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Comparision Of D-Statcom And E-Statcom For Mitigating Harmonic Distortion In Grid

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Abstract
With the sudden raise of pollution in India the government is focusing on Electrical Vehicles to control the pollution. By using EV's it reduces the noise pollution, environment pollution and cost of the fuel. To make the Electrical Vehicles efficient we are using new battery technologies and power electronic converters. In reactive power both storing and restoring. Due to reactive power that harmonics are generated. To reduce the harmonics, we use power quality devices are used. The EV are always kept in idle in parking lots and only used for short distance. In order to provide the harmonic and reactive power grid is possible by using D-STATCOM or E-STATCOM and shunt active filter. The main objective of this paper is comparison of D-STATCOM and E-STATCOM for reducing the power quality issues in grid. So, compared to D-STATCOM using E-STATCOM the efficiency of the system is high and the current harmonics are reduced. For efficient system, the THD should be less than five percent. As the result the devices connected to the grid will not be affected by the connection of a nonlinear load and improve the quality of the distorted grid.
Keywords: Phase Locked Loop (PLL), Low Pass Filter (LPF), D-STATCOM, E-STATCOM, Shunt Active Power Filter, Direct Quadrature frame(dq), Hysteresis Controller, PI Controller.

Introduction

The main focus of this paper are development of three phase grid connected voltage source inverter control in d-q, frame Development of charging/discharging control of EV battery connected to the DC link where EV battery will be represented using a constant DC Voltage source, modify control to incorporate D-STATCOM function and develop the control to add active filter features to the converter. But for the time being here the main objectives that we found by the work till is to maintaining the DC link voltage constant irrespective of current flowing to the inverter and to measure the amount of harmonic current and reactive power. Also, to provide the switching pulse in such a way that required amount of harmonic current should be given by the filter [3].

BLOCK DIAGRAM

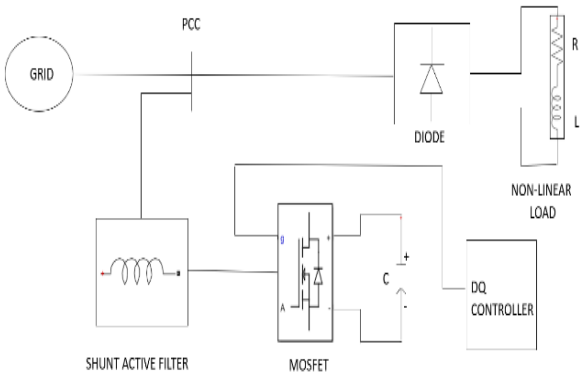

Fig1: Block Diagram of D-STATCOM

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D-STATCOM

It acts as a shunt compensator. STATCOM plays a key role in supporting the compensation of reactive power in the generation and transmission system. The STATCOM used in distribution side is known as D-STATCOM. In D-STATCOM consists of three main components voltage source converter, controller and coupling reactors. Where Metal Oxide Semiconductor Field Effect Transistor (MOSFET) is used for switching operations. Controller is based on the concept of pulse width modulation. Here the voltage source converter acts as a fully controllable. In order to reduce the reactive power loss, the PI controller is used here. The purpose of the PI controller is to generate the reference voltage with the sinusoidal PWM pulse. The DC capacitor is used to maintain the constant energy at the input of the D-STATCOM. The above fig1 shows the block diagram of D-STATCOM [11].

E-STATCOM

E-STATCOM stands for an energy unit added to the STATCOM. It is used in distribution line. The Battery is used to maintain the constant energy at the input of the E-STATCOM. The below figure shows the block diagram of E-STATCOM. The THD of the source current without connecting the DSTATCOM the THD is around 28.55%. By using D-STATCOM the THD value is reduced from 28% to 4.58%. By using E-STATCOM the THD value is reduced from 28% to 2.17%.

