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Functioning Of D-Statcom for Load Voltage Regulation Based Fuzzy Controller

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Abstract: *In this Project, a new D-STATCOM topology with reduced dc link voltage is proposed. The distribution static compensator (D-STATCOM) is used for load compensation in power distribution network. In the presence of feeder impedance, the inverter switching distorts both the PCC voltage and the source currents. In this situation, the source is termed as nonstiff. In this paper, a new topology for D-STATCOM applications with non stiff source is proposed. 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 D-STATCOM 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. The series capacitor enables reduction in dc-link voltage while simultaneously compensating the reactive power required by the load, so as to maintain unity power factor without compromising D-STATCOM performance. The shunt capacitor, along with the state feedback control algorithm, maintains the terminal voltage to the desired value in the presence of feeder impedance with the reduction in dc-link voltage, the average switching frequency of the insulated gate bipolar transistor switches of the D-STATCOM is also reduced. Consequently, the switching losses in the inverter are reduced. Detailed design aspects of the series and shunt capacitors are discussed in this paper. 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.

Introduction

A growing demand for excessive nice, reliable electric electricity and growing variety of distorting masses may also results in an improved awareness of energy first-class both by clients and utilities. The maximum not unusual strength excellent issues these days are voltage sags, harmonic distortion and coffee strength factor. Voltage sags is a brief time (10 ms to 1 minute) occasion throughout which a reduction in R.M.S voltage magnitude takes place. It is regularly set best with the aid of two parameters, depth/importance and period. The voltage sags magnitude is ranged from 10% to ninety% of nominal voltage and with period from 1/2 a cycle to 1 minimum.

FACTS Controllers:

With the speedy development of power electronics, Flexible AC Transmission Systems (FACTS) gadgets were proposed and implemented in power systems. FACTS gadgets may be utilized to control strength glide and beautify device balance. Particularly with the deregulation of the energy marketplace, there is a growing interest in using FACTS gadgets within the operation and control of electricity structures with new loading and energy drift situations. A higher utilization of the existing power structures to growth their capacities and controllability via installing FACTS devices will become imperative.

Definition of FACTS:

According to IEEE, FACTS, that's the abbreviation of Flexible AC Transmission Systems, is described as follows:

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Alternating current transmission systems incorporating strength electronics based and different static controllers to beautify controllability and electricity switch capability.

The simple packages of facts-devices are:

• Power Flow Control.

• Increase of Transmission Capability.

• Voltage Control.

• Reactive Power Compensation.

• Stability Improvement.

• Power Quality Improvement.

• Power Conditioning.

• Flicker Mitigation.

• Interconnection of Renewable and Distributed Generation and Storages.

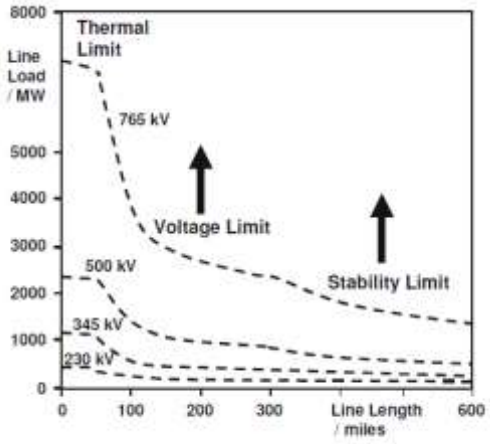


Figure 1.1 suggests the fundamental concept of data for transmission systems.

The improvement of statistics-gadgets has commenced with the developing skills of strength electronic components. Devices for excessive energy stages had been made available in converters for excessive and even maximum voltage stages. The overall starting points are community factors influencing the reactive strength or the impedance of part energy system.

