DSTATCOM Performance for Voltage Sag/swell Mitigation

Vidya. M, P. Pramila, A. M. Nagaraj

Abstract*: *The Indian economy has been growing at a fast pace since the beginning of this millennium. Due to constraints in the availability of fuel and environmental concerns, the power generation sector has not kept pace with other industrial sectors. One way of increasing the power availability is by reducing the high losses in the existing power transmission and distribution systems. The current increases in the motor windings when the voltages in the three phases are unbalanced. Compensation for reactive power and unbalance in the power distribution system are key factors in improving the power quality to the end user. A Distributed Static Compensator [DSTATCOM] is a custom power device, which is connected in shunt with the load in the distribution system to compensate the reactive power due unbalanced loads. The performance of the DSTATCOM is based on the control technique used for finding the voltage referred and current components to be considered. Voltage compensation is defined as the error in voltage in the grid and that the value of voltage that has to be induced in the grid. This is analyzed by using DSTATCOM for voltage compensation with series converter controller block. This paper gives the simulation of voltage compensation to rectify the issue of voltage swell/sag in order to improve the power quality in the distribution system.

Keywords*: *DSTATCOM, voltage compensation, series converter.

I. INTRODUCTION

In the present scenario power quality is an important factor to be considered in the power system. Power quality issues are vital aspects in the industry level. Equipments and machines in the industries require quality power as it greatly influences their efficiency. The industrial equipments used in present days are sensitive to power quality issues. It is less tolerant to problems like low power factor, harmonic distortion, voltage sag, swell. Power quality can be maintained by proper maintenance method both at end user and utility end of the power system. The power supply parameters include voltage, frequency, current, phase shift. The maintenance of the voltage profile in the system is one of the important factors to be considered. 85% of the power quality issue is caused by voltage sag. Voltage dip causes the severe disturbance in the industries. Many compensation devices are available to reduce the impacts of momentary power quality issues. Hence FACTS devices are used to overcome the power quality issues and provide better performance of the equipments in the power system.

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The compensation techniques are used to eliminate these disturbances. Sag is defined as decrease in voltage in its rms value of voltage or current at the power frequency. It is caused by the fault at customers side or due to sudden change in load current. Swell is the increment in rms value of voltage or current at power frequency. Hence the variation in the current and voltage waveform in the power system should be compensated in order to maintain the power quality of the system. The voltage sag is reduced by applying reactive power at the load point.

II. DISTRIBUTED STATIC COMPENSATOR

D-STATCOM is a device used to reduce the voltage swell and sag that occurs in the system by controlling the reactive power. It provides better performance of the system at the distribution side. A D-STATCOM comprises of a coupling transformer, a dc energy storage device, controller and a two-level VSC connected in parallel to the distribution network. The configurations include multi tasking configurations. The Voltage Source Converter converts the dc voltage across the storage device into three-phase ac output voltages. These voltages are in phase and coupled with the ac system of network through the coupling transformer. The applications of D-STATCOM are it can be used for correction of power factor, regulation of voltage, balancing the load and reducing the harmonics. The response of D-STATCOM is faster and has compact structure. Reactive power compensation is an important factor in controlling the distribution systems. The other methods that can be used are capacitor banks, parallel feeders and Uninterruptible Power Systems. The D-STATCOM can withstand the reactive current and acts as a frequency and voltage supporter. This is one of the plus point of using DSTACOM in improving the power quality of the distribution system.

III. CONTROL STRATEGY OF DSTATCOM

The purpose of using the controlling method is to control the D-STATCOM used for voltage rectification. When the point of common coupling voltage is lower than the reference or rated value then the D-STATCOM generates reactive power. When Point of Common Coupling voltage is higher than the value rated then the D-STATCOM absorbs reactive power. To obtain the characteristics required for power quality improvement, the pulse width modulation of voltage source inverter are controlled by the firing pulses. The original bus voltage is compared with the value rated and the error is fed to the propotional-integral controller. Hence a signal is generated and this is given as an input to the pulse width modulation generator. Therefore the voltage imbalance is corrected by generating the triggering pulses.