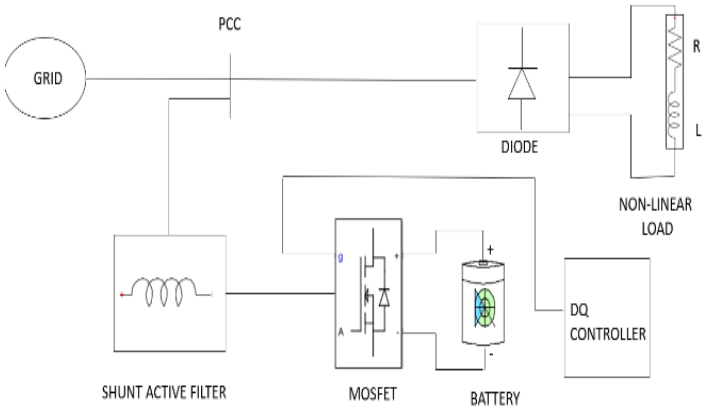

Fig2: Block Diagram of E-STATCOM

WORKING OF THE MODEL

Grid basically is a three-phase voltage source followed by voltage and current measurement from which we can see the source current and source voltage. It is connected to a non-linear load where NL load is observed as a diode bridge rectifier followed by the RL load. In the dc side has some amount of current and positive half cycle current won't be perfectly sinusoidal. It is non sinusoidal that mainly depend upon the load connected to the DC side. The AC side won't be perfectly sinusoidal. If the D-STATCOM or E-STATCOM didn't connect to the grid then whatever current needed by the load will be taken from the grid. Load requirement has harmonics because bridge rectifier is used here. If there is no additional arrangement for the current then the harmonics current will be taken from the grid as a result power quality condition of the current will decreases. Because there is only small value for resistance and reactance on the transmission line. NL current in the impedance causes NL voltage drop. Thus, that results in the distortion of the power quality of both voltage and current. So, to provide the harmonic current D-STATCOM or E-STATCOM is connected to the circuit. It can provide the required amount of reactive power to the load. [13]

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SIMULATION DIAGRAM

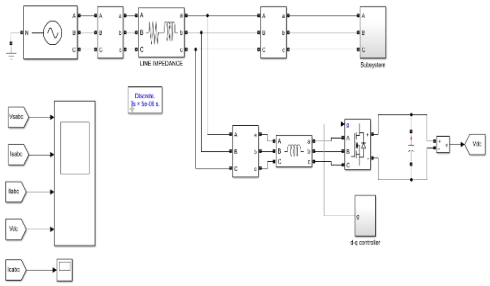

Fig3: Simulink Model of D-STATCOM

The major objective of this work is to maintain the DC link voltage constant irrespective of the current flowing to the inverter. The second objective is to measure the amount of harmonic current and reactive power required by the load. The ammeter or kind of special meters cannot be placed across the load or in some cases the load destination will be far from the filter also there is lack of adequate communications. The only measurement can be taken in the voltage and current at the point of common coupling. The third objective is to measure the amount of harmonic current and reactive power also to provide the switching pulses in such a way that the required amount of harmonic current should be given by the filter.

SIMULATION SETUP

Here when we are connecting a non-linear load which is taken as a diode bridge rectifier followed by a RL load. Because of the NL connected in the DC side result in the non-sinusoidal pulse at the AC side. This is mainly due to the harmonic generation by the non-linear load. If there is no arrangement then the harmonics will be taken from the grid. As a result, the power quality of the grid will be distorted. So, to avoid this a D-STATCOM is added in between a source and a load. Which provides required amount of reactive power to the load. Here STATCOM will also act as an Active Power Filter. It is modelled in such a way that whatever may be the amount of harmonic current needed will provide by the Active Power Filter. So, by the usage of the D-STATCOM it provides the harmonic current and as a result grid can seen a perfectly sinusoidal signal [11]. The difference can be seen by comparing a D-STATCOM and E-STATCOM. To maintain the DC voltage across a capacitor to be constant PI controller is used in D-STATCOM. To maintain the DC voltage across a battery to be constant PI controller is used in E-STATCOM. In order to get a DC component a LPF is also used. To switch the inverter of D-STATCOM in such a way that AC side current of the inverter should exactly track the reference current. So, we can use hysteresis controller.

