing inverter as shown in Fig. 1. It is shows that both load are connected that is non-linear load as well as unbalance load at distribution. Grid is connected to step down transformer with reduce voltage level for distribution side as shown in fig. 1

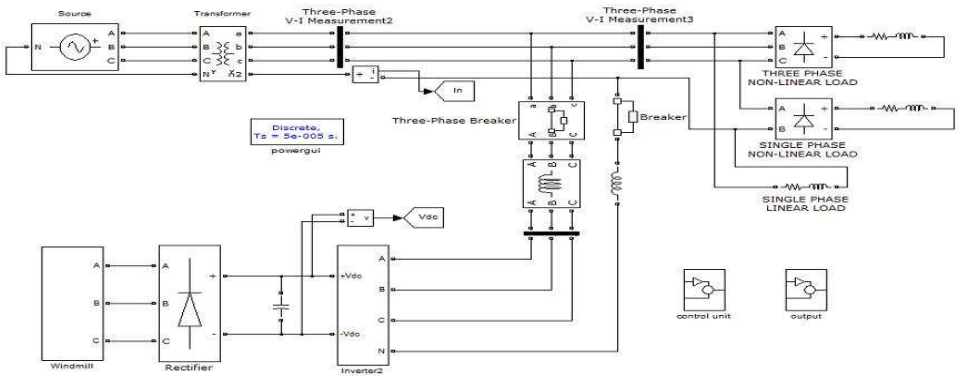

Fig.1. Schematic of Proposed Renewable Based Distributed Generation System.

For injecting Renewable energy to grid inverter that is power electronic devices is used. Power electronic devices produces the unwanted harmonics to reduce this shunt active power filter is used. Shunt active power filter is used to compensate load current harmonics by injecting equal but opposite compensating current. In this paper three phase four wire voltage source current controlled inverter is used. Generally three wire inverter is used but in this fourth terminal is used to compensate the neutral current. A voltage source inverter is convert renewable DC energy into Ac with required magnitude, phase angle and frequency. It also converts the DC voltage across storage devices into a set of three phase AC output voltages. It is also capable to generate or absorbs reactive power. If the output voltage of the VSC is greater than AC bus terminal voltages, is said to be in capacitive mode. So, it will compensate the reactive power through AC system. The type of power switch used is an IGBT in antiparallel with a diode. The three phase four leg VSI is modelled in Simulink by using IGBT. The driving voltage across the inductance determines the maximum di/dt that can be achieved by the filter. A large valve of inductance is better for isolation from the power system and protection transient distribution it also limit the ability of the active filter to cancel higher order harmonics.

