Power quality enhancement of Distribution system by using D-STATCOM

Shambu Narayan Yadav*[1], Dr. Sanjay Jain[2]

*[1] *M. Tech Student, Electrical Engineering Department, RKDF University, Bhopal, M.P.*

yshambhu694@gmail.com[1]

[2] *Professor & HOD, Electrical Engineering Department, RKDF University, Bhopal, M.P.*

jain.san12@gmail.com[2]

ABSTRACT

A wide variety of industries have adopted the usage of power electronic devices for various reasons such as variable voltage, variable frequency, and current regulation to achieve higher control, more effectiveness, and approved in advance. Evolution of the digital technology is getting highly responsive and offering valuable contributions. If you have attractive technology, you also increase ripple voltage for numerous consumers. This power transmission problem is mostly due to the usage of power conservation units and electrolytic capacitors, computers or motor controllers, which function as semi loads. With the growing usage of transformers, the voltage / current harmonic currents that are generated leads to higher stress on the power system, which in turn contributes to the production of active power. Fortunately, it hasn't reached a level where equipment gets too sensitive yet. To sum up, the basic difficulty here is that the rectifiers and inverters that these machines utilise all have an unchanging non-sinusoidal current that additionally incorporates harmonics. The primary difficulty is that those same electronic systems devices, such as MOSFET, BJT, SCR, IGBT, etc., show switching behaviours including such Capacitor, Jfet, SCR, Field effect transistor.

Key words- Power quality, DSTATCOM, FACTS devices

1. INTRODUCTION

Energy efficiency mainly affects the way energy producers and consumers communicate, so it may suggest an increase between the energy system and the appropriate electricity demand. The design of the power grid focuses on this goal of providing consumers with electricity. With the dramatic growth of the industrial sector during the last half century, electricity consumption has grown exponentially, necessitating the creation of more power generation and distribution facilities. Because as more and more industrial and domestic energy use grows, more and more pressures are placed on energy production. Today's operational resources are linked to more than just the construction of complex infrastructure. Many such factors had made the electric grid more vulnerable to generators. The economic planning system has a number of objectives other than "well-being" such as "trustworthy

performance" and includes "reduced initial costs" and "long-term assets." The system integrity problem is solved when equipment malfunctions are handled. In most cases, whenever researchers talk about electrical performance, they refer to volts because they are always. Electrical performance is closely linked to all device reliability in transmission networks.

1.2 DISTINCTNESS OF POWER QUALITY

The appropriate current or voltage signal is the same size and the single harmonic waveform controlled by dc. Dc power efficiency depends on the quality of energy received from the power supplied to the customer. That deviation of the output, flow, or occurrence of its positive value, which may cause the device to malfunction, is referred to by someone as a system reliability challenge. Electro - magnetic incompatibility is a term commonly used locally for voltage stability; people seem genetically similar but actually different. [20]

According to IEEE standards, energy efficiency is defined as the process of wiring and empowering sophisticated technologies to achieve an acceptable and tolerable level of success.

Its electrical stability is a combination of efficient and effective energy efficiency. The operating system controls the power factor and the connector, while the customer requirement controls the full operation in just the junction box.

1.3 NEED OF BETTER POWER QUALITY

There are different power quality issues in power transmission system. Power quality is becoming an important concern because of many reasons. Some major reasons are shown in below figure 1.1 –