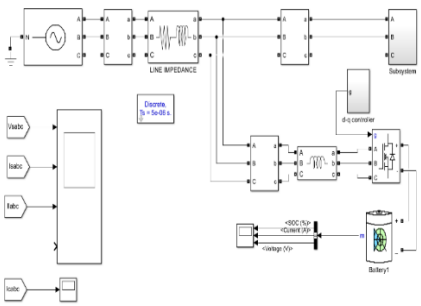

Fig4: Simulink Model of E-STATCOM

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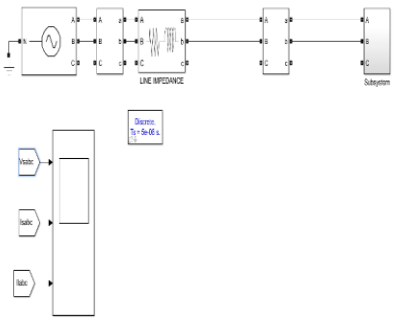

Fig 5: Simulink model without D-STATCOM

SIMULINK RESULTS

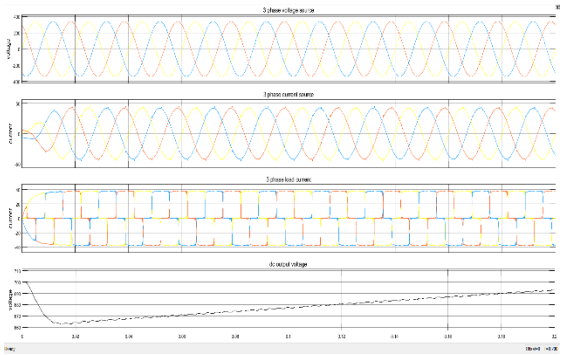

Fig 6: Simulink waveform when D-STATCOM is Connected

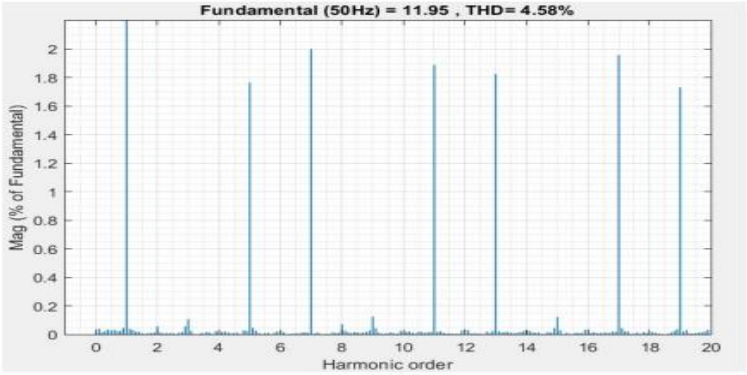

Fig 7: THD Waveform When D-STATCOM is Connected

This shows the results of the Simulink diagram model which discussed in previous section. Fig: shows the waveform of the D-STATCOM connected the first graph explains the source voltage, second graph explain the source current, third graph shows the load voltage which is distorted by the nonlinear load and fourth graph explain the output voltage. Fig5: shows the THD value of the source current is around 4.58% which is nearly a distortion less waveform when D-STATOM is connected. Fig5: shows the THD value of the source current is around 2.17% which is nearly a distortion less waveform when E-STATOM is connected. The THD of the source current without connecting the DSTATCOM the THD is around 28.55%. By using D-STATCOM the THD value is reduced from 28% to 4.58%. By using E-STATCOM the THD value is reduced from 28% to 2.17%. So, comparing with D-STATCOM by using E-STATCOM thus the distortion is reduced, so E-STATCOM is preferable.