FUZZY LOGIC CONTROL FOR DSTATCOM

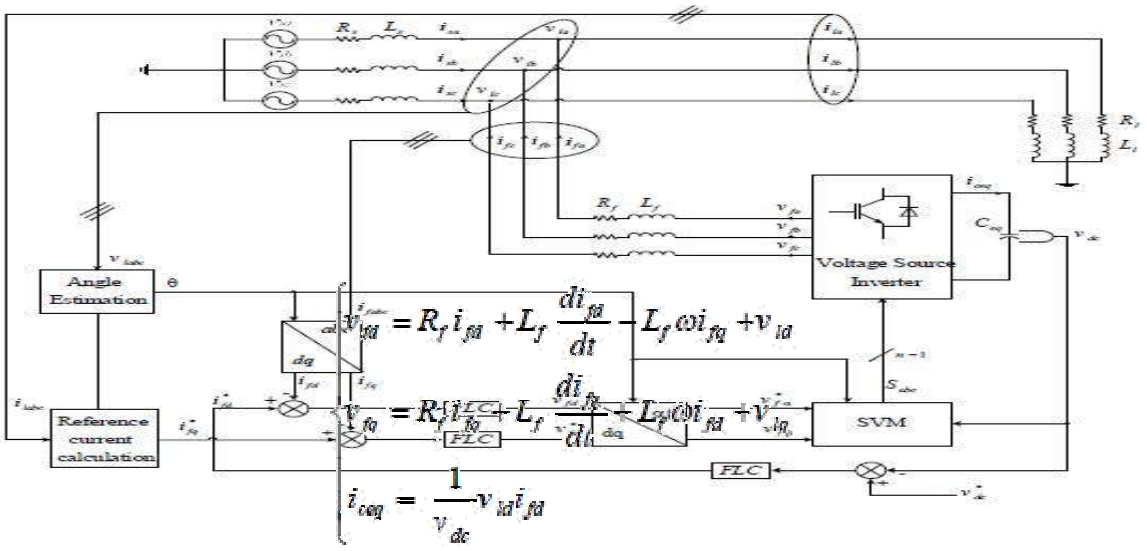

Fig.2 Fuzzy logic control of DSTATCOM

The control of five-level DSTATCOM is shown in Fig. 2. The inner current control loop calculates the reference voltage necessary for the SVM block. The outer voltage control loop calculates the DC sidecurrent reference *iceq* *, then the direct current reference *ifd* * is given from above equation. Fuzzy Logic Controller (FLC) is considered for both the loops. The reactive current reference *ifq* * can be given according to the operating process of the DSTATCOM, either by regulate the PCC voltage[11], or by regulate the reactive power exchanged between the DSTATCOM and the distribution network [13]. This last method was adopted in this work. The instantaneous detection of the reactive power consumed or delivered by the load makes it possible to order the DSTATCOM so that it delivers or consumes this power, thus allowing to compensate the totality of the reactive power and consequently obtaining a unit power-factor side source. In this case, the reactive current reference *ifq* * is only the imaginary component of the current load.

SIMULATION RESULTS

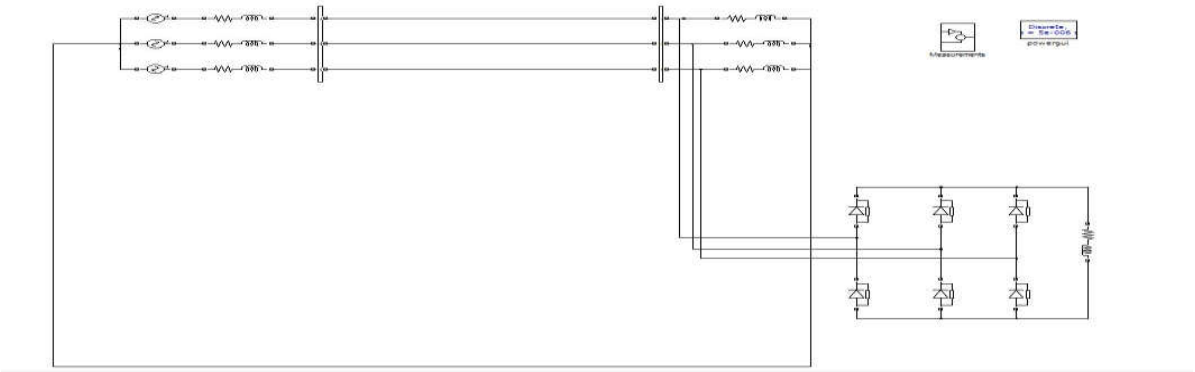

Fig.3.Matlab/Simulink model of the Power system Network with Linear and Non-Linear load with D-Statcom

