JuniKhyat
(UGC Care Group I Listed Journal)
ISSN: 2278-4632
Vol-11 Issue-01 March 2021

Utilizing D-STATCOM for Reactive Power Compensation

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***Abstract*— A compensating device called D-STATCOM is employed in distribution systems to regulate the flow of reactive power. Since the majority of the loads in this system are inductive, they need more reactive power. As a result, the load's power factor degrades, which restricts the active power flow in the line. The goal of the study is to create a D-STATCOM that injects reactive power into distribution lines and is based on a voltage source converter. To manage VAR generation, the output voltage of D-STATCOM is set to lag behind the system voltage. Utilizing a PI controller, D-STATCOM is implemented in MATLAB/Simulink.**

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

I. INTRODUCTION

Fast and accurate control over transmission characteristics including voltage, line impedance, and phase angle between the transmitting end and receiving end voltage is made possible by the FACTS devices. The bespoke power device, on the other hand, is utilised for low voltage distribution and enhances power quality, making the system more dependable. The FACTS devices and custom power equipment are extremely similar. The most well-known bespoke power devices are the D-SATCOM, UPQC, and DVR. D-STATCOM is particularly well-known because it may offer an affordable solution for reactive power compensation [1]. A FACTS is a power electronic-based device that manages the dynamic stability of the system by adjusting system characteristics like voltage, phase angle, and impedance. It also maintains power quality by ensuring improved power flow. The Distributed Static Compensator (D-STATCOM) is employed in this paper. A D-STATCOM is a power electronic device that receives power from a VSI and is shunt connected to the network to reduce harmonics and other power quality issues. Different control techniques that are utilised to extract reference currents and supply pulses to the VSI's gate terminals determine how well the D-STATCOM performs. Various study types conducted over D-STATCOM have been the subject of a literature review [2]. The D-STATCOM is very good at regulating load voltage, but from the perspective of the customer, keeping load voltage at the rated amount has a number of undesirable impacts. D- STATCOM forces the load to function constantly at rated power when the load point voltage is 1p.u. [3]. D- STATCOM is the STATCOM utilised in distribution systems (Distribution-STATCOM). By adjusting the converter voltage's amplitude and phase angle relative to the line terminal voltage, it is able to interchange both active and reactive power with the distribution system [4].

II. DESIGN OF DSTATCOM

A. *Principle of DSTATCOM*

The schematic representation of a D-STATCOM (Distribution Static Compensator) in Figure 1 shows that it is made up of a two-level Voltage Source Converter (VSC), a dc energy storage device, and a coupling transformer that is shunt-connected to the distribution network. A series of three-phase ac output voltages are created from the dc voltage across the storage device by the VSC. Through the coupling transformer's reactance, these voltages are in phase and connected with the ac system. The active and reactive power exchanges between the D-STATCOM and the ac system can be effectively controlled by appropriately adjusting the phase and magnitude of the D-STATCOM output voltages. With this set up, the gadget can generate or absorb controllable active and reactive power.

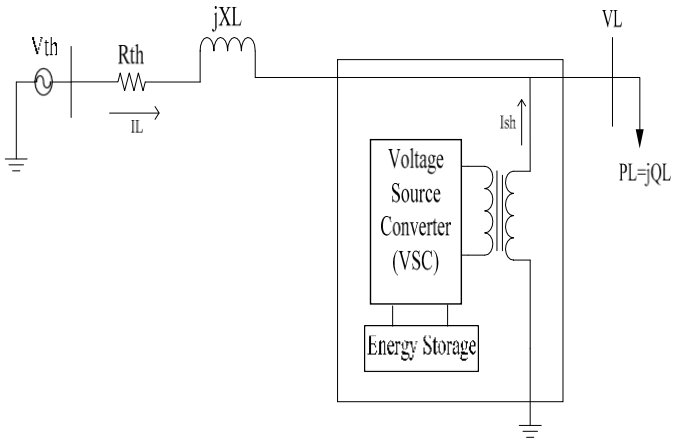

Fig.1 Schematic Diagram of D-STATCOM

Three very different uses for the VSC's multifunctional architecture that is connected in shunt with the ac system are as follows: Reactive power compensation and voltage regulation; power factor correction; and current harmonic elimination. Here, a converter that is indirectly controlled by the device is used to offer continuous voltage regulation. As depicted in Fig. 1, the voltage sag is corrected by altering the voltage drop across the system impedance Zth. By altering the converter's output voltage, the value of Ish can be changed [4].

