Simulate to Power Quality or Improvement in D-Statcom with and without connected to Grid during voltage sag Problems

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ABSTRACT:-

D-STATCOM is a compensation device that is used to control the flow of reactive power in distribution systems. Most of the loads in this system, being inductive in nature, consume more reactive power. As a result, the load power factor deteriorates and this limits the active power flow in the line. The document aims to develop a D-STATCOM, based on the voltage source converter, which injects the reactive power into the distribution line. The output voltage of D-STATCOM is brought to the system voltage to control the generation of VAR. The implementation of D-STATCOM through the use of the PI controller is carried out in MATLAB / Simulink.

Keywords: D-STATCOM, voltage source converter (VSC), reactive power.

1.1 INTRODUCTION ─FACTS devices provide fast and reliable control over transmission parameters, such as voltage, line impedance and phase angle between the emitting end and the receiving final voltage. On the other hand, the custom power device is used for low voltage distribution and improves the quality of energy thanks to which the system becomes reliable. Custom power devices are very similar to FACTS devices. The best known custom power devices are D-SATCOM, UPQC, DVR among them. D-STATCOM is well known as it can provide a cost effective solution for reactive power compensation. A FACTS is a device based on power electronics that maintains energy quality by maintaining a better energy flow and controls the dynamic stability of the system by changing system parameters, such as voltage, phase angle and impedance. The static distributed compensator (D-STATCOM) is used in this document. A D-STATCOM is a VSI-powered electronic power supply device that is referred to the network to mitigate harmonics and other power quality problems. The performance of D-STATCOM depends on different control algorithms that are used for the extraction of reference currents and to provide pulses to the VSI gate terminals. A review of the literature on different types of studies on D-STATCOM was performed. The D-STATCOM is highly effective in providing charge voltage regulation; However, maintaining the charging voltage at the nominal value has several undesirable effects from the customer's point of view. With voltage of 1p.u. At the point of charge, DSTATCOM forces the load to always work at nominal power. The STATCOM used in distribution systems is called DSTATCOM (Distribution-STATCOM). You can exchange active and reactive power with the distribution system by varying the amplitude and phase angle of the converter voltage with respect to the line terminal voltage.

2.1 DSTATCOM principle: -

A D-STATCOM (Static Distribution Compensator), which is schematically depicted in Figure 1, consists of a two-level voltage source converter (VSC), a DC energy storage device, a coupling transformer connected by branch to the distribution network through a transformer coupling. The VSC converts the DC voltage in the storage device into a set of three-phase AC output voltages. These voltages are in phase and combined with the AC system through the coupling transformer reactance The proper adjustment of the phase and the magnitude of the D-STATCOM output voltages allows an effective control of the active and reactive power exchanges between the D-STATCOM and the AC system Such a configuration allows the device to absorb or generate controllable active and reactive energy.

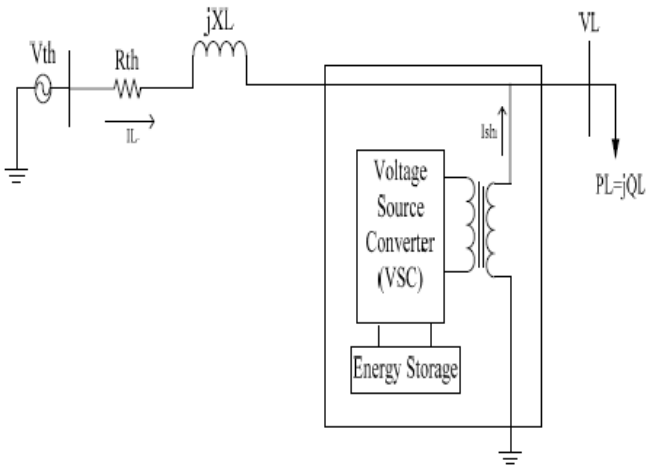

Fig. 2.1 Schematic diagram of D-STATCOM

The VSC connected bypass with the AC system provides a multifunctional topology that can be used for three very different purposes: 1. Voltage regulation and

reactive power compensation; 2. Power factor correction; 3. Elimination of current harmonics. Here, said device is used to provide continuous voltage regulation using an indirectly controlled converter. As shown in Figure 1, the current injected into Ish corrects the voltage drop by adjusting the voltage drop across the system's impedance Zth. The value of Ish can be controlled by adjusting the output voltage of the converter.