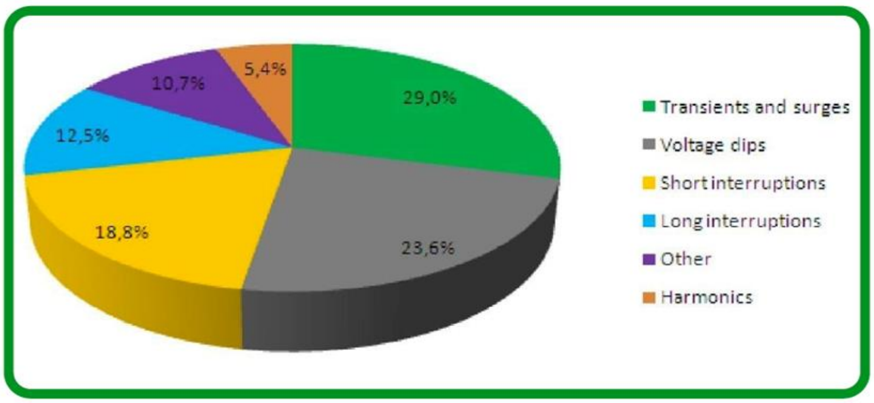


Fig 1.1 – Power Quality issues

Many new technologies, including power converters as well as expandable electric motors, are becoming increasingly popular to improve the efficiency of energy systems. Such technology raises the sinusoidal limit of the electric platform, and thus leads to higher levels of anxiety.

Electrical controls and chargers that use a computer system and the control of small controls appear to be at high risk for power outages. Power grid interference has a major impact on today's major dependencies, as in the event of a single failure, the entire device becomes infected. The knowledge of the entire grid customers or end users with

smart grid challenges and challenges such as low power, overheating, blips, and other problems is growing rapidly, leading to the need for more efficient energy efficiency.

2. TECHNICAL BACKGROUND

Electrical-based equipment has become an integral part of today's distribution system. They offer many advantages, but they also have several drawbacks. They produce harmonic current beyond the normal range of energy, polluting the distribution system. The concept of flexible AC transmission systems (FACTS) was introduced for the ultimate in providing custom solutions to the growing challenges posed by distribution networks. These FACTS devices are used to enhance the transmission power of the power transmission and power switch.

2.1SVC

Compensation, such as STATCOM, STATCOMS, SVC, and TSC, is used. To compensate for changes in the current alternating voltage, static VAR compressors (SVC) use idle elements such as resistors and capacitors to absorb and emit active energy. A prominent component of SVC is the anti-parallel thruster.

2.2 STATCOM

Compensation, such as STATCOM, STATCOMS, SVC, and TSC, is used. To compensate for changes in the current fluctuating voltage, VAR compactor (SVC) compressors use idle objects such as resistors and capacitors to absorb and emit active energy. A prominent component of SVC is the anti-parallel thruster.

2.3 DYNAMIC VOLTAGE RESTORER

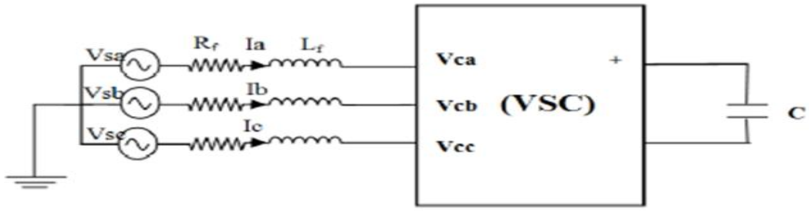
Powerful power renewals compensate for the rising cost of network performance (DVR). It is made up of a power source inverter with a power supply line designed to help achieve a certain level of electricity. An external DC power source can be used to support VSI, reduce voltage coherence, and stabilize load

2.4-FILTER CUT-OFF LEVEL

Energy power distribution system problems are effectively addressed with functional power filters. These functional filters include integrated power filters, series power filters, and a mixed power filter, which combines both. The main function of a series active power filter is to reduce electrical harmonics, while the active shunt power filter adjusts current current.

2.5 DB SIGNAL INTENSITY

The Bespoke power device, connected to the shunt and load, carries the active power and balance of the distribution system due to its wide range. DSTATCOM performance is affected by the current output control method. This chapter discusses the regulation of DSTATCOM, and its statistical model is introduced.



.

