International Journal of Advanced Computer Technology
ISSN: 2319-7900 www.ijact.org Volume-X, Issue-VI, December 2021

ENHANCEMENT OF VOLTAGE PROFILE IN TRANSMISSION LINE USING DSTATCOM AND DVR

Vivek Kushawaha[1], Rajeev Yadav[2], susheela Maurya[3] Ayush Rawat[4] Anoop Verma[5]
Department of EE, MGIMT Lucknow India
[1]vivekkushawaha93@gmail.com,[2]yadavrajeev489@gmail.com,[3]sushilamaurya171@gmail.com,[4]rawatayush746@gmail.com [5]anoopverma1242@gmail.com

ABSTRACT:- *In this paper, a STATCOM and DVR are used to mitigate power quality issues in power system (Transmission Line), STATCOM and DVR both are used in transmission line simultaneously for enhancement of Voltage quality in Transmission Line Voltage related issues sags and swells are the by-products of symmetrical as well as unsymmetrical faults of the electrical power system(Transmission Line). The excessive reactive power demand in the line degrades the voltage magnitude from its specified limit. Power quality has become a crucial factor today due to the wide application of power electronics-based equipment. Day by day, power electronics-based devices are widely used in industries and distribution areas and create more power quality problems. The quality of the power is defective for certain reasons. This power quality improvement is seen, e.g., as sag, swell, overvoltages, Undervoltage, and harmonics. Conventional equipment for enhancement of power quality is becoming inadequate.*

KEYWORD: Transmission Line, DVR, STATCOM.

1. INTRODUCTION

Electrical Energy is invisible, a universal commodity that is immediately available in most of the world, and it has now been recognized as an everyday consumer need [1]. Renewable Energy Systems (RESs) are used to aid the primary energy demand in solar, Solar thermal, wind energy. The intermittent nature of RESs, harmonics and reactive power problems halt the power system's performance by originating stability concerns in the power system [2, 3, 10]. The Flexible AC Transmission Systems (FACTS) devices are widely adapted for reactive power compensation, voltage stability, and power quality in distribution grids worldwide [4, 5]. Nowadays, the continuous flow of electrical power between suppliers and consumers is essential for reliable operation and proper utilization of electrical energy. So far, various techniques have been developed for mitigating voltage profile issues. To mitigate voltage profile disturbances, we have shown the application of D-STATCOM and Dynamic Voltage Restorer (DVR). As we know, voltage-related issues, sags, and swells are the by-product of symmetrical and unsymmetrical faults of the electrical power system. We have shown some MATLAB results to elaborate the operation of D-STATCOM and DVR.

2. POWER QUALITY ISSUES AND THEIR EFFECTS ON TRANSMISSION LINES

The guidelines for measuring the power quality of wind turbines are developed by The International Electro-Technical Commission (IEC) in coordination with the Technical Committee-88.

Figure1(a) Flow diagram for the evaluation of power quality problems, solution of a problem comes through a process starting with identification of the problem category.

This commission explained the methodologies for measuring the power quality characteristics of a wind turbine [4] for grid connection, the base for the analysis is provided by the datasheet with the electrical characteristic of the wind turbine. Perfect power quality means that the voltage is continuous and sinusoidal, having a constant amplitude and frequency. Power quality can be expressed in terms of the physical characteristics and properties of electricity. It is most often described in terms of voltage, frequency, and interruptions. The quality of the voltage must fulfill requirements stipulated in national and international standards. In these standards, voltage disturbances are subdivided into voltage variations, flicker, transients, and harmonic distortion [5]. Figure 1 shows a classification of different power quality phenomena.

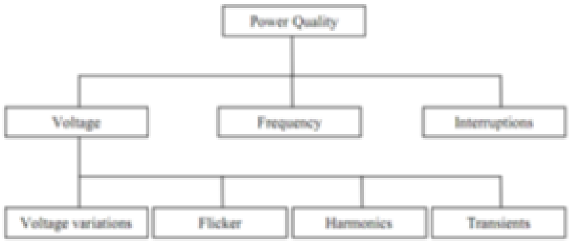

Figure 1(b) Classification of different power quality phenomena

2.1 POWER QUALITY ISSUES

A. VOLTAGE VARIATION

The voltage variation mainly results from the wind velocity and generator torque. The voltage variation is directly related to real and reactive power variations. The wind generating system equipped with an asynchronous generator consumes the reactive power and can cause an additional negative problem for the grid. Switching the wind turbine generator ON and OFF also varies the voltages. The voltage variation is commonly classified as short-duration and long-duration voltage variation. Various types of voltage variations are given as follows: Voltage sag, Voltage flicker, Short interruptions Voltage swells.

