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Voltage regulation using DSTATCOM in Distribution system for enhancement of power quality

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Abstract – A Power quality problem is an occurrence manifested as a nonstandard voltage, current or frequency that results in a failure or a mis-operation of end user equipment's. In industries of diversified specifications, there is a big place for various kinds of equipment ranging from machinery to computers. All of them need sufficient voltage and good power quality to accomplish the respective industrial operations with greater efficiency. Nowadays, power quality concerns are prevalent in industries and they account for operational uncertainties. Upon finding better solutions for removing such concerns, the industries can get fruitful results. Among all controllers, DSTATCOM is most effective solution of power quality problems. DST A TCOM is shunt connected device and it is widely used as power quality mitigation device. The performance of DSTATCOM depends upon the control algorithms those are used to generate reference source current. In this paper PV based DST A TCOM is used so the DC voltage regulation is also very important that can vary with the irradiation level. To control the DSTATCOM, dq and pq based algorithms are used Simulation results demonstrate the effectiveness of controller of DST ATCOM for reactive power compensation, harmonic reduction and load balancing under the unbalanced conditions.

Keywords- **D-STATCOM, Total harmonics Distortion (THD, Voltage Sag/swell, Voltage Source Converter (VSC).**

Introdution

Due to the wide use of power electronic based equipment's in the electricity consumer community, power quality has become the key challenge to the researchers. Because all automatic equipment's draw reactive power and inject harmonics into the distribution system so responsible to the poor power quality. Due to limitations and environmental issues of conventional energy sources, continuous efforts are going on to increase the use of renewable energy sources for generation of electrical power . Some researchers have come up with new solutions in the area of renewable energy sources in terms of power quality improvement while dealing with distribution systems. At the distribution side , use of automated, computing devices is increasing day by day such as Personal computers, printers, scanners, fax machines etc. and many other nonlinear loads, so power quality has become major concern among the electric utilities. These type of power electronic based sensitive loads inject harmonics into the line and responsible to the waveform distortions that results poor power factor also. All the power quality mitigation controllers which are used in distribution systems are known as custom powerdevices (CPD's).

Among all controllers, DSTATCOM is most effective solution of power quality problems. DST A TCOM is shunt connected device and it is widely used as power quality mitigation device. The performance of DSTATCOM depends upon the control algorithms [1] those are used to generate reference source current. In this paper PV based DST A TCOM is used so the DC voltage regulation is also very important that can vary with the irradiation level. To control the DSTATCOM, dq and pq based algorithms[7] are used Simulation results demonstrate the effectiveness of controller of DST ATCOM for reactive power compensation, harmonic reduction and load balancing under the unbalanced conditions.

Summary of Literature Review

[1] S. S. Pawar, A. P. Deshpande and M. Murali, "Modelling and simulation of DSTATCOM for power quality improvement in distribution system using MATLAB SIMULINK tool," *2015 International Conference on Energy Systems and Applications*, Pune, 2015, pp. 224-227

In this paper a reduced rating voltage-source converter as a distribution static compensator is proposed for power-quality improvement in the three-phase four-wire distribution system. The proposed DSTATCOM using synchronous reference frame theory is employed for the compensation of reactive power, harmonics currents, neutral current, load balancing and the voltage regulation a the point of common coupling. The performance of the DSTATCOM is validated through simulations using MATLAB software with its simulink and power system blockset toolboxes.

[2] V. F. Pires, A. Cordeiro, D. Foito and J. F. Silva, "Control of Bidirectional Quadratic DC-DC Converters for Storage Support of DC Power Grids," 2018 7th International Conference on Renewable Energy Research and Applications (ICRERA), Paris, 2018, pp. 227-232, doi: 10.1109/ICRERA.2018.8566946.

Many applications require a DC bus supporting co nnections to several renewable energy sources, storage systems and loads. However, due to the intermittent nature of renewable energy sources and load variations it is essential to stabilize the voltage of the DC bus. Usually a battery is used to support the DC bus voltage, but their continuous charge and discharge cycling will affect his lifetime. Thus, the use of a storage system based in supercapacitors provides an interesting alternative to stabilize the DC power grid. In this context, this work presents a study of a storage system based in supercapacitors combined with a bidirectional quadratic DC-DC converter to support the DC bus. A full design of the controllers for the quadratic converter is also presented. The behaviour of the system will be tested through several simulation results

[3] G. Varshney, D. S. Chauhan and M. P. Dave, "Performance analysis of photovoltaic based DSTATCOM using SRF and IRP control theory1," 2015 1st International Conference on Next Generation Computing Technologies (NGCT), Dehradun, 2015, pp. 779-783, doi: 10.1109/NGCT.2015.7375226.