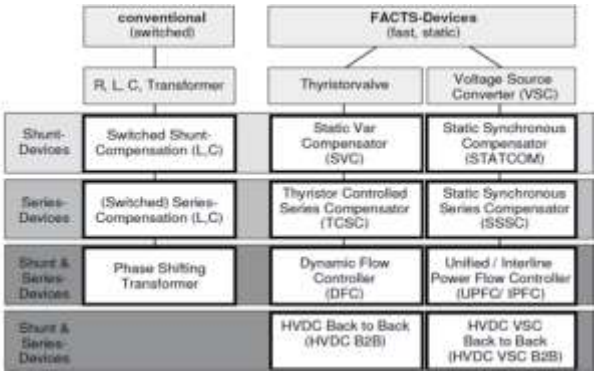
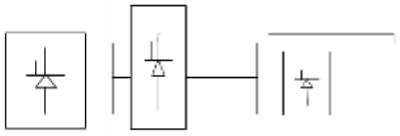
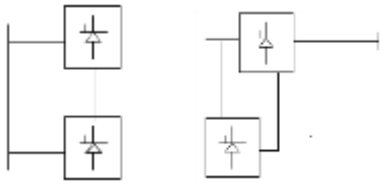


Figure 1.2 suggests some of simple gadgets separated into the conventional ones and the information-gadgets.

Symbols for FACTS Controllers:



(a) (b) (c)



(d) (e)

Fig.1.3: general symbols of FACTS controllers

(a) General symbol for a FACTS Controller

(b) Series controller

(c) Shunt controller

(d) Combined series-series controller

(e) Combined shunt-series controller

SCHEME OF D-STATCOM
Distribution Static Compensator (D-STATCOM):

A D-STATCOM (Distribution Static Compensator), which is schematically depicted in Figure, includes a two-level Voltage Source Converter

(VSC), a dc power storage device, a coupling transformer connected in shunt to the distribution network via a coupling transformer. The VSC converts the dc voltage across the garage device into a set of 3-section ac output voltages. These voltages are in segment and paired with the ac device through the reactance of the coupling transformer. Suitable adjustment of the section and value of the D-STATCOM output voltages permits powerful manipulate of energetic and reactive energy exchanges among the D-STATCOM and the ac machine. Such configuration allows the device to soak up or generate controllable lively and reactive power.

Modelling of the D-STATCOM:

A D-STATCOM consists of a 3-section voltage supply inverter shunt-related to the distribution network by using a coupling transformer. Its topology lets in the tool to generate a set of 3 almost sinusoidal voltages at the essential frequency, with controllable amplitude and section angle. In general, the D-STATCOM can be utilized for imparting voltage regulation, strength aspect correction, harmonics reimbursement and load levelling. The addition of energy garage via the best interface to the energy custom tool ends in a greater flexible included controller. The ability of the D-STATCOM/ESS of offering efficiently extra lively energy allows increasing its compensating moves, lowering transmission losses and improving the operation of the electric grid.

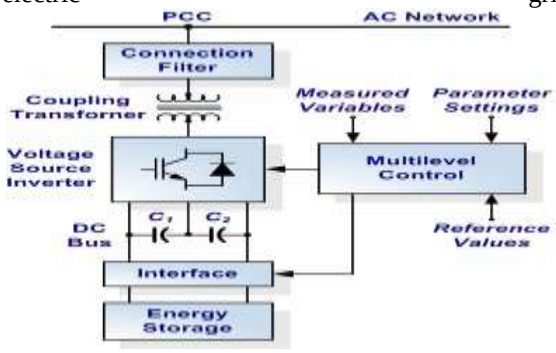


Fig 2.3 Basic circuit of a D-STATCOM

Basic Configuration and Operation of D-STATCOM:

The D-STATCOM is a 3-section and shunt connected energy electronics based device. It is attached near the load at the distribution structures. The predominant components of a D-STATCOM are shown. It consists of a dc capacitor, three-segment inverter (IGBT, thyristor) module, ac filter, coupling transformer and a control strategy .The simple digital block of the D-STATCOM is the voltage-sourced inverter that converts an input dc voltage into a three-section output voltage at fundamental frequency.