2.2 D-STATCOM operation

D-STATCOM is a bypass device used to regulate the system voltage by generating and absorbing reactive power. The network is connected to D-STATCOM through the transformer and D-STATCOM consists of a PWM inverter and a PWM inverter consisting of two IGBT bridges. On the DC side of the inverter, a capacitor provides DC link voltage and that capacitor draws power from the grid for charging. The D-STATCOM controller provides control of the DC link voltage and bus voltage. The main function of D-STATCOM is to synchronize the bus voltage generating and absorbing reactive power, as well as a static thyristor compensator (TSC). The transfer of reactive power between the network and D-STATCOM is possible by the leakage reactance of the coupling transformer by using a secondary voltage in phase with the primary voltage (network side). The secondary side is D-STATCOM and the primary side is the network. There are two conditions for the operation that are (also shown in Figure 1): (1) If the bus voltage is higher than the secondary, then the D-STATCOM absorbs the reactive power as an inductor.
(2) If the bus voltage is less than the secondary voltage, then the D-STATCOM generates reactive power as a capacitor.

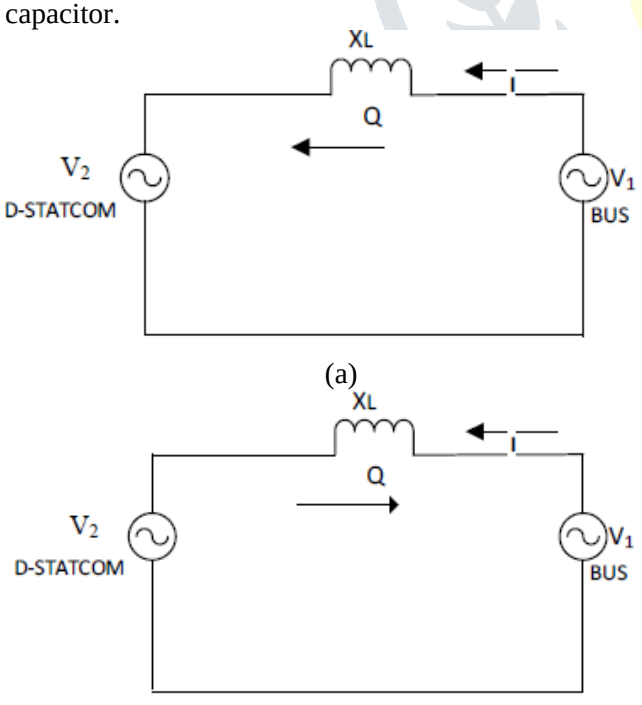

Figure 2.2 Operation D-STATCOM (a) inductive operation (b) capacitive operation In steady state condition, D-STATCOM produces a small active power to compensate for inverter losses and the bus voltage drives the inverter voltage at a small angle .

3.1 It can be described in the following points:

DSTATCOM is a device that is considered a controlled source of current. The most fundamental purpose of a voltage source converter (VSI) is to generate AC voltages in sinusoidal forms with an insignificant harmonic disturbance that occurs from a DC voltage source. The processes in the operation of D-STATCOM are those mentioned above: The voltage of the AC bus voltage system (Vs) first coincides with the voltage of the VSI voltage.

(1) The D-STATCOM acts as an inductance connected to the terminals of the AC system, when the VSI voltage (Vc) is less than the AC bus voltage. (yes)

(1) Or, the AC system sees the DSTATOM as a capacitance connected to its terminals, that is, magnitude of AC bus voltage <Vc

(2) There will be no exchange of reactive power if the Vc voltages and the AC bus voltage are equal. DSTATCOM supplies real power to the distribution system from its DC source or available power. This is achieved by calibrating the phase angle of the AC power system with the phase angle of the D-STATCOM. When the phase angle of the AC power system leads to the VSI phase angle, DSTATCOM absorbs the actual power of the AC system, if the phase angle of the AC power system is less than the VSI phase angle, D-STATCOM supplies real power to the AC system "(Kumar. S et al, 2011). [1] The principle of operation of a D-STATCOM can be seen in Figure 1.
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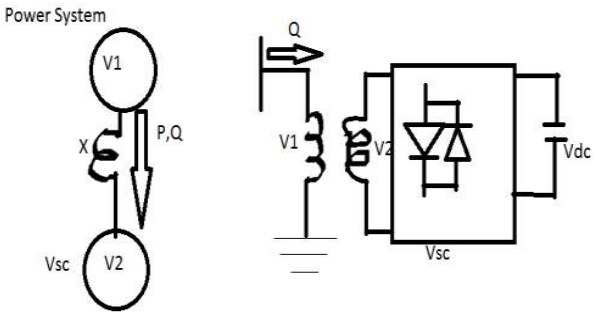