The Power quality has become one of the most vital issue to both electric utilities and end level users of electric power. Automation has completely changed the load nature due to widespread use of power electronic based drives such as adjustable speed drives, Energy efficient lighting, PC's, office accessories etc. All power electronic based sensitive equipments are the major fatalities of power quality problems such as voltage Sag, Swell,

Waveform distortion, Poor power factor etc. In this paper, a three phase three wire Distribution Static Compensator (DSTATCOM) which is fed by Photovoltaic (PV) array is proposed for power quality improvement. The DSTATCOM is a three leg voltage source Inverter (VSI) with a DC link capacitor. Photovoltaic module is used to keep regulate the desired voltage at DC link. The Power quality improvement is achieved in terms of reactive power compensation, Power factor correction, Harmonic reduction, DC voltage control. In this paper, the performance of DSTATCOM is shown for Power factor correction(PFC) and Zero voltage regulation (ZVR) modes using d-q and p-q theories of control. The effectiveness of the PV based DSTATCOM is verified with simulation results. The simulation is carried out on MATLAB software using Simulink and PSB toolboxes.

What is Power Quality?

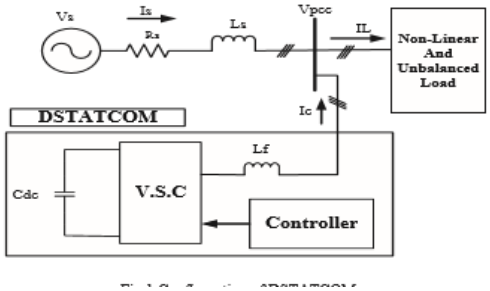
Power quality is nothing but the quality and amount of substantial voltage provided from the power supply to the final load or industrial equipment. The electric and electronic devices – whether in industries, houses, shopping malls, or any other places – will need good power quality to run smoothly. If there are any disturbances occur in the power supply, then the voltage levels and supply to the devices will be altered. So, their function will be disrupted – this will be showing an impact on the final device. Due to , this devices may get damaged and sometimes the functioning will be improper, and hence may not get normal results. This will be critical in case of sensitive equipment. So, everyone must ensure that they enable a good quality of power to the concerned devices.

Certain Disturbances Affecting Power Quality

a) Voltage surges or spikes
b) Under voltages
c) High-voltage spikes
d) Voltage Dips
e) Frequency variations
f) Voltage fluctuations
g) Voltage Unbalance
h) Noise

Problem Formulation

Exiting system with DSTATCOM is the most versatile device. However, the DSTSTCOM is not widely applied in utility grids, Exiting system with Withought PV source as input is mostly preferred. Exiting system shown in fig



Proposed system introduces a new concept of DTATCOM that Use conventional FACTS and D-FACTS devices. The DPFC gives the possibility of control all system parameters, such as line impedance and power angle, mitigate sag, swell and Harmonics. At the same time, it provides higher reliability and lower cost.

Proposed System

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Research Objectives

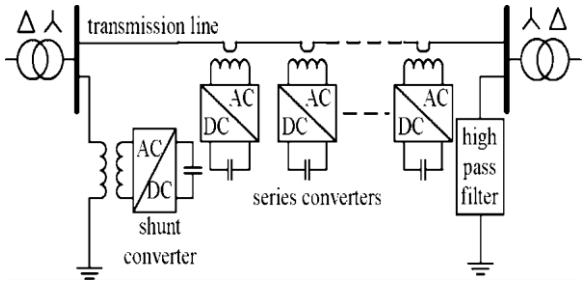
Design and simulation of VSC(Voltage source converter) based DSTATCOM for the compensation of power quality problems to make the distribution system more efficient using MATLAB software.

1. Main objective of project to eliminate the power quality problem
2. To minimize the sag using DSTATCOM
3. To minimize swell using DSTATCOM
4. To Reduce harmonics using DSTATCOM
5. To design PV based DSTACOM to solve Power Quality Problem

Research Methodology/Planning of Work

The proposed work is planned to be carried out in the following manner:

1. Study of basic concepts of Distributed Power flow Controller.
2. Finding the problems from conventional system by surveying literature.
3. Design the distribution System.
4. Design and study of DPFC.
5. Analysis of the proposed topology.
6. Study of the control strategies of system.
7. Design and Implementing a PV system for DSTATCOM in a system.
8. Simulation of the model can be done in MATLAB software. Evaluation of the performance.



The proposed work is planned to be carried out in the following manner

. Expected Conclusion;-

6. The power quality improvement using Dstatcom will be simulated in the MATLAB Simulink and related waveform will be observed
7. Without DSTATCOM (Waveform observe)
8. a) sag
9. b)swell
10. c) Harmonic
11. With DSTATCOM (Waveform observe)
12. a) sag
13. b)swell
14. c) Harmonics
15. With and without DSTATCOM result Compare

Bibliography:

1] S. S. Pawar, A. P. Deshpande and M. Murali, "Modelling and simulation of DSTATCOM for power quality improvement in distribution system using MATLAB SIMULINK tool," *2015 International Conference on Energy Systems and Applications*, Pune, 2015, pp. 224-227.

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