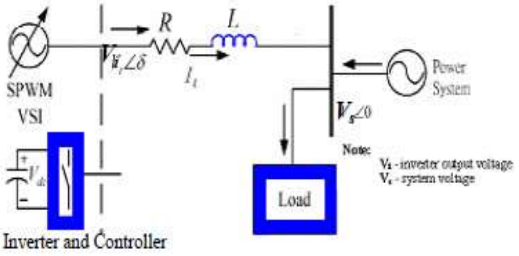


Fig 2.5 Basic Building Blocks of the D-STATCOM

LITERATURE SURVEY

Power Quality:

Our technological international has emerge as deeply dependent upon the continuous availability of electrical energy. In maximum nations commercial power is made to be had through national grids, interconnecting severa producing stations to the loads. The grid ought to deliver primary country wide needs of residential, lights, heating, refrigeration, air con and transportation as well as vital supply to governmental, business, monetary, commercial, and medical and communications groups. Commercial electricity actually allows nowadays modern world to function at its busy tempo.

Many electricity troubles originate inside the business power grid, which with its heaps of miles of transmission strains is concern to weather conditions along with hurricanes, lightning storms, snow, ice and flooding along with device failure, site visitors injuries and essential switching operations. Also strength troubles affecting nowadays technological device are frequently generated domestically inside a facility from any number of conditions including local construction, heavy begin up hundreds, defective distribution components or even traditional history electrical noise.

PROPOSED D-STATCOM CONCEPT

4.1D-STATCOM IN THE POWER DISTRIBUTION SYSTEM

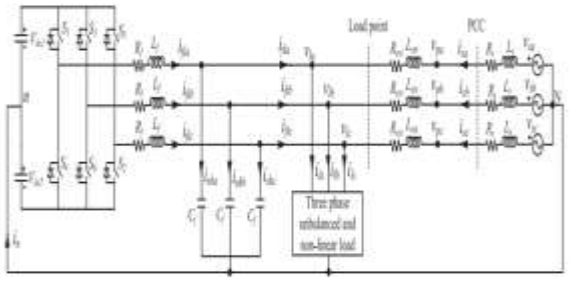


Fig.4.1. Three-phase equivalent circuit of D-STATCOM topology in the distribution system.

The Fig.4.1 shows the power circuit diagram of the D-STATCOM topology linked inside the distribution system. Ls and Rs are source inductance and resistance, respectively. An outside inductance Lext is covered in collection between load and supply factors. This inductor helps D-STATCOM to gain load voltage regulation functionality even in worst grid conditions, i.e., resistive or stiff grid. From IEEE-519 wellknown, factor of commonplace coupling (PCC) ought to be the factor which is obtainable to each the software and the patron for direct dimension. Therefore, the PCC is the factor where Lext is connected to the supply. The D-STATCOM is hooked up on the factor wherein load and Lext are connected. The D-STATCOM uses a 3-segment 4-cord VSI. A passive LC filter is attached in each section to filter out excessive-frequency switching components. Voltages throughout dc capacitors, Vdc1 and Vdc2, are maintained at a reference cost of Vdcref.

FLEXIBLE CONTROL STRATEGY

This sections presents a flexible control strategy to improve the performance of D-STATCOM in presence of the external inductor Lext. First, a dynamic reference load voltage based on the coordinated control of the load fundamental current, PCC voltage, and voltage across the external inductor is computed. Then, a proportional-integral (PI) controller is used to control the load angle, which helps in regulating the dc bus voltage at a reference value. Finally, three-phase reference load voltages are generated. The block diagram of the control strategy is shown in Fig.4.4

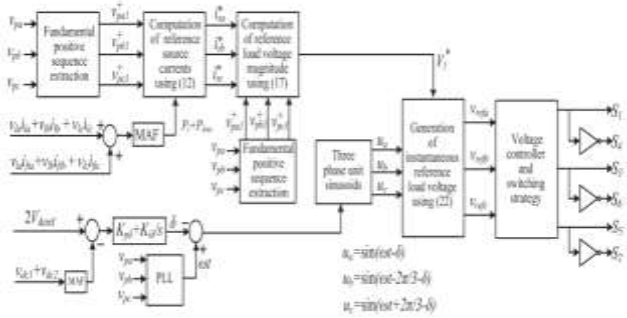


Fig.4.4. Block diagram of the proposed flexible control strategy.