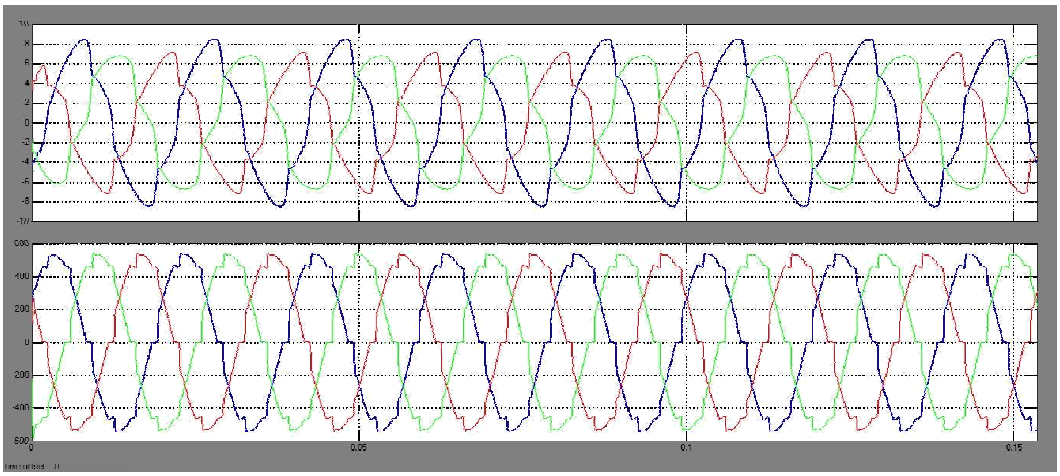

Fig.4.Simulated output wave form of the Source Current and Voltage of the Power system Network with Linear and Non-Linear load with D-Statcom

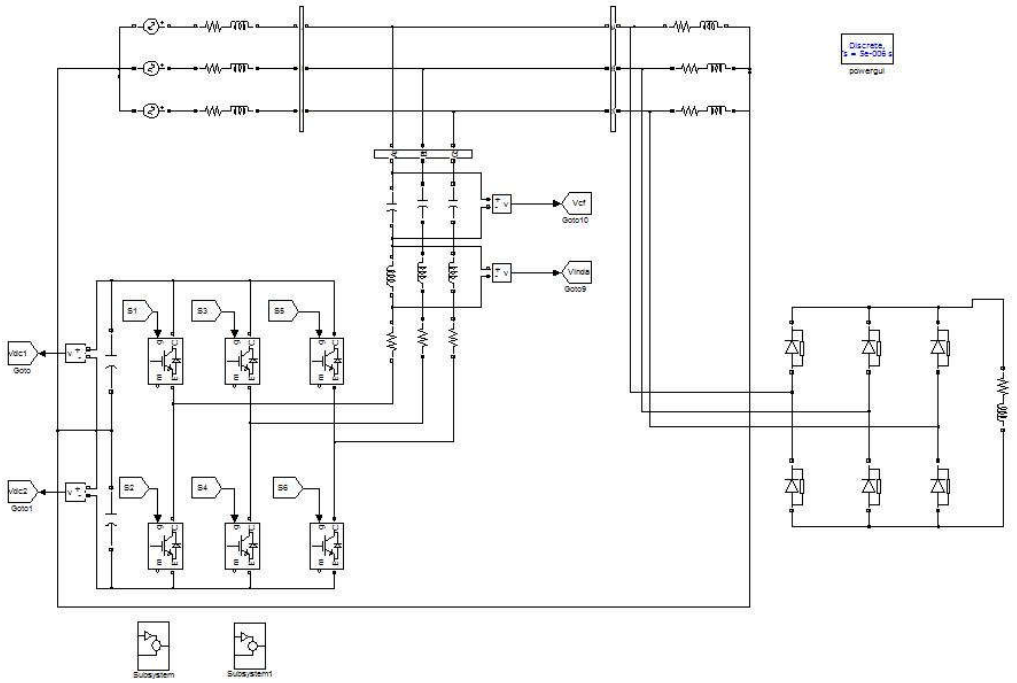

Fig.5.Matlab/Simulink model of proposed neutral clamped VSI topology-based DSTATCOM (hybrid filter).

