Application of STATCOM In Transmission Line-A Review

Mr.Arvind S. Hirole[1], Prof.YogeshP.Sushir[2], Prof. Jitendra R. Hanumant[3]
[1]Dept of Electrical (Electronics& Power) Engineering
[2, 3]Assistant Professor, Dept of Electrical (Electronics& Power) Engineering
[1, 2, 3] Padm.Dr.V.B.Kolte College of Engineering, Malkapur2,3(MH) India

Abstract- *Power quality issues, particularly reactive power and harmonics, are a severe danger to the safe operation of the power grid as the type and capacity of electricity loads grows. "As a major member of the FACT, the static synchronous compensator (STATCOM) has been widely used as the state-of-the-art dynamic shunt compensator for managing reactive power in transmission and distribution. It has gained a lot of attention in the scientific and engineering fields both at home and abroad due to its great performance in terms of smooth reactive power control and quick dynamic features. when compared to a typical synchronous condenser The static var compensator SVC, STATCOM, which has a small size, a faster speed, and a wide operating range, has a significant performance advantage and can effectively compensate reactive power, suppress harmonic current, and provide voltage support for transmission systems, and it will become increasingly popular. This paper introduces application of STATCOM in electric transmission line for various condition".*

Keywords- STATCOM; control strategy; inverter, FACTS devices; voltage source converter; power system stability; Power quality.

I. INTRODUCTION

"The grid load is unlikely to be a pure resistance load, as the majority of the load is inductive. In many industrial fields today, the load that might generate reactive current is divided into three categories: Due to the presence of inductive load, such as transformers and motors, when such a load is granted access to the electricity grid for working, there will inevitably be a phase mismatch between current and voltage, resulting in a power factor of less than 1. Crystal tube rectifier bridges and transverters are examples of high-power electrical equipment. STATCOM, which is a major component of the Flexible AC Transmission system, can be utilised to not only compensate for reactive power, but also to improve system stability and support key nodes in the voltage transmission system [1]. As a result, STATCOM is a key development direction for dynamic reactive power compensation devices, with a significant impact on power quality. Static synchronous compensator (STATCOM) is a controllable reactive power that may adjust the inverter's voltage and current waveform by power electronic means, emitting or absorbing no power, and suppressing voltage flicker and voltage drop, as well as improving power quality [2-4]. It is quite important. In practise, the power users of power quality care that encourages the power quality controlling technology development by incorporating high technology and complex equipment into national economic production. As the most modern device for reactive power compensation equipment, the development of STATCOM has been a source of significant concern" [5].

II. BASIC STRUCTURE OF STATCOM

STATCOM is separated into two types based on the distinct circuits: voltage-bridge circuits and current-bridge circuits. "Because the rate of a voltage-bridge circuit is higher than that of a current-bridge circuit, voltage-bridge circuits are frequently used in STATCOM applications [6]. The voltage-bridge circuit is also used in the simulation model. The STATCOM main circuit is made up of voltage-bridge circuits, as indicated in the diagram, and the structure is made up of the following parts: Voltage source inverter (VSC), which is made up of high-power electric electronic switching devices (GTO or IGBT) and uses pulse width modulation technology (PWM) to control the power electronic switch, reversing DC voltage of the capacitors into AC voltage with a certain amplitude and frequency; Coupling combined transformer and reactor, not only has the high power converter. In optimal operating conditions, the device does not absorb active power, resulting in a pure reactive power exchange between the converter and the system's energy [7-9]. The connection between the inductive and capacitive continual adjustments produces reactive power as shown in fig. 1. In actual operation, because the converter and connecting the reactor are grid components that lose power, it is necessary for the grid to provide the necessary active power to compensate for some loss; otherwise, the ministry's DC side capacitor energy consumption will empty the ministry" [11].