MATLAB / SIMULATION RESULTS

5.1 About MATLAB / Simulation

MATLAB is a excessive-overall performance language for technical computing. It integrates computation, visualization, and programming in a smooth-to-use surroundings where issues and solutions are expressed in acquainted mathematical notation. Typical uses encompass-

- Math and computation
- Algorithm improvement
- Data acquisition
- Modeling, simulation, and prototyping
- Data evaluation, exploration, and visualization
- Scientific and engineering photos

MATLAB is an interactive gadget whose basic records detail is an array that does not require dimensioning. This allows solving many technical computing troubles, in particular people with matrix and vector formulations, in a fraction of the time it'd take to write down a program in a scalar non-interactive language along with C or FORTRAN.

MATLAB / SIMULATION RESULTS
I.EXISTING RESULTS

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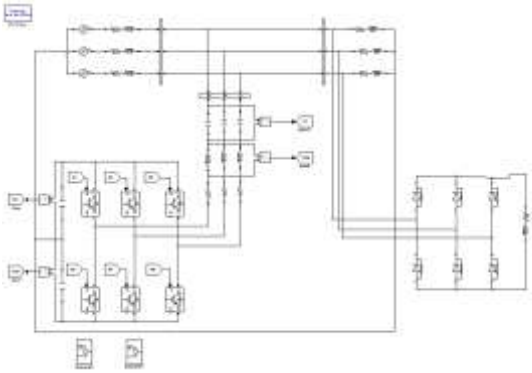

Fig 6.1 MATLAB/Simulink diagram of EXISTING SYSTEM

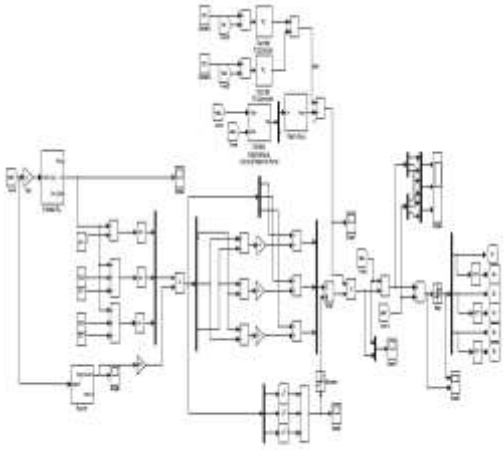

Fig 6.2 controller subsystem

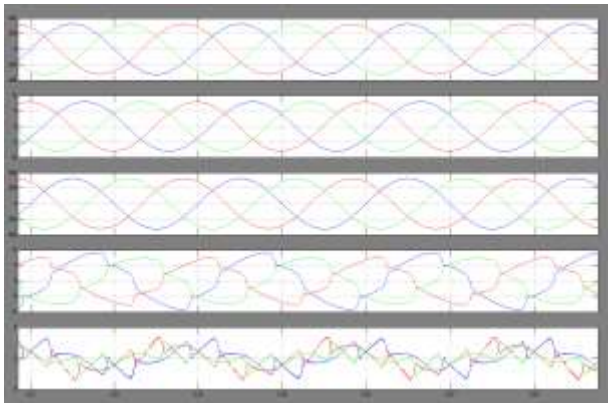

Fig 6.3Simluation results of normal operation Source voltage, Source current, Load voltage, Load current, filter current