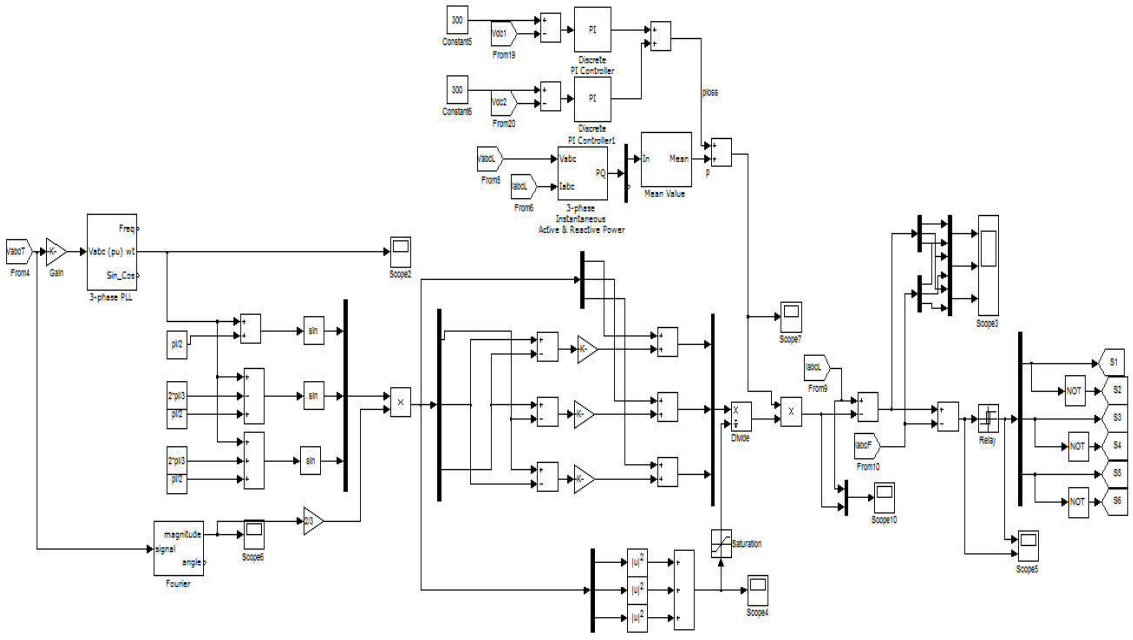

Fig.6.Matlab/Simulink model of Control circuit of proposed neutral clamped VSI topology-based DSTATCOM (hybrid filter).

