A Review on Voltage Compensation Devices STATCOM and DSTATCOM

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Abstract: Static Compensators i.e. STATCOMs are kind of Flexible AC Transmission System (FACTS) devices that are utilized to manage the line voltage of electric power system. STATCOM has become the trending topic among the researchers for developing advanced innovations in this domain. These innovations are done by using controller devices such as PID, Fuzzy controllers etc. Thus, the Distributed STATCOM (D-STATCOM) is introduced to compensate the reactive power and unbalancing that occurs due to the different loads in the distributed power systems. DSTATCOM works on the basis of the VSC principle. It is installed in parallel order within a dispersed system. DSTATCOM is basically used to obtain the best performance of the distributed power systems. The major role of the DSTATCOM is to tune the performance of the power systems. This study generates a review of the DSTATCOM and various research works that have been done in this field during some previous years.

Index Terms **- Distributed Power System, STATCOM, D-STATCOM, Tuning.**

I. INTRODUCTION

With the improvement in automation sector in modern industries and deregulations, the parameters required to maintain the power quality has been changed [1]. If there is any kind of variation in line voltage as compared with ideal sinusoidal waveform, then it will also affect the drive converters along with the computer and process managing devices. The usual issues that can be raised are Voltage sags, distortion in the signal sue to presence of harmonics [2]; flicker and non continuous power supply. As these problems are increasing on wide scale therefore new equipments need to implement in the place of ordinary devices like PWM converter based shunt connected Power Conditioners also referred as DSTATCOM (Distribution Static Compensator) [3]. The flexibility in the operation in the utility section and various other sections of industries can be introduced by adding the energy storage unit with power conditioners [4]. Two identical loads with different types of feeders have been considered in this type of test model. Out of two feeders, one is linked with the DSTATCOM and other remained as it is. The test model has been examined for various fault conditions and also with the non linear loads connected with the system [5]. The proportional integral (PI) controller are used to implement the control technique, these PI controller initiates with difference current produced by the difference between the DSTATCOM current and reference current value [6]. The value of signal thus obtained is known as reference voltage of the inverter or also known as reference modulating signal [7,8]. Nowadays, various issues related to bad quality of generated power come across the distribution system. Some of the examples that represent the poor quality of power are poor power factor, load connected with three phases remain unbalanced, voltage dip and distortion because of introduction of harmonics in the signal [9, 10]. Factors responsible for the bad quality of power generated are reactive component in the system, non balanced and nonlinear loads like motors, variable speed and frequency drives and power electronic converter that are used in both domestic and industrial applications [11]. The power transmission as well as voltage dip at the load end is affected by the reactive component in the system [12]. Furthermore, the harmonics are introduced in the system by the nonlinear loads like ASDs, Variable Frequency Drives and power electronic converter can affect the quality of voltage signal at PCC and also affect the signals at various other loads linked with the similar terminals [13,14]. To resolve this issue related to the quality of power the DSTATCOM should be connected at PCC. In order to produce reliable distribution power quality, DSTATCOM can be implemented in the network [15]. It implements the voltage boosting technique by connecting the solid state switches in the parallel to compensate the voltage dips in the network. The loads which can largely affected by any small variation in the voltage level of network can be compensated by the implementation of DSTATCOM. With the help of this, the power quality of the signal can be maintained effectively.

Mainly the power quality of the system is affected by the voltage drop in the network. The voltage drops occur in industrial applications can create large scale losses. Mainly the quality of power affected due to the variation in end user devices [16, 17]. The distortion in the signal can also be introduced by the harmonics in the signal, the low value of power factor, heating in electrical components etc. This can result in vibration and noise in the devices and can also lead to the breakdown of sensitive machinery parts [18]. To resolve the power quality issues in transmission and distribution network, different ways have been introduced. Out of all these, the optimum way is to implement the D-STATCOM in the network. By using the D-STATCOM in the network, the reactive component at low voltage can be sustained by using the batteries in the network in place of capacitors to store the charge in it [19].

The Distribution Static Compensator (DSTATCOM) is a type of power electronic device (PED) whose concept is derived from the phenomenon of connecting the Voltage Source Converter (VSC) in parallel with the distribution networks [20].