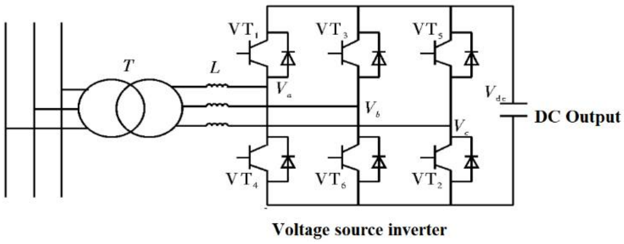

Fig. 1 Structure for STATCOM

III. FACTS CONTROLLER IN POWER SYSTEM

"Because of their potential to govern power system operations through reactive power control, power quality enhancement, and control over transmission capabilities, FACTS controllers have become a prominent topic of research. In [12]-[14], different topologies of FACTS controllers are proposed. FACTS devices are divided into two categories as a result of technological advancements: One class employs thyristor-based reactor and capacitor switching. In this initial class of controllers, tap altering transformers are also used. For switching, other types of controllers use IGBTs, MOSFETs, and GTOs [15]-[16]. Power flow can be manipulated in STATCOM by injecting or absorbing reactive power. When the voltage at the PCC falls below a particular threshold, STATCOM sends reactive power to the grid. STATCOM absorbs reactive power when the voltage at the PCC exceeds the required level [17]. STATCOM injects current that is 90 degrees phase shifted by voltage to match capacitive or inductive reactance at the common coupling point [18]. STATCOM has either a current source converter or a voltage source converter. The [15] presents various STATCOM control techniques and control algorithms. The Electrical Power Research Institute (EPRI) identified some major issues with FACTS controllers and proposed potential remedies [16]. Voltage instability issues may become more dynamic as a result of higher load growth and transmission constraints. STATCOM with Magnetic Energy Storage System [24] can help to solve these issues as shown in fig. 2. When compared to two-level traditional converter technology, multilayer technology has many additional advantages, such as larger power rating, reduced total harmonic distortion, and higher efficiency [25]. The Thyristor and Gate Turn off have a low switching frequency, which is an issue for conventional converters (GTO). Multilevel converters solve these issues while also being cost-effective and providing great performance" [26]-[28].

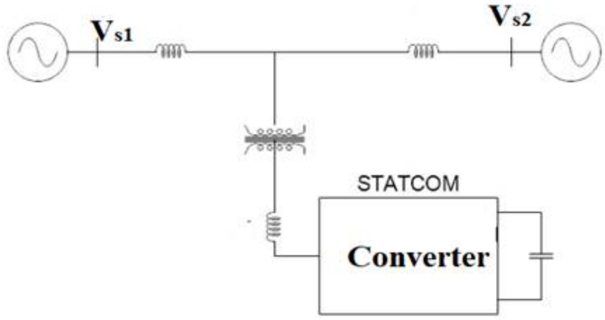

Fig.2 Grid connected STATCOM

IV. STATCOM CONTROLLER

"The Hysteresis-band PWM is a type of instantaneous feedback current control in which the real current follows the command current with a hysteresis band [19-21]. The sine reference current wave of desired amplitude and frequency is generated by the control circuit and compared to the real phase current wave. The upper switch in the half-bridge is turned off and the lower switch is turned on when the current exceeds a prescribed hysteresis band. The lower switch is turned off and the top switch is turned on as the current crosses the lower band limit. At each transition, a lock-out time(t_d) is provided to prevent a shoot-through fault. By switching the upper and lower switches back and forth, the actual current wave is forced to track the sine reference wave inside the hysteresis region" [22].The inverter effectively transforms into a current source with peak-to-peak current ripple that can be regulated within the hysteresis band regardless of V_d fluctuations. The breadth of the hysteresis band affects the peak-to-peak ripple and switching frequency [23]. Fig. 2 depicts the proposed hysteresis controller. by infusing the reactive component current into the system, which modulates the voltage. The reactive current required for power factor adjustment is calculated based on the load current. There are various large-capacity STATCOM devices in use around the world right now. In 1979, Japan's Mitsubishi Corporation successfully manufactured the world's first 20Mvar capacity of SVG. After that, static synchronous compensators with capacities of 10Mvar, 80Mvar, and 1000Mvar were installed. The China Electric Power Research Institute was established in 2011 with great success. STATCOM, a dynamic reactive power compensation device based on IGBT, is a novel technology alternative for large-capacity national backbone grid applications [24-27]. These serially multiplexed transformer devices, which are employed in the main circuit, minimise the voltage method while also improving the power level.

V. CONCLUSION

"The development of the PWM converter as the primary form is based on the main circuit of STATCOM, which was viewed as a multiple of the square wave converter as the main form in the early period. To lessen the effect of coupling voltage, most multi-technology and multilayer PWM converters combine. The purpose of STATCOM compensation, which compensates for transmission-based systems in the early stages, is to eventually expand to include distribution systems and all levels of load compensation. A range of advanced control strategies, such as fuzzy control, robust adaptive control, and artificial neural network control methods, are applied to STATCOM's control techniques in order to suit all system requirements".

REFERENCES

[1] Haixue Lin, "Basic problems of modern power quality," power system technology, vol.25, no.10,pp.5-12,2001.

[2] SharmeelaC,UmaG,Mohan M R."Multi-level distribution STATCOM for voltage sag and swell reduction [C],"IEEE Power Engineering Society Generd Meeting,vol.2,pp.1303-1307,2005.

[3] K. Somsai and T. Kulworawanichpong, "Instantaneous Power Control of D-STATCOM with Consideration of Power Factor Correction", Power System Research Unit, School of Electrical Engineering, Suranaree University of Technology NakhonRatchasima, Thailand 30000, April 3,2014.

[4] Sabha Raj Arya, Bhim Singh, Ambrish Chandra and Kamal Al- Haddad, "Power Factor Correction and Zero Voltage Regulation in Distribution System Using DSTATCOM", IEEE International Conference on Power Electronics, Drives and Energy Systems December16-19, 2012,

[5] KolliNageswarRao, C. Hari Krishna, Kiran Kumar Kuthadi, " Implementation of D-STACTOM for Improvement of Power Quality in Radial Distribution System", International Journal of Modern Engineering Research (IJMER) Vol. 2, Issue. 5, Sep.-Oct. 2012 pp-3548-3552.