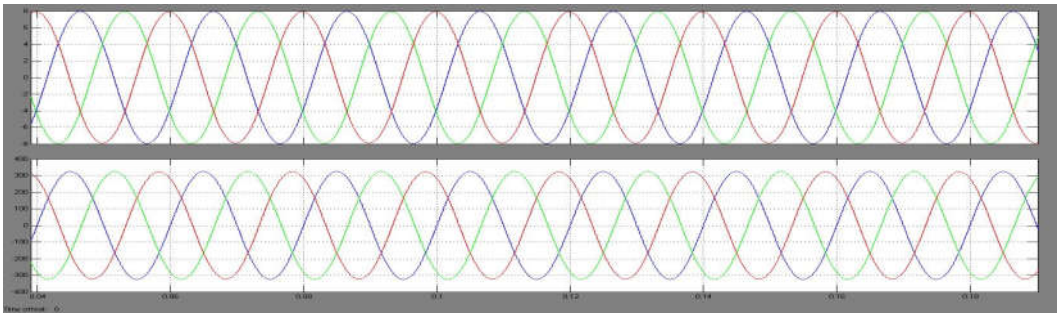

Fig.7.Simulated output wave forms of the Terminal current and voltage

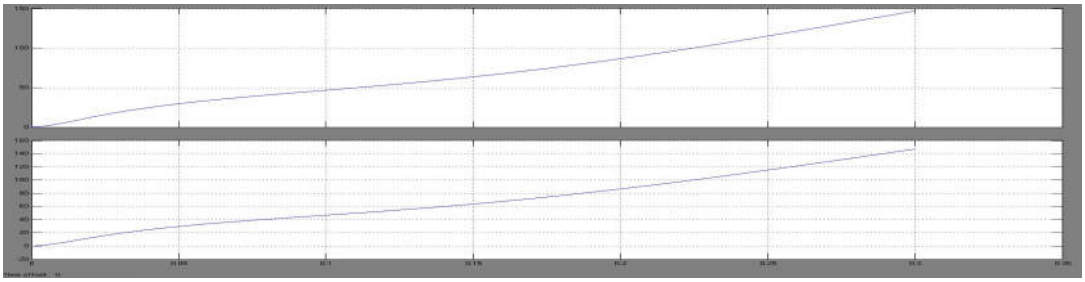

Fig.8.Simulated output wave forms of the Dc Capacitor voltages

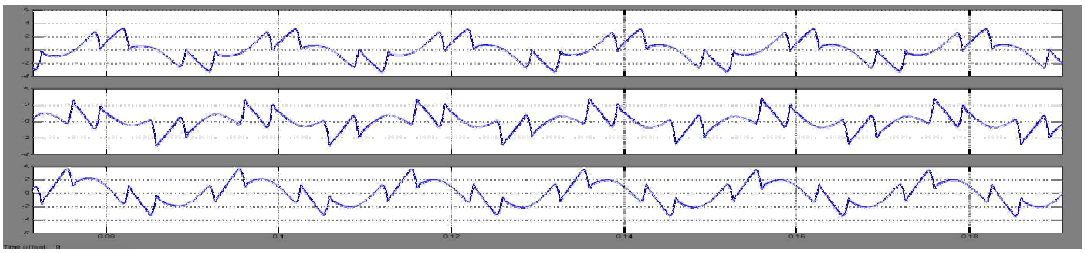

Fig.9.Simulated output wave forms of the Filter currents

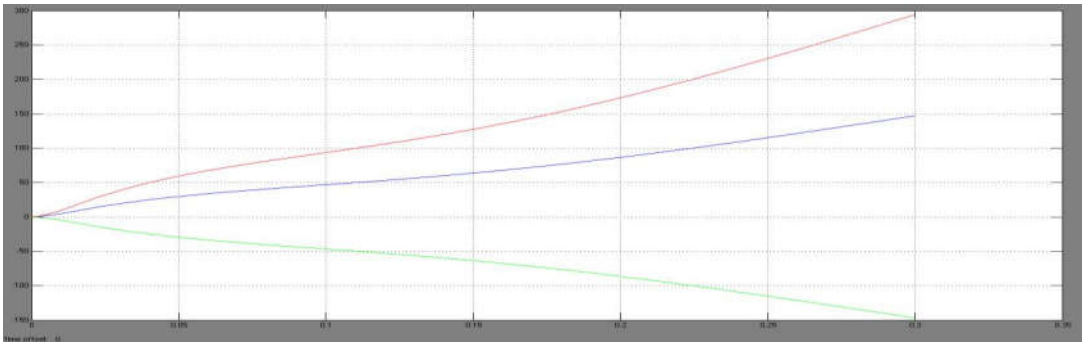

Fig.10.Simulated output wave forms of dc-link voltage (*V*dc1 + *V*dc2)

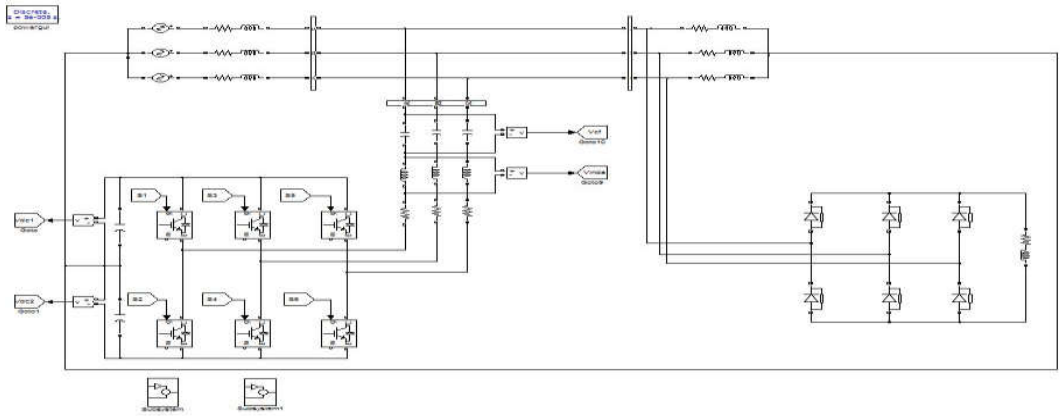

Fig.10.Matlab/Simulink model of proposed neutral clamped VSI topology-based DSTATCOM With fuzzy logic Controller.