Generally, the DSTATCOM is implemented in the network to monitor the system voltage effectively, improve the parameters of the voltage signal, minimize the level of harmonics in the signal and also used for compensation of reactive component produced due to load end [21]. Moreover, it is also used to resolve the issues related to the voltage drops raised due to reactive component introduced at the grid. If it is required to compensate amplitude as well as a phase component of the signal the active power need to be introduced in the network [22]. Instead of using the ordinary capacitor and inductors integrated with fast acting switches, the DSTATCOM utilize the power electronics converter in order to obtain the reactive component in the output [23]. If the DSTATCOM is compared with the STATCOM converter then it was observed that the DSTATTCOM has lower rated power, and is equipped with quick response power electronics switches, therefore the frequency of carrier signal in PWM can be higher in distribution controller as compared to the transmission controller [24].

II. RELATED WORK

Manpreet Singh et al [1], had presented the architecture and perform simulation on DSTATCOM along with a proportional integral controller to enhance the quality of power. After performing simulation the results are shown. In past few years, maintaining the good quality of power has become a major topic for power engineers to be concerned about. The power electronic devices (PED) are sensitive to disturbances in the network and therefore can be easily affected by various issues like voltage drop, swells, and harmonics in the signal. Improvement in the power quality of the signal in distribution network can be obtained by connecting a device in parallel to the network that can compensate the reactive component in the network and it can be referred as distribution static compensator (DSTATCOM). The quick operation of DSTATCOM had resulted in its implementation fin distribution network for improving the power quality. It can be implemented with the various types of controllers.

Chao-Shun Chen et al [2], Due to the production of a large amount of intermittent power, the voltage produced by distribution network varied and hence it results in the limited amount of penetration in Photo Voltaic connected in the system. In this paper, the efficiency of DSTATCOM had been examined. DSTATCOM used to compensate the reactive component in the network in order to control the output voltage produced by the system whenever there is a large number of solar radiations so that the installation capacity of PV in the system improve significantly. It helped in resolving the problems related voltage violation. The analysis of PV had been done by using the data obtained by weather bureau about the hourly solar radiation as well as temperature. After implementing the presented voltage controlling technique of DSTATCOM when there is a large amount of solar radiation, the total amount of power generated as well as delivered by the photo voltaic system for the one year can be analyzed. To compute the total cost of investment over the complete system life cycle and the final net present value of photo voltaic project various parameters are required such as annual sales of power produced by the photovoltaic cells, operation, and maintenance cost of the system, implementation cost of DSTATCOM in the network and implementation cost of PV system. In order to compensate the reactive component in the network, the proposed DSTATCOM voltage control technique had been executed. It also helped in identifying the optimal capacity to install the PV system in the network to increase the net present value so that the cost of implementation can be reduced without hampering the performance of the system.

Pinaki Mitra et al [3], had proposed the DSTATCOM implementation in the network in order to increase the quality of power generated in the ship power system. Controlling technique of DSTATCOM can effectively adjust the voltage as per requirement at the common coupling point. In this paper, the new adaptive control technique for distributive STATCOM on the basis of the artificial immune system (AIS) had been proposed along with Particle Swarm Optimization (PSO). This will help in providing the immunity from various types of disturbances in the system. To prevent the system from unknown and arbitrary system disturbances, the parameters of the controller are varied online. Proposed DSTATCOM with an artificial immune system based adaptive control technique had been analyzed by using the MATLAB simulation software. The obtained results were validated with the help of real time simulator software and control paradigm on a DSP (Digital signal processor). DSTATCOM act as a shunt compensating component usually implemented to resolve the problems related to the maintenathe nce of power quality.

B. Singh et al [4], had focused increasing on the quality of power generated with the help of Distributive STATCOM implemented on 42.5kVA alternator that produces the signal which in turn transmitted towards 3-phase, 3 wire distribution system**.** Various factors related to maintaining the good power quality are as follow: improving the power factor, regulating the voltage, linear load balancing. These all parameters had been discussed in this paper and were used with Distributive STATCOM. The Distributive STATCOM had been comprised of Insulated Gate bipolar transistor based PWM –VSI bridge along with the DC bus capacitor. The gating pulses required for the operation of insulated gate bipolar transistor had been produced with the help of hysteresis rule based carrier-less PWM (Pulse Width the Modulation) current controller. By analyzing the proposed system on simulation software the observed results had shown that the DSTATCOM can effectively eliminate the reactive component from the network and can enhance the quality of power generated in the distribution system.