Figure3.1: Operating principle of a D-STATCOM

3.2 VOLTAGE SOURCE CONVERTER (VSC): -

A voltage source converter is an electronic power device that is connected in shunt or parallel to the system. It can generate a sinusoidal voltage with any required magnitude, frequency and phase angle. The VSC used to completely replace the voltage or inject the "missing voltage". The "missing voltage" is the difference between the nominal voltage and the actual voltage.

Proper adjustment of the phase and magnitude of the D-STATCOM output voltages allows effective control of the active and reactive power exchanges between the D-STATCOM and the AC system. In addition, the

converter is usually based on some type of energy storage, which will supply the converter with a DC voltage

3.3 CONTROLLER: -

The objective of the control scheme is to maintain a constant voltage magnitude at the point where a sensitive load is connected, under system perturbations. The control system only measures the r.m.s voltage at the load point, that is, no reactive power measurements are required. The VSC switching strategy is based on a sinusoidal PWM technique that offers simplicity and good response. As custom power is a relatively low power application, PWM methods offer a more flexible option than the fundamental frequency switching (FFS) methods favored in FACTS applications. In addition, the high switching frequencies can be used to improve the efficiency of the converter, without incurring significant switching losses.

3.4 Control system of a D-STATCOM

Figure From figure 2 the composition of a control system is represented.

• The V5 sequence part of primary voltage of the 3 phase is coordinated and combined with the phase locked loop (PLL). The quadrature and the components of the direct axis are calculated with the help of the outputs (angle Θ = ωt) of the PLL. The components of the shaft are currents and voltages of 3-φ AC and are given in Figure 2.4 as Id, Iq and Vd, Vq.

• Parts q and d of the AC positive sequence voltage are calculated with the help of measuring systems and also help regulate Vdc. The regulation loop on the outside side is for regulating voltages consisting of a DC and an AC voltage regulator. I qref is known as the reference current and is the output of the AC voltage regulator (Iq = quadrature current with voltage that is needed to control reactive power flow). Id ref (where Id is the current that is in phase with the voltage that controls the active power flow) is produced by the DC voltage regulator.

• The current regulation device forms the internal circuit of current regulation. The phase and magnitude of the voltage generated by the pulse width modulator converter (V2d V2q) acquired from the reference currents Iqref and Idref produced by the AC and DC voltage regulator (when operating in control mode) voltage). Feed forward type regulator helps the current controller to predict V2, which is the voltage output (V2d V2q), from the measurement V1. (V1d V1q) and also find the transformer leakage reactance

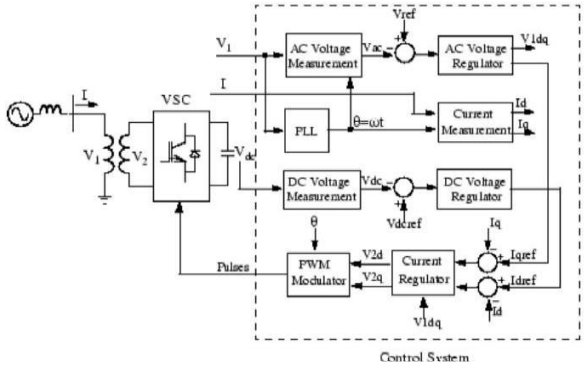

Figure 3.4: block diagram of the control system

3.5 Operating modes of a DSTATCOM

Figure 3, 4 represents three modes of operation of D-STATCOM with its output current known as I, which changes according to Vi. If Vi = Vs, then the reactive power will be 0 and also D-STATCOM will not produce or reduce the reactive power. Whenever Vi is greater than V, D-STATCOM will represent an inductive reactance in its terminal. The current known as I moves through the transformer reactance of the D-STATCOM system to the A.C system, and the equipment will generate capacitive reactive power. When Vs is more than Vi, D-STATCOM is seen by the system as a capacitive reactance. When the current flow comes from the A.C. for D-STATCOM, the absorption of inductive power will result.