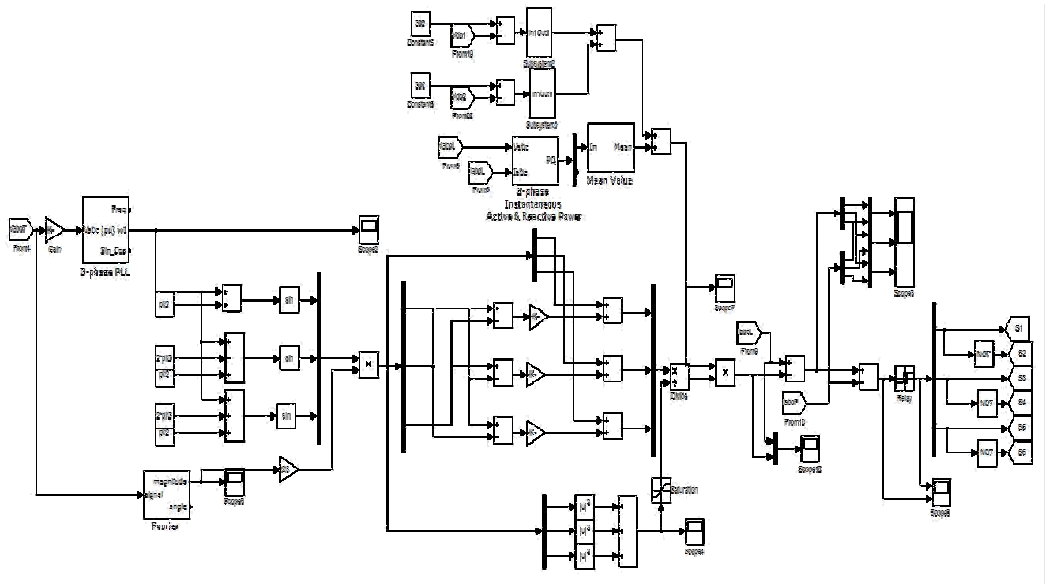

Fig.11.Matlab/Simulink model of Control circuit of proposed neutral clamped VSI topology-based DSTATCOM With fuzzy logic controller.

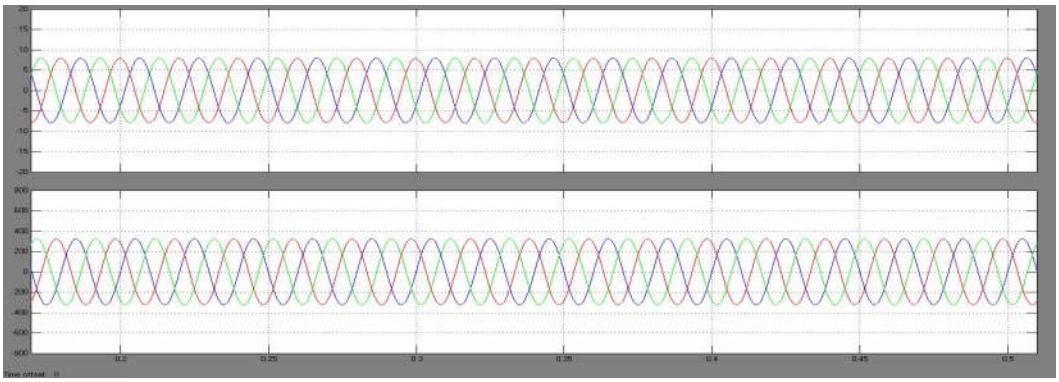

Fig.12.Simulated output wave forms of the Terminal current and voltage with Fuzzy Logic Controller

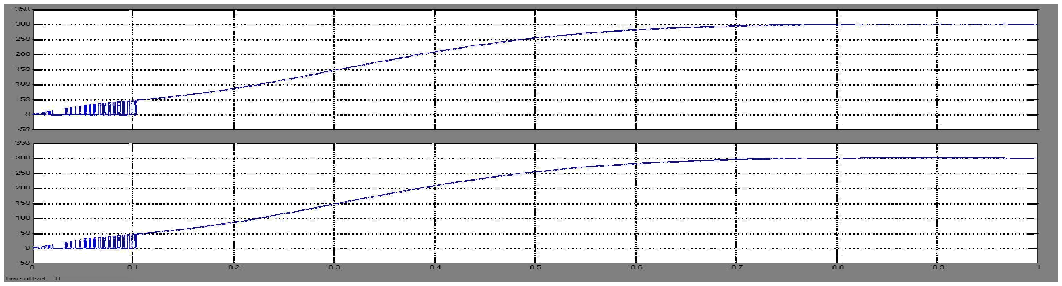

Fig.13.Simulated output wave forms of the Dc Capacitor voltages with Fuzzy logic Controller