ISSN: 2278-4632
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B. *Control for Reactive Power Compensation*

The control strategy aims to maintain constant voltage magnitude at the connection point for a sensitive load that will experience system disruptions. Only the rms voltage at the load point is measured by the control system. The sinusoidal PWM approach, used in the VSC switching strategy, is simple and offers good response. PWM techniques provide a more flexible alternative to the fundamental frequency switching techniques utilized in FACTS applications because custom power is a relatively low-power application. In addition, high switching frequencies can be used to increase the converter's efficiency while minimizing switching losses. The reference voltage and the observed rms terminal voltage are used to create the error signal for the controller input. Such a mistake is handled by a PI controller; the output is the angle 0, which is provided to the PWM signal generator. It is important to note that in this case, of indirectly controlled converter, there is active and reactive power exchange with the network simultaneously. The PI controller processes the error signal and generates the required angle to drive the error to zero, i.e. the load rms voltage is brought back to the reference voltage [4].

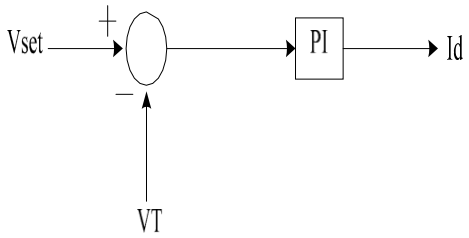

Fig. 2. PI control for reactive power compensation

III. Simulations And Results

A. *Uncompensated Line*

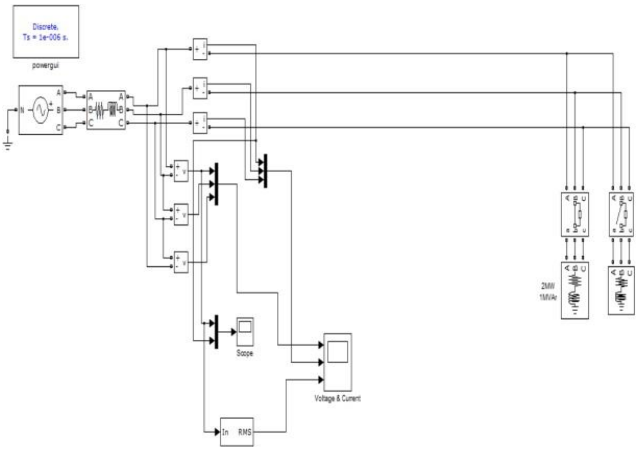

Fig. 3. Simulink model of uncompensated line with Inductive load

We first took into consideration the scenario of an inductive load that is connected to the line using Fig. 3. The circuit breaker closes after 0.066 seconds, and the line is then linked to the load of 2MW, 1MVAr. We see specific outcomes in voltage, current, and size of voltage waveform as a result of this enormous load (Fig. 4). As we can see in the first window, the load is receiving a lot of power from the supply side, which causes the voltage waveform to get lowered and the current to climb significantly.