Hojat Hatami et al [5], had concentrated on the operation and simulation of custom power controllers**.** In order to improve the quality of power transmission in distribution network producing a low level voltage signal, the power electronic devices are used in the network. This paper had proposed a novice pulse width modulation based controlling technique that needs to analyze the voltage parameter rather than the reactive components in the network. To analyze the presented technique, the simulation had been performed on PSCAD/EMTDC. The efficiency and reliability of the presented controlling technique had been proved by obtaining the results after simulation. The proposed method can effectively compensate the voltage disturbances because of variations in load.

Alpesh Mahyavanshi et al [6], had proposed the method to solve the problems related to voltage dip by using the distributive static compensator. Nowadays mostly the industries are facing the problems related to maintaining the good quality power and that is usually affected by the voltage drop in the networks. The paradigm used for controlling the power balance that had been implemented to obtain the reference source current signals to regulate the voltage at Point of Common Coupling for Distributive STATCOM had been evaluated in this paper. Distributive STATCOM was comprised of voltage source converter (VSC) and DC

link capacitor. The simulation had been performed for a proposed technique for various load conditions. After Simulation, the results had shown that the performance of distributive STATCOM was optimum.

Chandan Kumar et al [7], had introduced a novice paradigm that can produce the reference voltage signal operating the DSTATCOM in voltage control mode. The presented technique associated with various advantages as compared with the ordinary voltage controlled DSTATCOM and here the reference voltage was randomly taken as 1.0 p.u. The presented technique was capable to bring the value of power factor to unity at load terminal. The proposed scheme ensures that unity power factor (UPF) is achieved at the load terminal while operating under normal conditions and it was not probable in ordinary techniques. Moreover, the low level current signal had been also produced by the compensator and hence resulted in low losses in the feeder as well as voltage source inverter. In addition to this, the saving in the rating of DSTATCOM had acquired that further improve its ability to overcome the issues of voltage dips in the network. In order to obtain the quick voltage regulation when there are disturbances in the voltage produced in the system, the state-space model of Distributive STATCOM integrated with the deadbeat predictive controller was used. The distributive STATCOM can easily overcome the power quality related problems such as correcting the value of power factor, removal of harmonics, load balancing, and regulation of system voltage on the basis of load requirement. The proposed system had been analyzed by using the simulation software and the observation had shown that the technique was optimum.

Chanchal Katariya et al [8], the Static Compensator (STATCOM) may be described as FACTS controller unit. FACTS stand for flexible ac transmission system. STATCOM can help n compensating the reactive component in the system; therefore it can absorb as well as produce the reactive power. To compensate the reactive component in the distributive network and also compensate the unbalance created by different loads in the network, the Distribution Static Compensator (DSTATCOM) had been introduced. To optimize the value of voltage drop, voltage swell and to obtain the power factor up to unity, the distributive static compensator produces the current signal and fed it into the distributive system. Distribution STATCOM is an optimum way to acquire stable voltage and also effective in obtaining good power quality of distribution system. In this paper, the controlling scheme of DSTATCOM and its analysis had been done. Various controlling methods and paradigms to model the distributive STATCOM were analyzed in this paper and its operation had been evaluated by using the simulation software.

Ch. Siva Koti Reddy et al [9], has described the issues related to the power quality because of integration of wind turbine with the grid. The author had introduced a technique in which the DSTATCOM was integrated with the battery energy storage (BES) unit in order to resolve the problems related to the power quality in the system. BES was used here to maintain the actual power source when the power produced by the wind energy fluctuates. The proposed controlling technique of Distributive STATCOM integrated with wind energy production system in order to maintain the good quality of power in the system had been analyzed by using the MATLAB simulation software. The presented technique was implemented on both balanced and non balanced loads and it had resulted in improvement in power generation by Grid connected Wind energy production system. To enhance the quality of power generated by the wind energy generation system integrated with Grid for balanced and unbalanced non linear loads various paradigms had been proposed in this paper. A major issue in wind energy generation system was a connection of the system with the grid. When the power generated by the wind turbine had passed through the grid then it had resulted in the degraded power quality and that had affected the operation of the system. Because of fluctuation in the power generated by the wind farm due to the varying nature of wind energy had resulted in the introduction of harmonics in the system. Various parameters were affected due to the integration of grid in wind energy generation system and these parameters were degrading the power quality. The major influence was on the active and reactive component in the system, it can vary the voltage signal, incur flicker and harmonics and these were analyzed

III. CONCLUSION

In a distributed system, the issue of power quality exists due to the usage of power electronic devices, non-linear and inductive loads etc. The power quality of the system can only be enhanced by using STATCOM i.e. Static Compensator. This study comprised of a basic introduction to the DSTATCOM and various amendments that have been done during last years in this field by various scholars. This study can be considered as a guide for the naïve scholars. In future, more advancement is possible in this domain with respect to the used controllers.