Fig 2.1 Simplified single-line diagram of the DSTATCOM

3. SIMULATION MODEL EXPLANATION.

Power supply for 25kV, 100MVA distribution network is controlled using Distribution Static Synchronous Compensator. Bus B2 and B3 both connect to loads at a distance of 22 km and 2km, using two servers located at 21km and 2km. Power is intended to be sent to shipments from suppliers. The shunt capacitor is placed between bus B2 and bus B2 for the purpose of adjusting the power factor. Six hundred volts are connected by a descending transformer with a voltage of 25,000 volts / 600 volts. This current flexible load absorbs energy. To control the alternating current switch, DSTATCOM (STATCOM direct heat) is attached next to bus B3 at a constant 5Hz frequency. To put it another way, within a distance of M 3MVA, the assumed load capacity varies greatly. The load capacity is maintained at 0.9 lagging throughout the process. By producing or absorbing active energy, DSTATCOM controls the voltage consuming bus B3. For the active power to be transferred, a leaky coupling transformer leak is used. By synchronism with the main network voltage, the transformer creates a secondary voltage. Active power flow occurs when the secondary voltage of the transformer and the bus voltage B3 are compared. In this example, DSTATCOM provides active power (if the secondary voltage is greater than the bus voltage) and draws active power (if the secondary voltage is less than the bus voltage). The 25KV / 1.25KV coupling transformer that connects to the network can be found in the model in Figure 3.1.

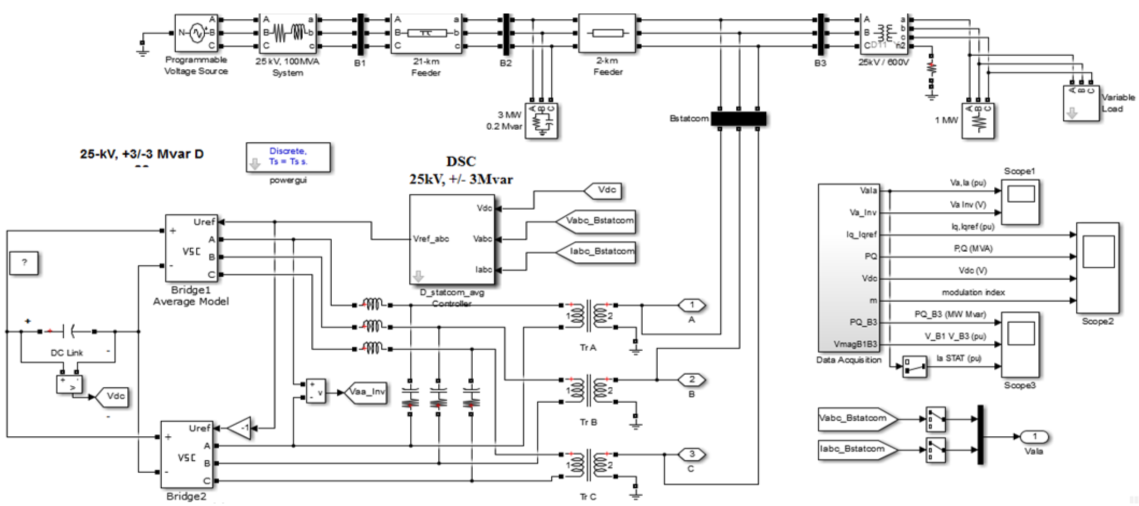


Fig. 3.1 D-STATCOM based power quality enhancement [Complete Model]

Table 3.1 Parameter Values of proposed Model

S. No.	Parameters	Values
1	Source Voltage	25kV/50Hz
2	Source Power	100MVA
3	Total Line length	23Km
4	Coupling Transformer	25kV/1.25kV
5	Modulation frequency	1.40kHz
6	DC link Voltage	2.4kV