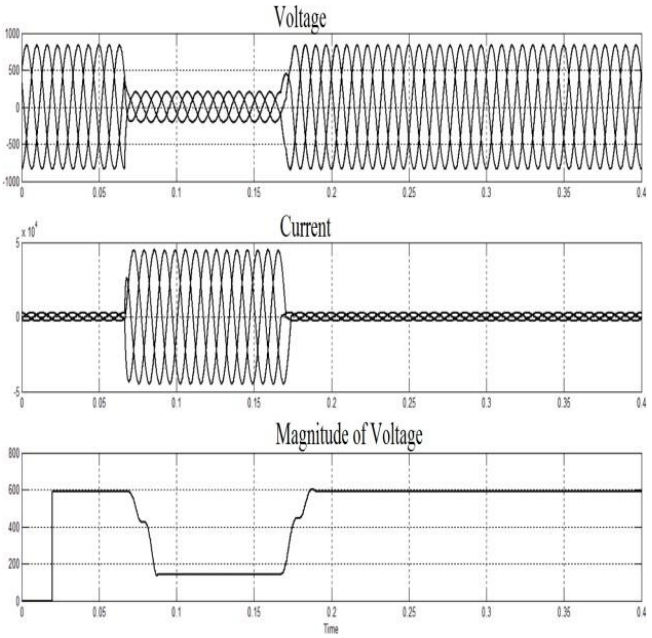

Fig. 4. Waveform of Voltage , Current and Magnitude of voltage

B. *Compensated Line*

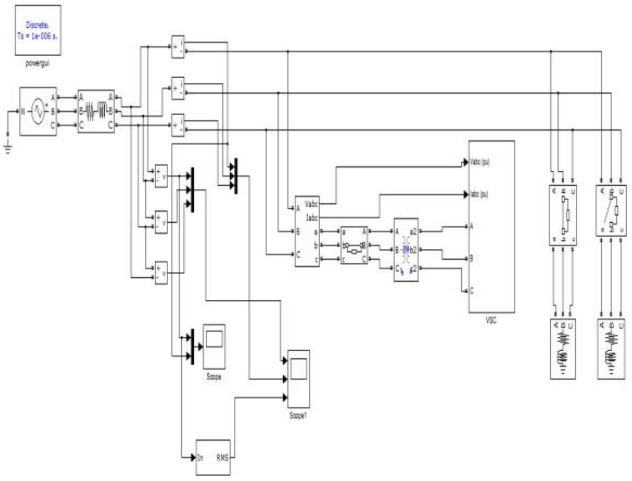

Fig. 5. Simulink model of compensated line with Inductive load

Taking into account the D-shunt STATCOM's connection to the line Starting with Fig. 5, the line is initially connected to a fixed inductive load. The circuit breaker is closed after 0.066 seconds, at which point a load of 2MW and 1MVAr is delivered to the line. We can see from Fig. 6 that there are less dips in

ISSN: 2278-4632
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voltage due to injection of reactive power by the D-STATCOM. The top window shows the variation in voltage waveform in which the magnitude of voltage is been improved to some value and current waveform gets reduced.

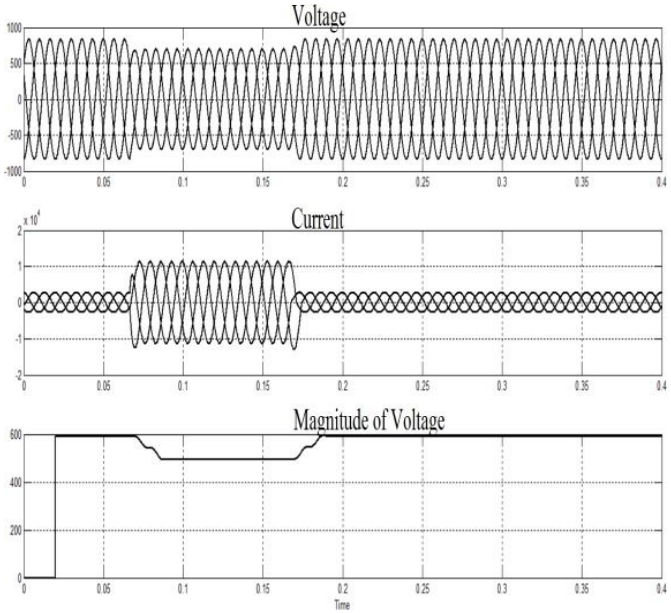

Fig. 6. Waveform of Voltage, Current and Magnitude of voltage

IV. Applications Of DSTATCOM

a. It is used in providing isolation to Distributed Power generation of the Power System for improving power quality [7].
b. Its is also used in Brushless Permanent Magnet and Non-Permanent Magnet Machines for improving quality of power [6].
c. A dual three- leg VSI based D-STATCOM is used in Three-phase four- wire Distribution systems [5].
d. For enhancing the Photo Voltaic penetration with the use of custom power device D-STATCOM [8].