B. FLICKER

Voltage flicker describes dynamic variations in the network voltages caused by a wind turbine or by varying loads. Thus the power fluctuation from wind turbines occurs during continuous operation. The amplitude of voltage fluctuation depends on grid strength, network impedance, phase angle, and power factor of the wind turbines. It is defined as a fluctuation of voltage in a frequency of 10-35 Hz. The IEC 61400-4-15 specifies a flicker meter that can be used to measure flicker directly. The flicker coefficient gives a normalized dimensionless measure of flicker, independent of network situation and independent of short circuit apparent power of the grid. It gave a ratio of short circuit power and generated rated apparent power, which is necessary to achieve a long-term flicker level[6].

The causes are fluctuation of active and reactive power of wind turbine, i.e., yaw error, wind shear, wind turbulence or fluctuation in the control system, switching operations in the wind turbine. In a fixed-speed wind turbine, each time a rotor blade passes through the tower, the power output of the turbine reduces. This effect causes periodical power fluctuation with a frequency of 1 Hz, whereas variable speed turbine power fluctuation is smoothed. Flickers are produced by arc furnaces, arc lamps, capacitor switching.

Consequences are power quality degradation, damage to sensitive types of equipment.

C. HARMONICS

It results from the operation of power electronic converters. The harmonic voltage and current should be limited to the acceptable level at the point of the wind turbine connected to the network. The harmonic current emission during the continuous operation of wind turbine with power converter has to be stated. The relative harmonic current limit is stated as shown in Table 1.

Harmonic Number	5	7	11	13
Admissible Harmonic (I_h/I_l)	5-6	3-4	1.5-3	1-2.5

TABLE 1 Relative Harmonic Current Limit

Where I_h is the total harmonic current of h^{th} order caused by the consumer, and I is the rms current corresponding to the consumer agreed with power.

3. TRANSMISSION LINE

The transmission line is the long conductor with a special design (bundled) to carry the bulk amount of generated power at a very high voltage from one station to another as per variation of the voltage level. In a transmission line, the determination of voltage drop, transmission efficiency, and line loss is important to design. These values are affected by line parameters R, L, and C of the transmission line. Lengthwise transmission lines are three types

- Short Transmission Line
- Medium Transmission line
- Long Transmission Line

(a)Short Transmission Line :

- A short transmission line is classified as a transmission line with:
- A length less than 80km (50 miles)
- Voltage level less than 69 kV
- The capacitance effect is negligible
- Only resistance and inductance are taken in calculation capacitance is neglected

(b) Medium Transmission Line :

- A medium transmission line is classified as a transmission line with:
- A length more than 80 km (50 miles) but less than 250 km (150 miles)
- The operational voltage level is from 69 kV to approx 133 kV
- Capacitance effect is present
- Distributed capacitance form is used for calculation purposes.

(c) Long Transmission Line :

- A long transmission line is classified as a transmission line with:
- A length more than 250 km (150 miles)
- The voltage level is above 133 kV
- Line constants are considered as distributed over the length of the line

4. D STATCOM

A Distribution Static Compensator is, in short, known as D-STATCOM. It is a power electronic converter-based device used to protect the distribution bus from voltage unbalances. It is connected in shunt to the distribution bus generally at the PCC[7].

Basic Structure of D STATCOM

D-STATCOM is a shunt-connected device designed to regulate the voltage either by generating or absorbing the reactive power. The schematic diagram of a D-STATCOM is as shown in Figure 2 contains.

- DC Capacitor
- Voltage Source Inverter (VSI)
- Coupling Transformer
- Reactor

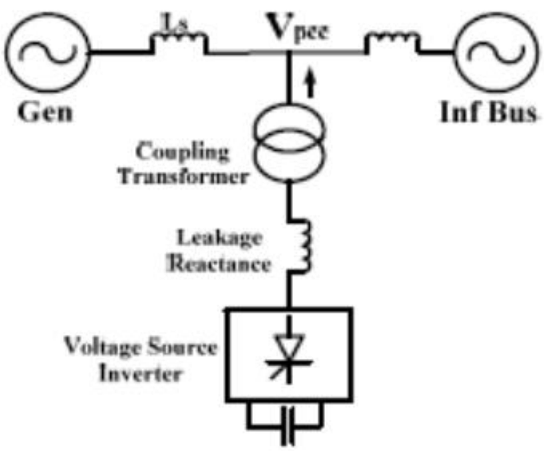

Figure 2 Schematic Diagram of D-STATCOM

5. DYNAMIC VOLTAGE RESTORER (DVR)

A Dynamic Voltage Restorer is a power electronic converter-based gadget intended to ensure the discriminating burdens from all unsettling supply-side influences other than deficiencies. It is connected in arrangement with the distribution feeder for the most part for regular coupling[8-9].