4. RESULTS

4.1 RESULT ANALYSIS OF D-STATCOM BASED

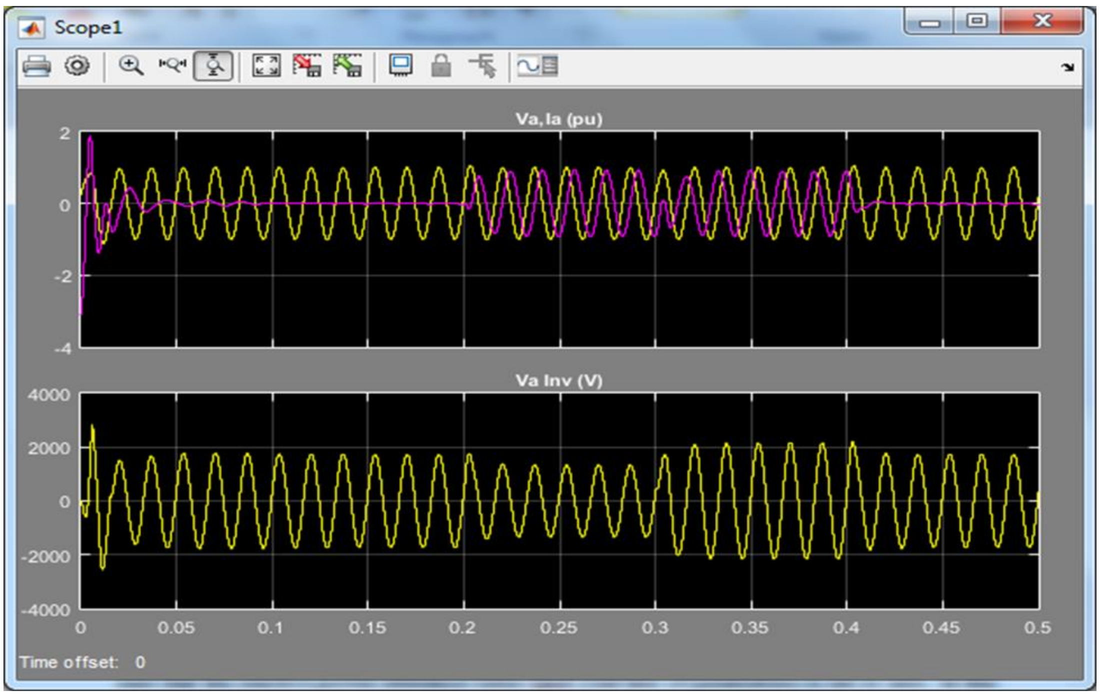


Fig. 4.1 Phase Voltage and Current Waveform of D –STATCOM

Figure 4.1 shows the electrical power of the D-STATCOM phase and the current waveform of the proposed D-STATCOM model. In the diagram above show clearly that between 0.2 and 0.3 seconds a voltage flicker occurs and this flashes by 0.4 seconds.