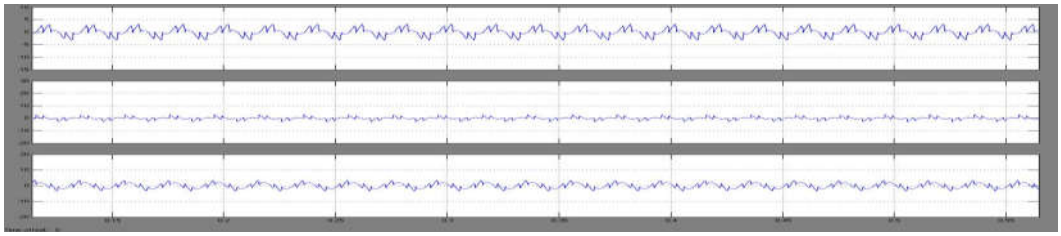

Fig.14.Simulated output wave forms of the Filter currents with Fuzzy logic Controller

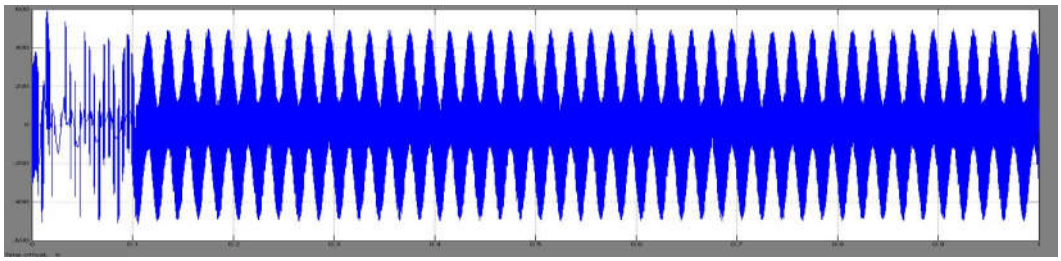

Fig.15.Simulated output wave forms of the Inductor current with fuzzy logic controller

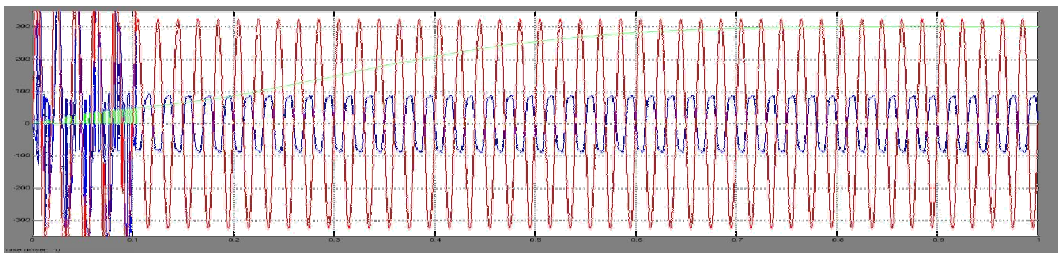

Fig.16.Voltage across top dc capacitor, series filter capacitor, and terminal voltage

CONCLUSION

In this paper, the behavior of DSTATCOM connected to a distribution network is studied either in inductive mode or in capacitive mode. We have proposed a design procedure of fuzzy logic controller for providing reactive power compensation at the point of connection PCC. The study was beginning by a phase of DSTATCOM description consist those topology and mathematical model followed by the synthesis of their control using fuzzy logic and finally discuss the simulation results.The performance of DSTATCOM has been found satisfactory various control strategies. For estimation of active and reactive power components of load currents only numerical integration is used so it has been found simple and accurate compared to others control algorithms. The DC bus voltage of the DSTATCOM has also been regulated without much overshoot to desired value under concern control schemes. It is shown that the proposed topology provides superior current compensation compared to traditional topology using a much lower value of dc link voltage as well as interfacing filter inductor. Therefore, the cost, size, weight, and power rating of the DSTATCOM will be significantly reduced compared to traditional topology. A procedure to design LCL filter parameters and series capacitor has been presented. Effectiveness of the proposed DSTATCOM topology over traditional topology is verified through extensive simulation using Matlab/Simulink.

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