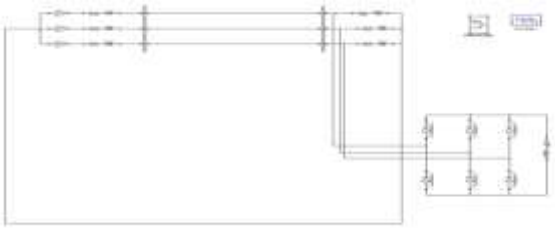

Fig 6.4 MATLAB/Simulink diagram WITH out D-STATCOM

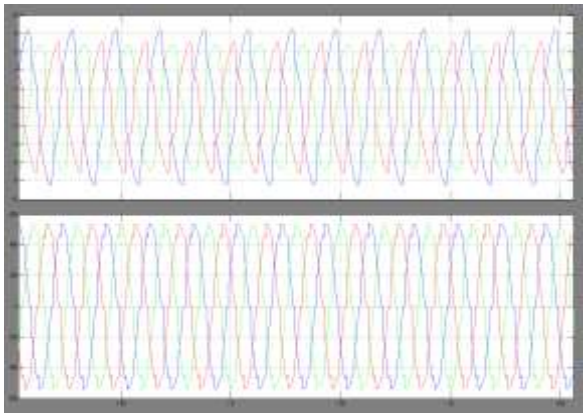

Fig 6.5 Source Current and Voltage

II. EXTENSION RESULTS

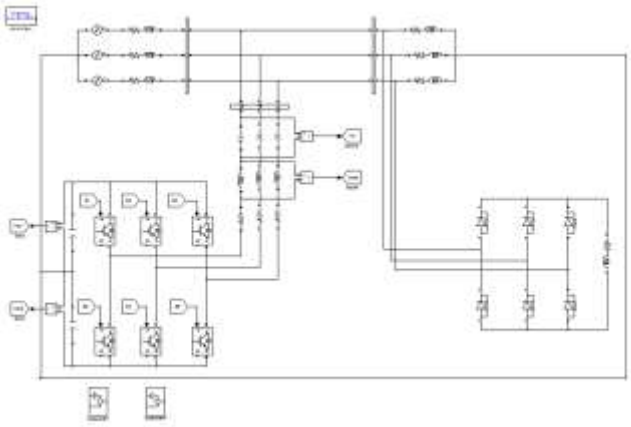

FIG 6.6 MATLAB/SIMULINK diagram of proposed system

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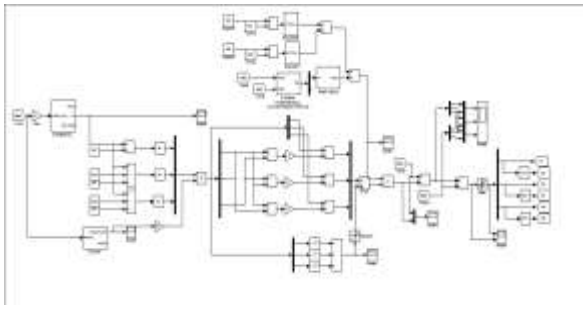