REFERENCES

[1] Manpreet Singh. 2015. Role of DSTATCOM in Distribution Network under Various Fault Conditions. IJAREEIE, 4(7): 6307-6315.

[2] Chao-Shun Chen. 2013. Enhancement of PV Penetration With DSTATCOM in Taipower Distribution System. IEEE, 28(2): 1560-1567.

[3] Pinaki Mitra. 2010. An Adaptive Control Strategy for DSTATCOM Applications in an Electric Ship Power System. IEEE, 25(1), 95- 104.

[4] B. Singh. 2005. Power Quality Enhancement with DSTATCOM for Small Isolated Alternator feeding Distribution System. IEEE.

[5] Hojat Hatami. 2008. Investigation on D-STATCOM and DVR Operation for Voltage Control in Distribution Networks with a New Control Strategy. IEEE.

[6] Alpesh Mahyavanshi. 2012. Reactive Power Compensation by Controlling the DSTATCOM. IJETAE, 2(11): 212-218.

[7] Chandan Kumar. 2014. A Voltage-Controlled DSTATCOM for Power-Quality Improvement. IEEE, Vol. 29(3): 1499-1507.

[8] Chanchal Katariya. 2014. Power Quality Improvement By Using D-STATCOM: Review. JEEE, 15-20, 2014.
[9] Ch. Siva Koti Reddy. 2014. A DSTATCOM-Control Scheme for Power Quality Improvement of Grid Connected Wind Energy System for Balanced and Unbalanced Non linear Loads. IJMER, 2(3), 661-666.
[10] P. Venkata Kishore. 2014. Compensation of Reactive Power Using D-STATCOM. IOSR-JEEE, 9(1): 17-27.
[11] P. S. Sensarma. 2000. Analysis and performance evaluation of a distribution statcom for compensating volt age fluctuations. IEEE.
[12] Bhim singh. 2009. A comparison of control algorithms for dstatcom. IEEE, 56(7): 2738-2745.
[13] B. Blazic. 2006. Improved d-statcom control for operation with unbalanced currents and voltages. IEEE, 21(1): 225-233.
[14] Sabha raj arya. 2013. Performance of dstatcom using leaky Lms control algorithm. IEEE, 1(2): 104-113.
[15] Bhattacharya Sourabh. 2012. Applications of DSTATCOM Using MATLAB/Simulation in Power System. Research Journal of Recent Sciences, 1: 430-433.
[16] Amrita Saraf. 2014. Design and Simulation of DSTATCOM Using Phase Shift Control Based On Sinusoidal Pulse Width Modulation. IJERA, 4(1): 331-337.
[17] Sai Kiran Kumar.Sivakoti. Power Quality Improvement In Distribution System Using D-Statcom In Transmission Lines. IJERA, 1(3): 748-752
[18] Rehan Abidi. 2014. Analysis Of A D-Statcom In A 25 Kv Power Distribution System Using Simulink. IJEER, 2(2): 26-34.
[19] Brijesh Parmar. 2014. Improvement of Voltage Profile using DSTATCOM – Simulation under sag and swell condition. IJIEEICE, 2(7): 1657-1661.
[20] Sujin P. R. 2012. ANN Based Voltage Flicker Mitigation with DSTATCOM Using SRF Algorithm. IJCET, 2(2): 231-238.
[21] Kolli Nageswar Rao. 2012. Implementation of D-STACTOM for Improvement of Power Quality in Radial Distribution System. IJMER, 2(5): 3548-3552.
[22] Manish Kumar. 2014. Power Quality Improvements Using Dstatcom. IMRJ, 1(10): 1-8.
[23] T.sukanth. 2012. comparative study of different control strategies for DSTATCOM. IJAREEIE, 1(5): 362-368.
[24] Hendri Masdi. 2009. Construction of a prototype D-Statcom for voltage sag mitigation. European Journal of Scientific Research, 30(1): 112-127.