Basic Structure of DVR

The DVR is a series-connected power electronic device used to inject voltage of required magnitude and frequency. The basic structure of a DVR is shown in Figure 3. It contains the following components-

- Voltage Source Inverter (VSI)
- DC storage unit
- Filter circuit
- Series Transformer

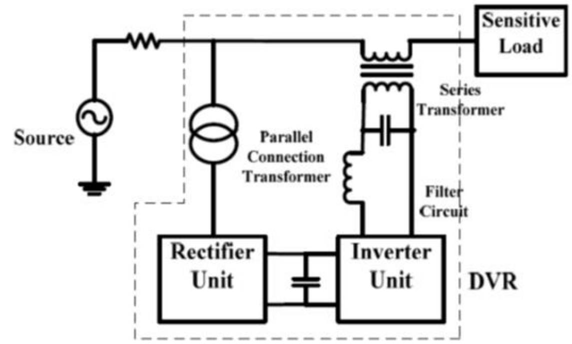

Figure 3 DVR without Internal Storage

6. SIMULINK MODEL AND RESULT

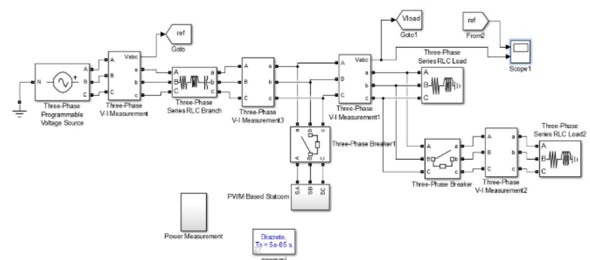

Figure.4 Simulink Model using DSTATCOM

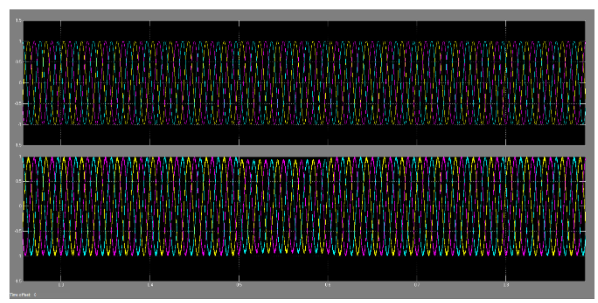

Figure 5. Simulink result using DSTATCOM

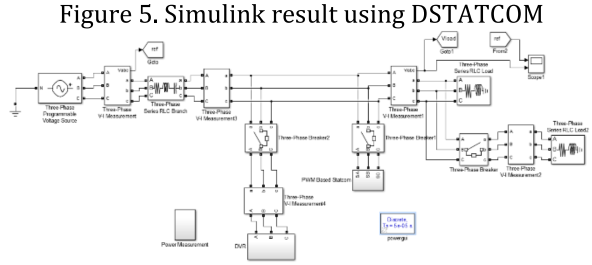

Figure 6 Simulink model using DSTATCOM and DVR

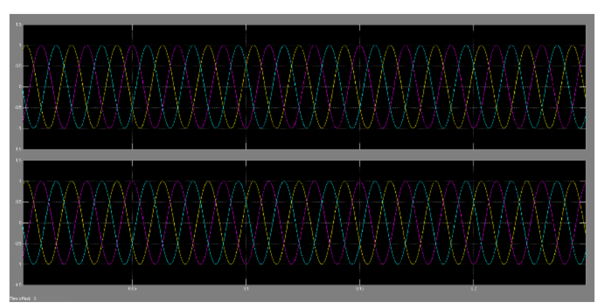

Figure 7 Simulink result using DSTATCOM &DVR

CONCLUSION

The demand for electric power is increasing exponentially, and at the same time, the quality of power delivered has become the most prominent issue in the power sector. Thus, to maintain power quality, the problems affecting the power quality should be treated efficiently. Among the different power quality problems, voltage sag is one of the major ones affecting the performance of the end-user appliances. In this project, the methods to mitigate the voltage sag are presented. From this project, the following conclusions are made Among the different methods to mitigate the voltage sag, the use of FACTs devices is the best method