V. Improvement And Benefits

The following points shows the improvement and benefits, [9]

a. It provides the quick response to system disturbances.
b. Gives the smooth voltage control over a varied range of operating condition.
c. Dynamic voltage control is achieved in distribution system.
d. Provides the transient stability in the system.
e. It has the ability to control both reactive power and also the active power (with a DC energy source available).

VI. Conclusion

The D-STATCOM custom power device, which runs on low voltage, has been investigated and explained in this essay along with how it can be used to compensate for reactive power since it injects reactive power into the line. The device actually functions as a voltage stabilisation capacitor (VSC), which is installed at the system's load side to enhance the voltage profile and lower power losses. D-STATCOM thereby enhances the system's voltage stability.

References

[1] Kiran Kumar Pinapatruni and Krishna Mohan L, “DQ based Control of DSTATCOM for Power Quality Improvement”,VSRD- IJEECE,Vol. 2(5), 2012, 207-227.

[2] Ranjan Kumar Mallick, Alok Mishra, Sayantan Sinha, “Improvement of Power Quality in DFIG Based Wind Farm Using Optimized DSTATCOM”, EESCO 2015, International Conference on 24-25 Jan. 2015, Vishakhapatnam, pp. 1-7, DOI: 10.1109/EESCO.2015.7253.786, IEEE.

[3] Chandan Kumar, M.V. Manoj Kumar, Mahesh K. Mishra, “A Control Scheme to Enhance DSTATCOM Operation in Power Distribution System”, PEDG 2015, 6th International Symposium on 22-25 June 2015, Aachen, pp. 1-6, DOI: 10.1109/PEDG:2015.7223034, IEEE.

[4] J. Ganesh Prasad Redy, K. Ramesh Reddy, “Design and Simulation of Cascaded H-Bridge Multilevel Inverter Based DSTATCOM for Compensation of Reactive Power and Harmonics”, 1st International Conference on Recent Advances in Information Technology(RAIT) 2012, IEEE.

[5] M.V. Manoj Kumar, Mahesh K. Mishra, Chandan Kumar, “A Dual Three-leg VSI Based DSTATCOM in Three- Phase Four- Wire Distribution Systems”, PEDG 2015,6th International Symposium on 22-25 June 2015, Aachen, pp:1-6, DOI: 10.1109/PEDG.2015.7223004, IEEE.

[6] RAVI KIRAN DASARI, SATHISH JUDE MADIPALLI, SUSMITHA JAVVADI, “Power Quality Improvement of Brushless Permanent Magnet and Non-Permanent Magnet Machines Using DSTACOM”, EESCO 2015, International Conference on 24-25 Jan. 2015, Vishakhapatnam, pp:1-6, DOI: 10.1109/EESCO.2015.7253763, IEEE.

[7] Sabha Raj Arya, Ram Niwas, Krishan Kant Bhalla, Bhim Singh, Ambrish Chandra, kamal Al-Haddad,“Power Quality Improvement in Isolated Distributed Power Generating System Using DSTATCOM”, Industry Application on 30 June 2015, pp:1, DOI: 10.1109/TIA.2015.2451093, IEEE.

[8] Chao-Shun Chen, Chia-Hung Lin, Wei-Lin Hsieh, Cheng-Ting Hsu, and Te-Tien Ku, “Enhancement of PV Penetration With DSTATCOM in Taipower Distribution System”, IEEE TRANSACTIONS ON POWER SYSTEMS, VOL. 28, NO. 2, MAY 2013.

[9] P. Venkata Kishore, Prof. S. Rama Reddy, “Compensation of Reactive Power Using D-STATCOM”, IOSR Journal of Electrical and Electronics Engineering (IOSR- JEEE) e-ISSN: 2278-1676, p-ISSN:2320-3331, Volume 9, Issue 1 Ver. I (Jan. 2014), PP 17-27.