Fig 6.7 proposed controller

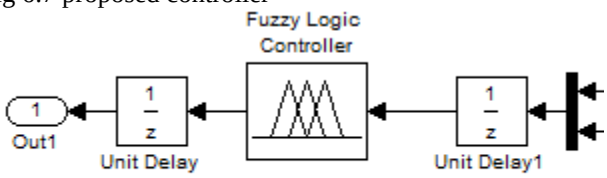

Fig 6.8 fuzzy controller subsystem

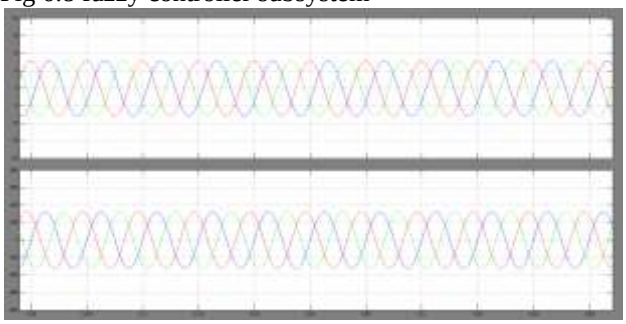

Fig 6.9 Source current and voltage

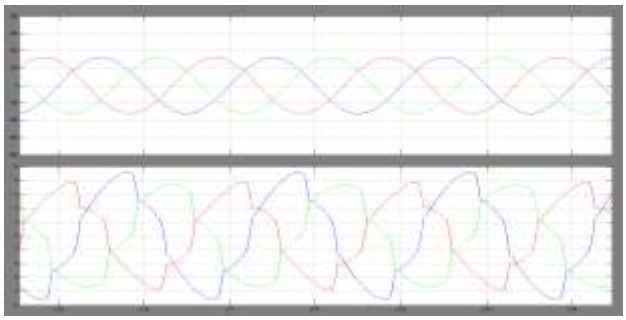

Fig 6.10 Load voltage and current

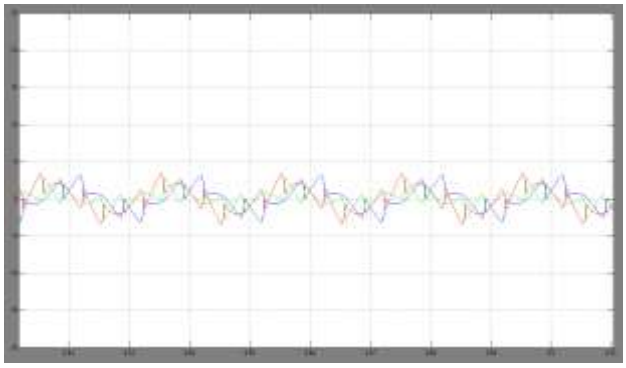

Fig 6.11 filter current

CASE1: UNDER SAG CONDITION

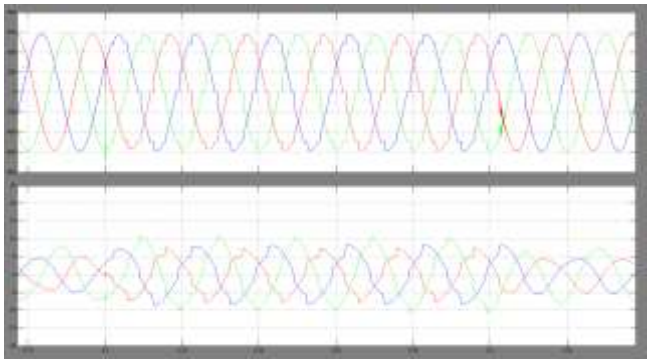

Fig 6.12 Source voltage and source current

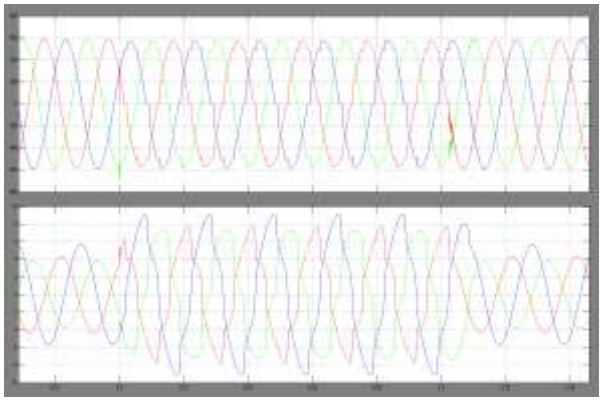

Fig 6.13 Load voltage and Load current

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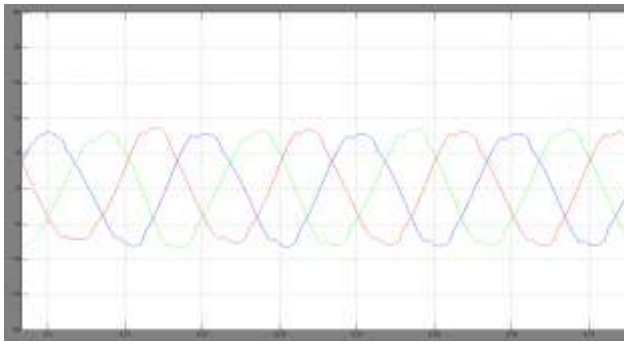

