Improving the power quality of power system using 48 pulse Static Synchronous Compensator.

KISHORI M. WARHATE
Department Of Electrical Engineering
G. H. Raisoni College of Engineering,
Nagpur 440016, India
Kishoriwarhate1995@gmail.com

Dr. V.K.CHANDRAKAR
Department Of Electrical Engineering
G. H. Raisoni College of Engineering,
Nagpur 440016,India
vinod.chandrakar@raisoni.net

Abstract— **The comparison of harmonic of a two-area Various-machine power grid, by utilizing 12 pulse and 48 Pulse STATCOM (Static Synchronous Compensator) with heavy lagging load condition is preferred for analysis AC Transmission System (FACTS) device efficient of managing the power flow in a transmission line as well as harmonics by reduction. Harmonic domain Simulations are conducted in Matlab/Simulink atmosphere for the Various-machine power grid script with and without STATCOM. Examine the result of 12 pulse and 48 pulse STATCOM on harmonic consummation of the grid under the alternate varying load requirement. The simulation results showcased the efficacious and robustness of the recommended 48 Pulse STATCOM on harmonic reduction of the grid under heavy lagging load condition.**

Keywords—12 pulse, 48 pulse, harmonic, STATCOM, voltage, power quality, Reference paper, Total harmonic distortion.

I. INTRODUCTION

Harmonic in power system is introduced by highly non-linear devices and it degrades its performance. Forced Commutated VSCs are the most building block for low and medium power application. Due to recent development within the semiconductor technology and convenience of high power switches e.g. Insulated Gate Bipolar electronic transistor (IGBT) gate put off Thyristor (GTO) have widespread acceptance certain high power VSC's, that area unit used for HVDC converters and FACTS controllers. The process of shrewd the magnitude and section of basic and better order of system signals suggests that facility analysis. The generation of harmonics in facility is thanks to giant size of power device. To reduce the harmonics within the system, filter and fashionable switch pattern are used. The increasing prevalence of flexible AC transmission system (FACTS) devices makes to have accurate model of these devices.

The prime object of this document is to devise a power grid connect with a STATCOM and prove the operation of the model in examine to enhance power grid oscillation durability used the immerse outcome of the STATCOM [1]. The impact of STATCOM integrated with a SMES on two machine power system is explored [2]. This file grant frequency demesne process for harmonic examine of space vector based STATCOM [3].

It shows a latest command policy of a three-level 48-pulse STATCOM is suggested with a PWD and constant dc link voltage at fundamental frequency switching [4]. [5] deals with the applications of STATCOM for improving the consummation of the Power grid for any load. An complete examination of equilibrium state fulfillment of STATCOM with the repositing of energy ideologically will be introduced by that paper. The operation of proffered specified script and command method is examine by digital simulation display using PSIM [6]. [7] grant the comparable operation of RBFN and Fuzzy logic controlled VSC based STATCOM in terms of enhance in power grasping sufficiency of the line, betterment in transient durabiity and immerse of oscillations in the SMIB and multi-machine system.

shows the advantage of Ultracapacitor as value addition to the D.C. link of VSC based FACTS controllers have demonstrated by this paper [8]. [9] The outcome of variant Loads, and voltage recompenses employing VSC based STATCOM is granted. [10] study The power grid harmonic review is the procedure of scheming the dimension and phases of the basic and upper order harmonics of grid signals. This paper furnish a survey on the main evolution in the area of power system harmonic analysis. [11] will studied the outcome of STATCOM in voltage durability development.

specify the modeling & study of STATCOM based on SVPWM [12]. An artificial neural network (ANN) based STATCOM for power grid immerse is designed by [13] to improves the productive execution of the grid. [14] use STATCOM for the restrain of voltage and flowing the power in long distance transmission line. [15] STATCOM, SSSC and UPFC these are the voltage source converters based flexible AC transmission system controlled by the relative functioning of RBFN is presented by this paper. This paper deals with the modeling and management theme of D-STATCOM.In this project by analyzing the different control techniques for designing the DSTATCOM & implementing the algorithm which will help in to design the model of DSTATCOM in MATLAB/simulink for the specified result [16].

This paper presents a unique plan wherever a STATCOM is employed innovatively as a load reactive power compensator associate interface unit between the grid and

renewable energy supply, and as an effective technique for real power exchange between the dynamic load system, grid and renewable energy supply [17]. The major problems dealt here is the voltage sag and swell.To solve this downside, custom power devices area unit used. One of those devices is the D-STATCOM, that is that the best and effective trendy custom power device employed in power distribution networks [18]. This paper presents Distribution Static Compensator (DSTATCOM) modeled in the MATLAB SIMULINK toolbox for the mitigation of the power quality issues in the distribution system.DSTATCOM is one amongst the custom power device utilized in distribution system for power acquisition [19]. This paper presents a study on the modeling of a STATCOM (Static Synchronous Compensator) used for reactive power compensation on a distribution network [20].