IV. SIMULATION AND RESULTS.

In a given system, there will be variations in the voltage levels during the routine operation. Hence to provide constant voltage to consumers, different techniques are implemented to improve the power quality. This system is made of a source which supplies the load at the end. The load in the power system is always increasing. Thus when a extra load is added in parallel with the available load in the system, voltage sag occurs in the system. This sagged voltage is sensed and the amount of voltage required to compensate the line voltage is obtained. The voltage is then injected into the line through an injection transformer. Thus a compensated voltage of rated value is obtained at the load end. Voltage compensation block presented in this paper depicts the voltage error in the grid and shows that the power quality is being improved by using the compensation network.

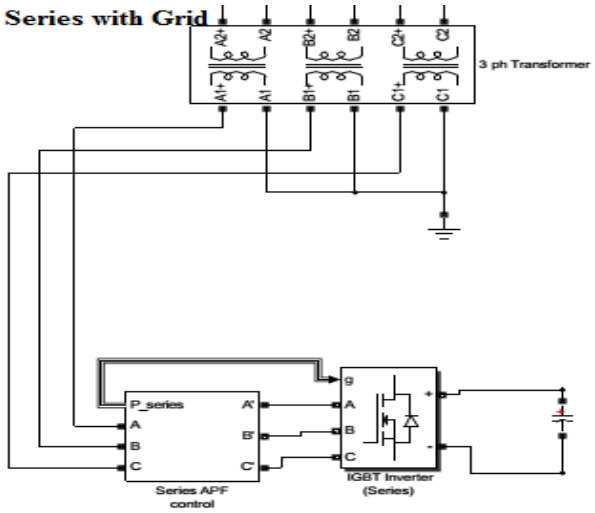

Fig: 4.1 Voltage Compensation block.

Table: 4 1 Parameters considered for simulation

Devices	Parameters	Values
Grid	AC phase to phase Voltage in V	415
	Frequency in Hz	50
	Power in MVA	100kVA
Linear Load	Real power in W	5000
	Reactive power VA	3000
DSTATCOM Coupling Transformer	Power rating Voltage	50kVA 200V

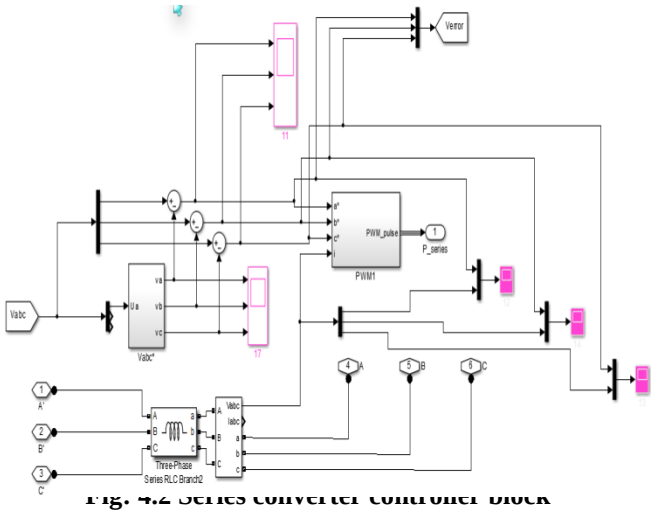

Fig: 4.2 Series converter controller block

The above figure 4.2 shows the series converter controller block used for voltage compensation. In this, the difference between the supply voltage and the voltage referred (V_{abc}*)is considered to calculate the voltage error. This value of voltage is compared with error voltage produced in three lines to obtain the Hysteresis control.