[6] TejasZaveri, B.R. Bhalja and NaimishZaveri, "Load compensation using DSTATCOM in three-phase, three-wire distribution system under various source voltage and delta connected load conditions,"Journal of Electrical Power and Energy Systems, vol. 41, pp. 34–43, 2012.

[7] Rajiv. K. Varma, Shriram. S. Rangarajan, IurieAxente, Vinay Sharma, "Novel Application of a PV Solar Plant as STATCOMduring Night and Day in a Distribution Utility Network", 2011 IEEE PES Power Systems Conference & Exposition, March 20- 23, 2011, Phoenix, Arizona, USA.

[8] R.K. Varma, V. Khadkikar and R. Seethapathy, "Nighttime Application of PV Solar Farm as STATCOM to Regulate Grid Voltage," IEEE Trans. on Energy Conversion (Letters), vol.24, no.4,2009, pp.983-985 Rajiv K. Varma and VinodKhadkikar, "Utilization Of Solar Farm Inverter as STATCOM", USProvisional Patent application filed 15 Sept. 2009.

[9] A new approach to load balancing and power factor correction in power distribution system," IEEE Trans. Power Delivery, vol. 15, 2000, pp.417–422,

[10] H. Akagi, Y. Kanazawa, and A. Nabae, "Instantaneous reactive power compensators comprising switching devices without energy storage components," IEEE Trans. Ind. Applicat., vol. IA-20, 1984, pp. 625–630

[11] S.SivaKesava Reddy, A. R. Vijay Babu, S. Suman, K.DivyaManasa, " Reactive Power Compensation Using DSTATCOM", International Journal of Engineering Research and Applications , pp: 1-6.

[12] R. Shah, N. Mithulananthan, R. Bansal, and V. Ramachandaramurthy, "A review of key power system stability challenges for large-scale PV integration," Renewable Sustain. Energy Rev., vol. 41, pp. 1423–1436, 2015.

[13] "Reliability Standards for the Bulk Electric Systems of North America," North Amer. Elect. Rel. Corp., Atlanta, GA, USA, 2017.

[14] R. K. Varma, S. A. Rahman, and T. Vanderheide, "New control of PV solar farm as STATCOM (PV-STATCOM) for increasing grid power transmission limits during night and day," IEEE Trans. Power Del., vol. 30, no. 2, pp. 755–763, Apr. 2015.

[15] R. G. Wandhare and V. Agarwal, "Novel stability enhancing control strategy for centralized PV-Grid systems for smart grid applications," IEEE Trans. Smart Grid, vol. 5, no. 3, pp. 1389–1396, May 2014.

[16] A. Reznik, M. G. Simoes, A. Al-Durra, and S. Muyeen, "LCL filter design and performance analysis for grid-interconnected systems," IEEE Trans. Ind. Appl., vol. 50, no. 2, pp. 1225–1232, Mar./Apr. 2014.

[17] "ERCOT Nodal Operating Guides," Elect. Rel. Council Texas, Austin, TX, USA, 2015.

[18] Hongbo Chu, "A study on the control of BP neural network based on STATCOM," Guangxi University, master thesis, 2006.

[19] LinjuXu, "Summary of the development in the STATCOM topology structure, "electronic world, vol.21,pp.81-82,2014.

[20] Xin Huang, Jincao Chen and Yinxiao Wen, "Based on research of a new STATCOM Z source inverter technology [J] ,"power system protection and control ,vol.39,no.20,pp.6-10,2011.

[21] PraneshRao, MLGrow and ZhipingYang."STATCOM control for power system voltage control applications[J],"IEEE Traws on power delivery, vol.15,no.4,pp.1311-1317, 2000.
[22] S. Dudhe, "Reactive Power Compensation Techniques in Transmission lines," International Journal on Recent and Innovation Trends in Computing and Communication, vol. 3, Issue 5, May 2015.
[23] N. S. Kumar, R. Srinivasan and M.A. Khan, "Damping Improvement by FACTS Devices: A Comparison between STATCOM, SSSC and UPFC," Journal of Applied Science, vol. 2, pp.171-178, 2008.
[24] N. G. Hingorani, "FACTS-Flexible AC Transmission System," IEEE 5th International Conference on AC and DC Power Transmission, London, pp. 1–7, 1991
[25] N. G. Hingorani, "Flexible AC Transmission," IEEE Spectrum, Palo Alto, USA, vol. 30, no. 4, pp. 40–45, 1993
[26] B. Singh et al., "Introduction to FACTS Controllers a Critical Review," International Journal of Electrical Energy Systems, vol. 3, no. 2, pp. 85–98, 2011
[27] S. Haddad, A. Haddouche and H. Bouyeda, "The use of FACTS Devices in Disturbed Power Systems-Modeling, Interface, and Case Study," International Journal of Computer and Electrical Engineering, vol. 1, no. 1, pp. 56-60, 2009