The FACT devices like DVR, D-STATCOM help overcome the

- ❖ voltage unbalance problems in power system
- ❖ DVR is a series-connected device and injects voltage to compensate for the voltage imbalance
- ❖ D-STATCOM is a connected shunt device and injects current into the system
- ❖ These devices are connected to the power network at the point of interest to protect the critical loads
- ❖ These devices also have other advantages like harmonic reduction, power factor correction

REFERENCE

[1]. N. Khan, S. Dilshad, R. Khalid, A. R. Kalair, and N. Abas, “Review of energy storage and transportation of energy,” Energy Storage, vol. 1, no. 3, Jun. 2019, DOI: 10.1002/est2.49.

[2]. M. A. Basit, S. Dilshad, R. Badar, and S. M. S. ur Rehman, “Limitations, challenges, and solution approaches in grid-connected renewable energy systems,” Int. J. Energy Res., vol. 44, no. 6, pp. 41324162, May 2020, DOI: 10.1002/er.5033.

[3]. A. Kalair, N. Abas, A. R. Kalair, Z. Saleem, and N. Khan, “Review of harmonic analysis, modeling and mitigation techniques,” Renew. Sustain. Energy Rev., vol. 78, pp. 11521187, Oct. 2017, DOI: 10.1016/j.rser.2017.04.121.

[4]. F. H. Gandoman, A. Ahmadi, A. M. Sharaf, P. Siano, J. Pou, B. Hredzak, and V. G. Agelidis, “Review of FACTS technologies and applications for power quality in smart grids with renewable energy systems,” Renew. Sustain. Energy Rev., vol. 82, pp. 502514, Feb. 2018, DOI: 10.1016/j.rser.2017.09.062.

[5]. A. M. Sharaf and A. A. Abdelsalamy, “A novel facts based dynamic voltage compensation scheme for smart electric grid stabilization and efficient utilization,” in Proc. 24th Can. Conf. Electr. Comput. Eng. (CCECE), May 2011, pp. 000042000047, doi: 10.1109/CCECE.2011.6030405.

[6]. R Blaabjerg, Z. Chen, SB Kjaer, “Power Electronics as efficient interface in the dispersed power generation system.” IEEE Trans. On Power Electron. Vol. 19, No. 5, pp. 1184¬1194., Sept. 2004

[7]. Sung-Hun, Seong R. Lee, HoomanDehbonei, Chemmangot V. Nayar, “Application of Voltage-and current-controlled Voltage Source Inverters for Distributed Generation System,” IEEE Transaction On Energy Conversion, Vol.21, No.3, pp. 782¬788, Sept. 2006.

[8]. Juan Manel Carrasco, ‘Power Electronic System for Grid Integration of Renewable Energy Source: A Survey, IEEE Trans on Industrial Electronics, Vol. 53, No. 4, pp. 1002¬1014, August 2006

[9]. X. Zhang, W. Zhang, Y. Lv, W. Liu, and Q. Wang, “Unified power quality conditioner with model predictive control,” in Proc. 5th Int. Conf.Comput. Sci. Educ., Aug. 24–27, 2010, pp. 1239–1244.

[10]. Yadav, Amrendra Singh, et al. “Increasing efficiency of sensor nodes by clustering in section based hybrid routing protocol with artificial bee colony.” Procedia Computer Science 171 (2020): 887-896.

AUTHORS PROFILE

	**Vivek Kushawaha** – Assistant Professor (Department of Electrical Engg) MGIMT Lucknow UP, Affiliated AKTU Lucknow.
	**Rajeev Yadav**- Pursuing B Tech(EE) Final Year From MGIMT Lucknow UP, Affiliated AKTU Lucknow.
	**Susheela** - Pursuing B Tech(EE) Final Year From MGIMT Lucknow UP, Affiliated AKTU Lucknow.

	**Ayush Rawat -** Pursuing B Tech(EE) Final Year From MGIMT Lucknow UP, Affiliated AKTU Lucknow.
	**Anoop Verma -** Pursuing B Tech(EE) Final Year From MGIMT Lucknow UP, Affiliated AKTU Lucknow.