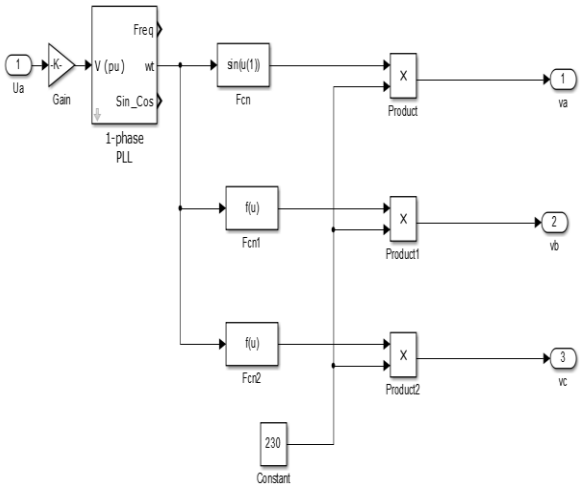

Fig: 4.3 Reference voltage generation

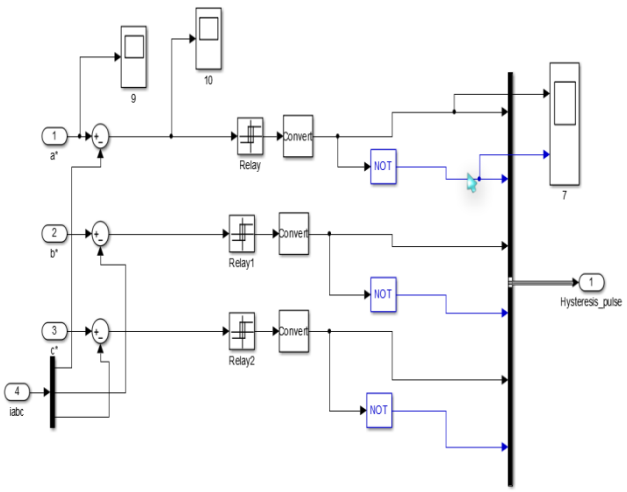

Fig: 4.4 Pulse width modulation

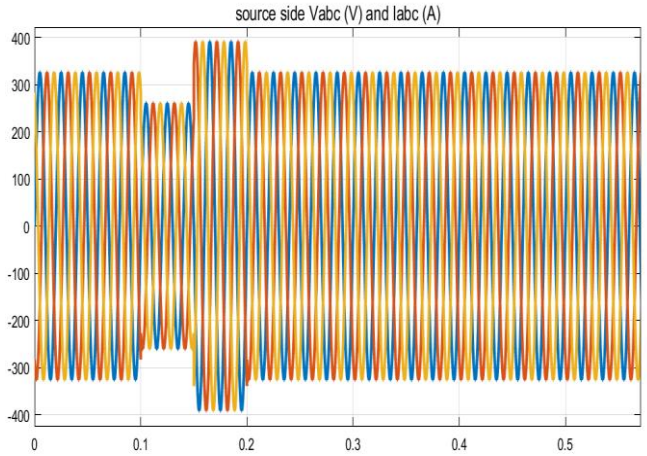

Fig:4.5 Phase A,B&C supply voltage and current without DSTATCOM [before voltage compensation]

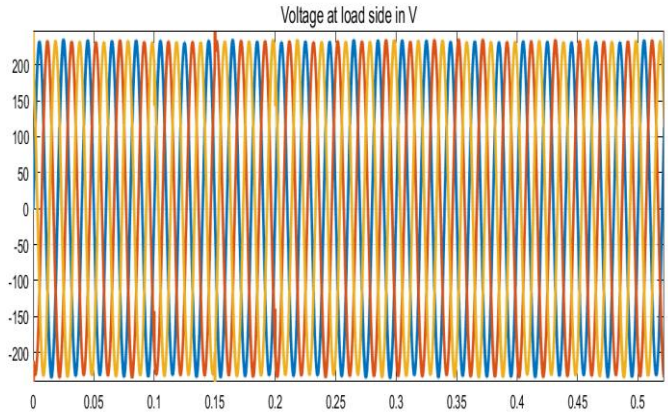

Fig:4.6 Phase A,B&C Load voltage with DSTATCOM [after voltage compensation]

Table: 4.2 Comparison of voltage sag and swell with and without DSTATCOM [Voltage Compensation]

Parameters	Without DSTATCOM	With DSTATCOM
Voltage sag [0.1sec]	50%	100%
Voltage swell [0.15 secs]	50%	100%

V. CONCLUSION

Since power quality is one of important aspect to be considered in electrical engineering, one has to have the track of the issues being exhibited in the power system. If the issues are not mitigated, then the performance of the system will be affected. This inturn affects the complete process of distribution of power to the consumers. Voltage sag/swell can be reduced by using the latest techniques. This paper explains about the reduction of voltage swell/sag in the power system by using Distributed static compensator to obtain good power quality. Voltage source inverter is used to create a compensating voltage at the time of fault occurrences. Whenever the fault is created a gate pulse is triggered to inject the voltage to the distribution line using the Voltage Source inverter circuit. LCL filter is used in the circuit to remove or reduce the ripples that are generated by the VSC inverter. The simulation results shows the voltage swell/sag can be rectified by using Distributed static compensator on the distribution side. The voltage source converter is used in combination with pulse width modulation and the reference voltage. Hence by implementing the voltage compensation controller block with Distributed static Compensator the problem of voltage swell/ sag is minimized thereby the performance of the system is improved.

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