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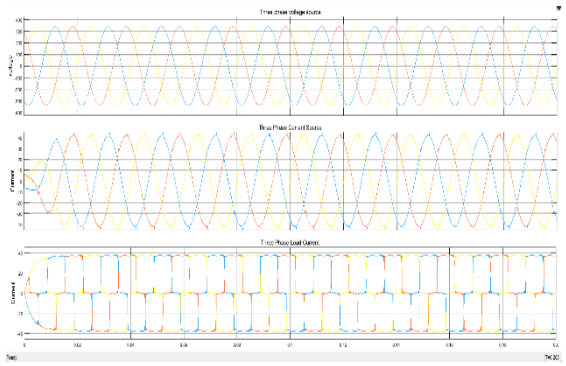

Fig 8: Simulink Waveform When E-STATCOM is Connected

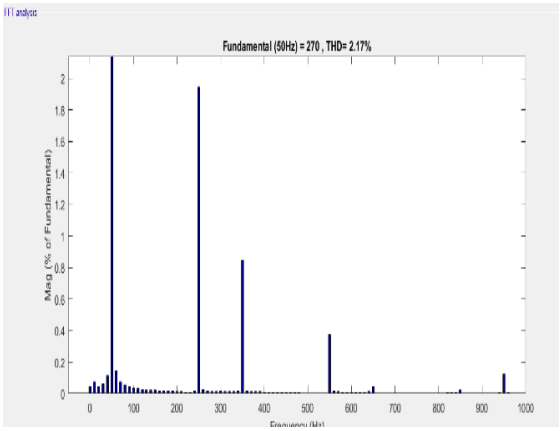

Fig 9: THD Waveform When E-STATCOM is Connected

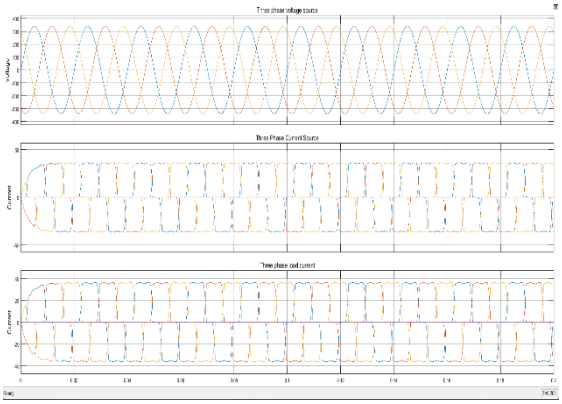

Fig 10: Simulink waveform when D-STATCOM is not connected

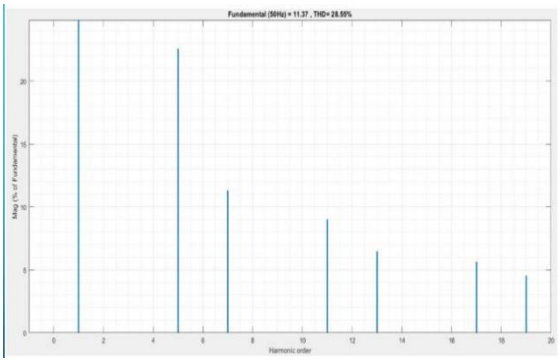

Fig 11: THD value without D-STATCOM

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CONCLUSION

The aim of this project is Comparisons of D-STATCOM and E-STATCOM, by using this two STATCOM's we can reduce the THD Value and to make the system efficient. Source Current of the D-STATCOM and E-STATCOM connected grid has a THD of less than 5 percent. Without Connecting the STATCOM's the THD value is around 28 percent. Comparing with D-STATCOM by using E-STATCOM the THD value is reduced to half of the D-STATCOM. So, power quality is improved.

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