In Figure 3.5, we see that part (a) shows the No load mode (Vs = Vi), part (b) shows Capacitive mode (Vi> Vs), part (c) shows Inductive mode (Vi < Vs)

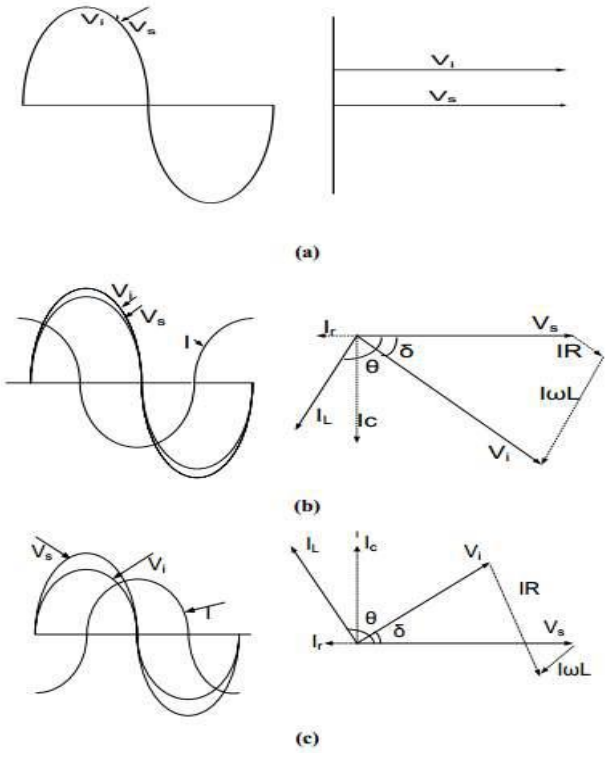

Figure 3.5: shows different modes of operation

4.1. RESULTS OF THE SIMULATION: -

4.1.1 Uncompensated line

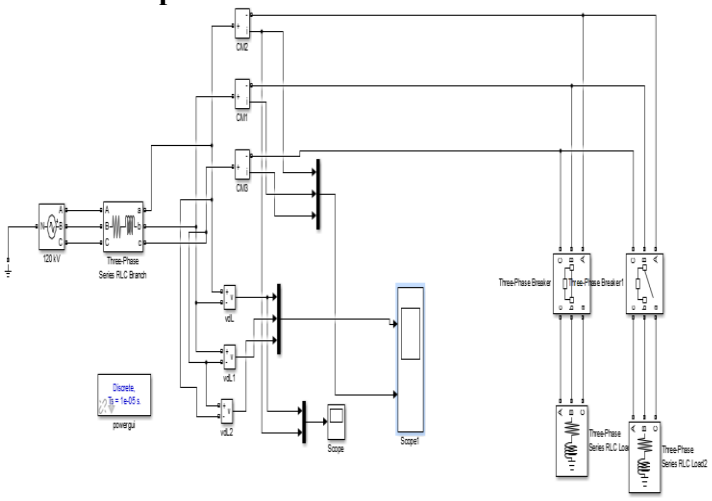

Fig.4.1.1 Simulink model of uncompensated line with Inductive load

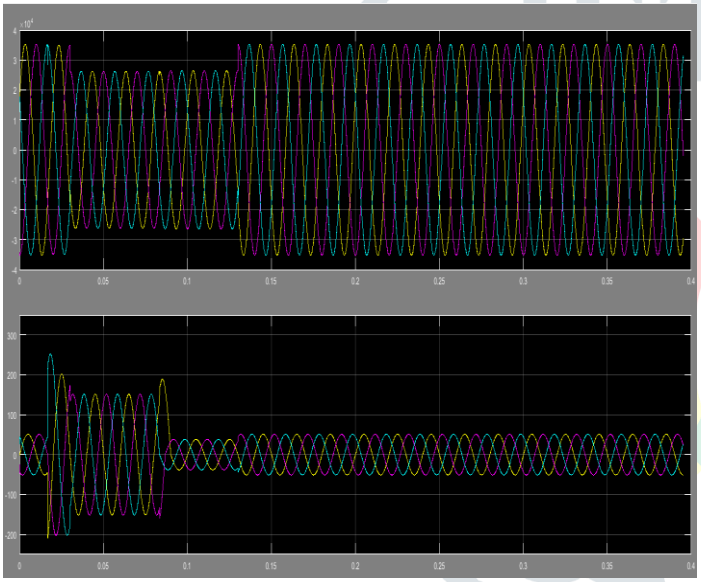

Fig. 4.1.1 Waveform of Voltage , Current

4.1.2 Compensated Line

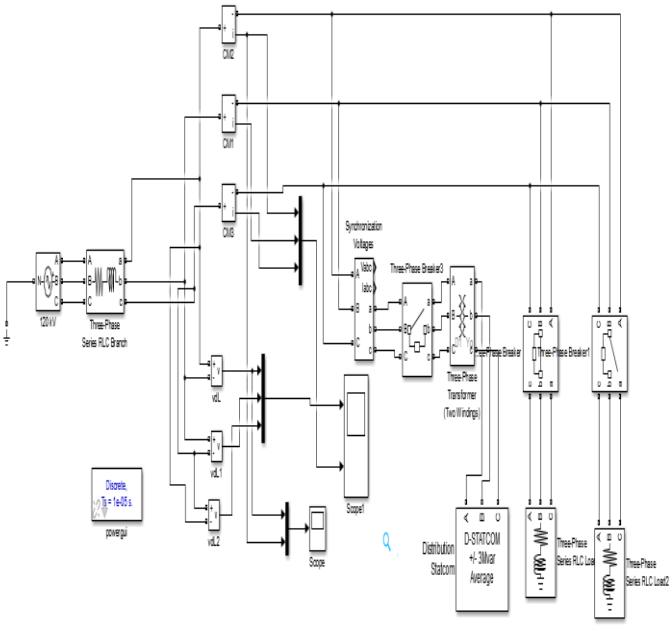

Fig.4.1.2 Simulink model of compensated line with Inductive load

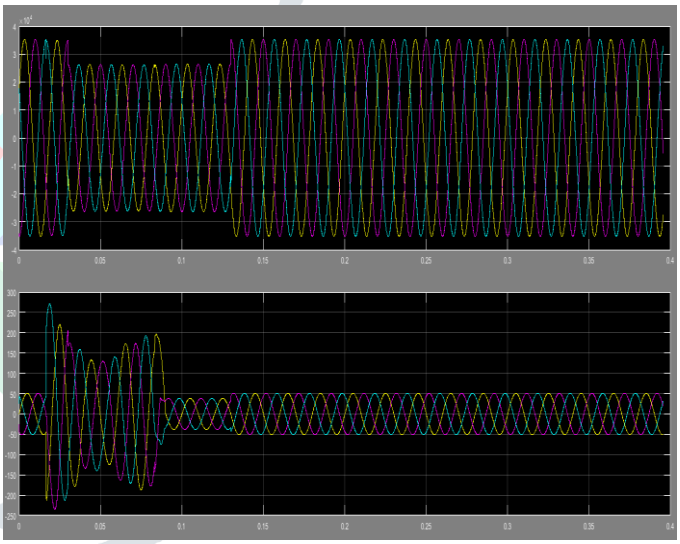

Fig. 4.1.2 Waveform of Voltage, Current

5. Conclusion and future scope: -

In this document we have studied and discussed the custom power device, that is, D-STATCOM that works with low voltage and how it is useful in compensating reactive power as it injects reactive power into the line. The device actually acts as a VSC that has been implemented on the load side of the system to improve the system's voltage profile and reduce energy losses. Therefore, D-STATCOM improves the stability of the system voltage.

5.1. DSTATCOM APPLICATIONS

to. It is used to provide isolation to the distributed power generation of the energy system to improve the second quality of energy. It is also used in permanent brushless magnets and non-permanent magnet machines to improve energy quality. A D-STATCOM based on

three-legged VSI is used in three-phase four-wire distribution systems. To improve the penetration of Photo Voltaic with the use of the D-STATCOM custom power device.

5.2. IMPROVEMENT AND BENEFITS

The following points show the improvement and benefits. It provides a quick response to second system disturbances. It provides a smooth control of the tension in a variety of operating conditions. Dynamic voltage control is achieved in the distribution system. Provides transient stability in the system. It is the ability to control both reactive power and active power (with an available DC power supply).

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