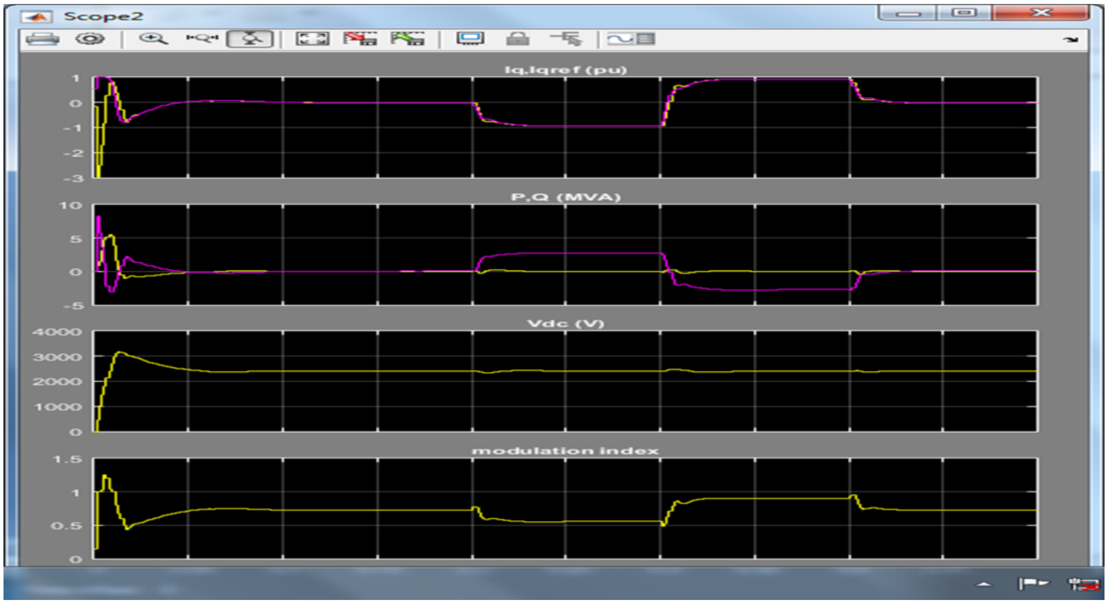


Fig. 4.2 Dynamic and Steady State response of D-STATCOM

After a while that lasts about 0.15 seconds. At t = 0.2s, the source strength increases by 6%. D-STATCOM compensates for this increase in power output by extracting active energy from the network (Reactive Power (Q) = + 2.7 M var on trace 2 of Scope2). At t = 0.3s, the supply voltage decreases from a value equal to Reactive Power (Q) = 0. D-STATCOM must generate active power to keep the voltage 1 Pu (Reactive Power (Q)) from + 2.7 MVAR to -2.8 MVAR). Note that after the D-STATCOM has switched from inductive to capacitive performance, the intermediate model variability rises from 0.56 to 0.9voltage.

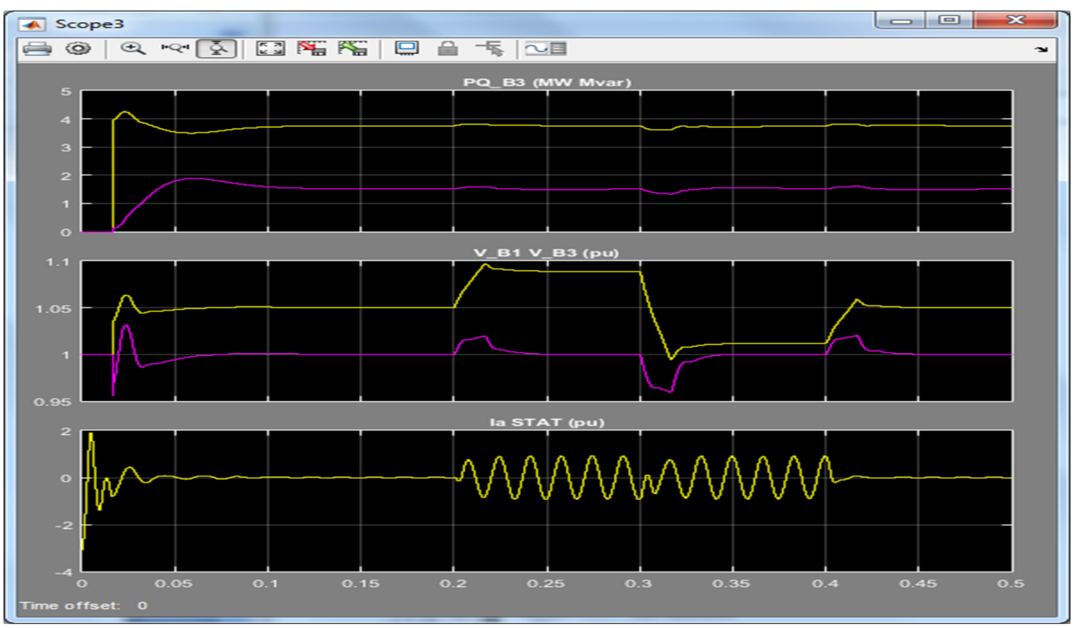


Fig. 5.3 D-STATCOM output with reduced Flicker

Scope 3 scope for active power (P) and Active Power (Q) in bus B3 (first track) is still the same as for power in buses B1 and B3 (trace 2). Although not a D-STATCOM, the B3 voltage varies between 0.96pu and 1.04 pu (four variants). Now, in the middle of the D-STATCOM controller, change the "process method" parameter to "Power Control" and start copying again. Analyze in Scope 3 that the voltage fluctuation in bus B3 has been reduced to 0.4%. D-STATCOM compensates for the voltage by injecting the active power changed to 5 Hz (trace 3 of Scope3) and ranges from 0.6 pu voltage occurring when the voltage is low and 0.6 Pu inductive when the voltage is high.

REFERENCES

[1] Kumar, Manoj. "Comparison of Control Algorithms of DSTATCOM for Power Quality Improvement." In 2020 International Conference on Power Electronics and Renewable Energy Applications (PEREA), pp. 1-6. IEEE, 2020.

[2] Karthik, Tanam, Mummadi Prathyusha, R. Thirumalaivasan, and M. Janaki. "Power quality improvement using DSTATCOM." In 2019 Innovations in Power and Advanced Computing Technologies (i-PACT), vol. 1, pp. 1-7. IEEE, 2019.