Fig 6.14 filter current

CASE 2: UNDER SWELL CONDITION

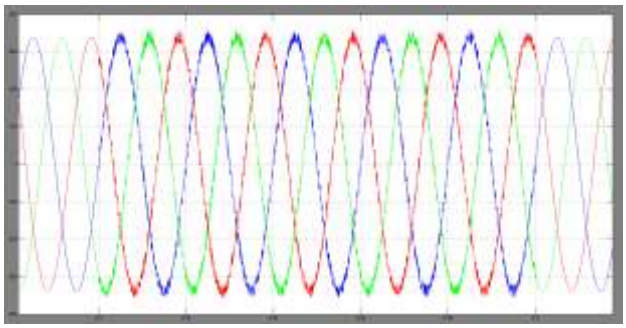

FIG 6.15 Load voltage

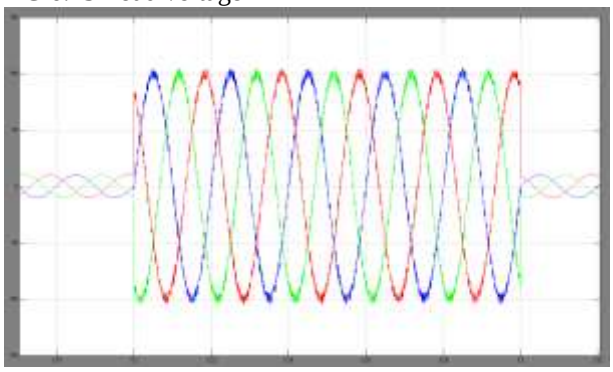

Fig 6.16 filter output voltage

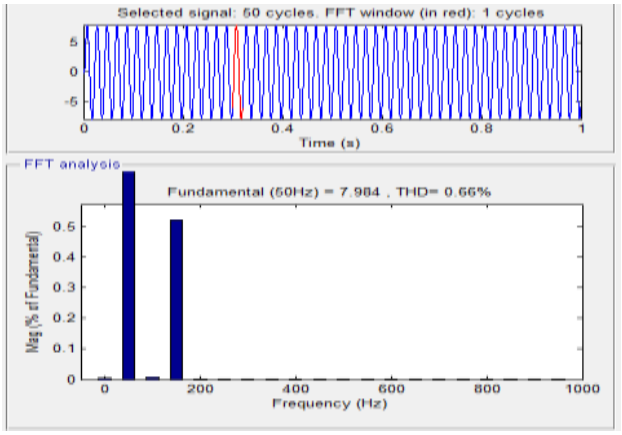

Fig 6.17 Thd % of Source current without fuzzy controller

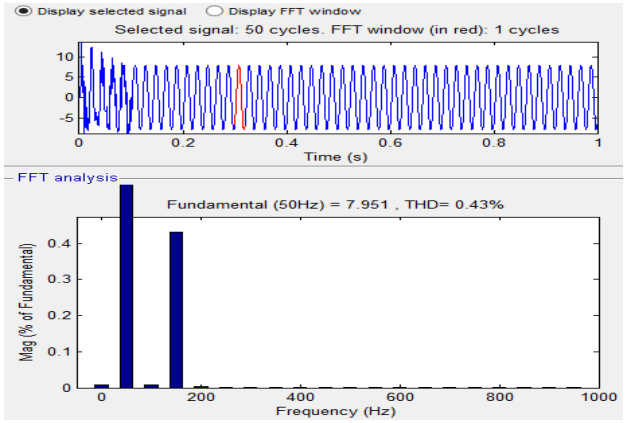

Fig 6.18 Thd % of Source current with proposed fuzzy controller

CONCLUSION

This paper has offered layout, operation, and control of a D-STATCOM operating in voltage manage mode (VCM). After offering an in depth exploration of voltage law functionality of D-STATCOM under numerous feeder scenarios, a benchmark layout method for selecting suitable value of external inductor is proposed. A set of rules is formulated for dynamic reference load voltage significance era. The D-STATCOM has progressed voltage law capability with a discounted modern rating VSI, decreased losses in the VSI and feeder. Also, dynamic reference load voltage era scheme allows D-STATCOM to set distinctive regular reference voltage for the duration of voltage disturbances.Simulation consequences validate the effectiveness of the proposed solution. The external inductor is a totally simple and reasonably-priced answer for enhancing the voltage law, but it stays linked at some point of the operation and continuous voltage drop throughout it

happens. The future paintings consists of operation of this constant inductor as a managed reactor in order that its impact may be minimized by means of varying its inductance.

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