In all above reference papers, STATCOMs have been generally used for voltage support over the last decade, to better power quality and voltage durability. The aim of this work is to identify how the 12 Pulse STATCOM can be used to reform the capacity of STATCOM units to assert a high quality of distribution voltage and better the system solidity as well as reduce the harmonics. The unique part of this paper is that it calculated the Total harmonic distortion (THD) under non linear load condition by using Fast Fourier transform (FFT) method while it shows the immense difference in the harmonics with and without 12 pulse and 48 pulse STATCOM.

II. 48 PULSE STATIC SYNCHRONOUS COMPENSATOR

The Static Synchronous Compensator Shows in Fig 1. It is a prime affiliate of the FACTS group of electronic based regulator. In recent's power grid these FACTS device is widely used and It has been studied for many years. STATCOM is a static reactive power compensator whose electrical capacity and electrical resistivity expense can be restrained absolute of the ac system voltage operated as a shunt connected SVC.

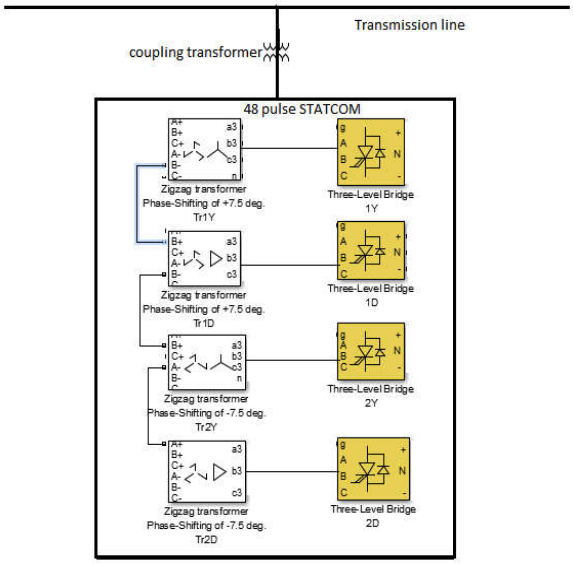

Figure1. 48 Pulse Static Synchronous Compensator (STATCOM)

III. MULTI MACHINE POWER SYSTEM MODEL

The system model considered for analysis is a two area multi machine system which is shown in the figure 2.

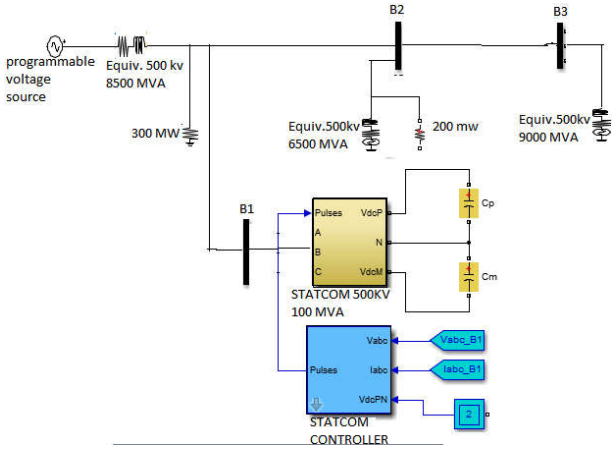

Figure 2. System with 48 pulse STATCOM

A 100-Mvar STATCOM regulates voltage on a three-bus 500kV system. The 48-pulse STATCOM uses a Voltage-Sourced Converter (VSC) built of four 12-pulse three-level GTO inverters. Look within the STATCOM block to examine however the VSC electrical converter is made. The four sets of three-phase voltages obtained at the output of the four three-level inverters are applied to the secondary windings of four phase-shifting transformers (-15 deg., -7.5 deg., 7.5 deg., +7.5 deg. phase shifts).

The fundamental elements of voltages obtained on the five hundred kilovolt aspect of the transformers square measure additional in part by the serial affiliation of primary windings. During steady-state operation the STATCOM system keeps the basic part of the VSC voltage in part with the system voltage. If the voltage generated by the VSC is higher (or lower) than the system voltage, the STATCOM generates (or absorbs) reactive power. The amount of reactive power depends on the VSC voltage magnitude and on the electrical device escape reactances.