[3] Gupta, Atma Ram, and Ashwani Kumar. "Reactive power deployment and cost benefit analysis in DNO operated distribution electricity markets with D-STATCOM." Frontiers in Energy (2017): 1-13.

[4] Visali, N., KamarthiSridevi, and N. Sreenivasulu. "Mitigation of Power Quality Problems in Distribution System Using D-STATCOM." Emerging Trends in Electrical, Communications and Information Technologies. Springer, Singapore, 2017. 433-443.

[5] Bala, Anju, Geeta Thakur, and Lini Matthew. "Design and implementation of three phase three level inverter based DSTATCOM." Power, Control & Embedded Systems (ICPCES), 2017 4th International Conference on. IEEE, 2017.

[6] Ragesh, R., A. Bharaneetharan, and R. Vengadesh. "Design and control of SVPWM based DSTATCOM for power quality improvement." Innovative Research In Electrical Sciences (IICIRES), 2017 International Conference on. IEEE, 2017.

[7] Muruganantham, B., R. Gnanadass, and N. P. Padhy. "Reactive Power Reallocation in the Distribution System with DSTATCOM." Energy Procedia 117 (2017): 485-492.

[8] Sirjani, Reza, and Ahmad RezaeeJordehi. "Optimal placement and sizing of distribution static compensator (D-STATCOM) in electric distribution networks: A review." Renewable and Sustainable Energy Reviews 77 (2017): 688-694.

[9] Kandadai, Venkatraman, et al. "Performance evaluation of FPGA-controlled DSTATCOM for load compensation." Arabian Journal for Science and Engineering 41.9 (2016): 3355-3367.

[10] Mishra, Soumya, Parvat Kumar Ray, and Santanu Kumar Dash. "A TLBO optimized photovoltaic fed DSTATCOM for power quality improvement." Power Electronics, Intelligent Control and Energy Systems (ICPEICES), IEEE International Conference on. IEEE, 2016.

[11] Biabani, Mohammed Abdul Khader Aziz, Syed Mahamood Ali, and Akram Jawed. "Enhancement of power quality in distribution system using D-Statcom." Signal Processing, Communication, Power and Embedded System (SCOPES), 2016 International Conference on. IEEE, 2016.

[12] Gupta, Atma Ram, and Ashwani Kumar. "Impact of DG and D-STATCOM placement on improving the reactive loading capability of mesh distribution system." Procedia Technology25 (2016): 676-683.

[13] Myneni, Hareesh, G. Siva Kumar, and D. Sreenivasarao. "Power quality enhancement by current controlled Voltage Source Inverter based DSTATCOM for load variations." Petroleum and Chemical Industry Conference/Industrial and Commercial Power Systems, 2015 IEEE IAS Joint (ICPSPCIC). IEEE, 2015.

[14] Kumar, Chandan, MV Manoj Kumar, and Mahesh K. Mishra. "A control scheme to enhance DSTATCOM operation in power distribution system." Power Electronics for Distributed Generation Systems (PEDG), 2015 IEEE 6th International Symposium on. IEEE, 2015.

[15] Yuvaraj, T., K. R. Devabalaji, and K. Ravi. "Optimal placement and sizing of DSTATCOM using harmony search algorithm." Energy Procedia 79 (2015): 759-765

[16] Gupta, Atma Ram, and Ashwani Kumar. "Energy savings using D-STATCOM placement in radial distribution system." Procedia Computer Science 70 (2015): 558-564.

[17] Bangarraju, J., V. Rajagopal, and A. Jayalaxmi. "Unit template synchronous reference frame theory based control algorithm for DSTATCOM." Journal of The Institution of Engineers (India): Series B 95.2 (2014): 135-141.

[18] Farhoodnea, Masoud, et al. "Optimum D-STATCOM placement using firefly algorithm for power quality enhancement." Power Engineering and Optimization Conference (PEOCO), 2013 IEEE 7th International. IEEE, 2013.

[19] Zhao, Qingxin, et al. "Controlling study of D-STATCOM based on PSO-PID algorithm." Advances in Electronic Commerce, Web Application and Communication. Springer, Berlin, Heidelberg, 2012. 343-348.