The fundamental part of VSC voltage is controlled by varied the DC bus voltage. In order to vary the DC voltage, and therefore the reactive power, the VSC voltage angle (alpha) which is normally kept close to zero is temporarily phase shifted. This VSC voltage lag or lead produces a short lived flow of active power which ends in a rise or decrease of condenser voltages. One of the 3 voltage sources employed in the five hundred kilovolt system equivalents will be varied so as to watch the STATCOM dynamic response to changes in system voltage.

IV. NON LINEAR LOAD

The load electrical resistance vary with the usable voltage when load is considered as Non-Linear. The varying electrical resistance means that the harmonic current flows by the non-linear load and produce the waveforms which is not in a the form of sine wave. These Non-Sinusoidal currents consists of harmonic currents produce voltage distortion and interacts with the resistivity of the electrical power distribution system and that can modify both the distribution grid tools as well as the loads which are connected to it. This behavior allow current with dissimilar type of equipment that are various of the basic consistency of the grid. These equimpents are called harmonics. Because of these harmonic current THD increases.

Previously, Non-Linear loads were generally identify in huge manufacturing appliances such as Inductive load, big variable frequency drives (VFD), 3 phase dynamic load, heavy rectifiers for electrolytic refining, etc .

In this paper a very popular load which is 3 Phase dynamic load and Inductive load which is highly Non-linear.

V. SIMULATION RESULT

a) FFT Analysis of system with RLC load lg fault-12 pulse statcom

When we inserted the RLC load and LG fault for the duration of 5-5.1 s that means that fault was their for only 0.1s. and this 0.1 s fault create a huge amount of harmonics which is dangerous for the system. It damage the components and it is not healthy for the system. After Harmonic Analysis of system with RLC load and LG fault With 12 Pulse STATCOM and Total harmonic distortion is 70.12 % by using of FFT Method, which is very high.

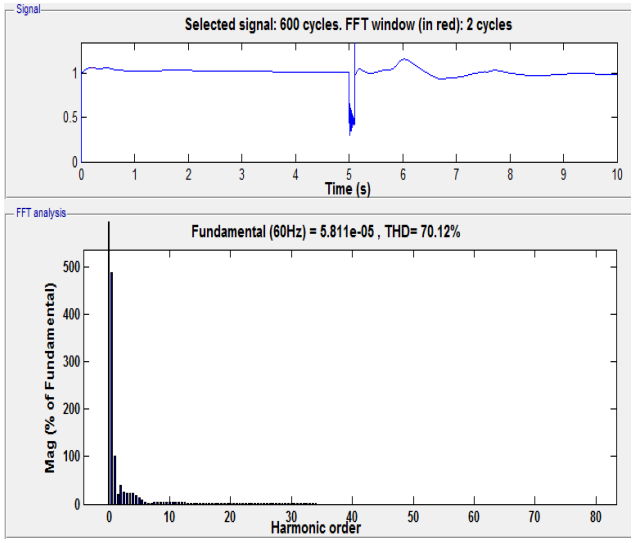

Figure 1. harmoni analysi with 12 pulse statcom

b) FFT analysis of power system with RLC load and lg fault- 48 pulse statcom.

Harmonic Analysis of system with 48 pulse STATCOM with RLC load and and LG fault which is only for 0.1 s. and its THD is 70.12 % Shows in Fig . It reduces the huge amount of harmonics as compare to 12 pulse STATCOM in the system and from this ratio of damaging electric tools is improve and also better the attribute of power grid.

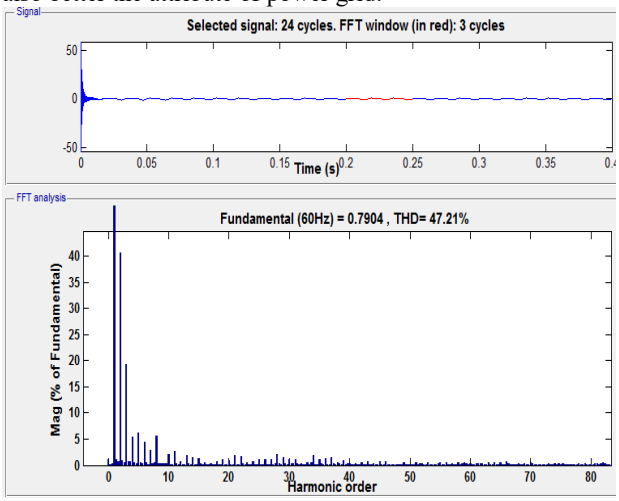

Figure 2. harmonic analysis with 48 pulse statcom

VI. CONCLUSION

In this paper the 48 Pulse based STATCOM advantage to increase the ability of STATCOM units to assert a high quality of distribution voltage and enrich the system durability as well as reduce the harmonics. Harmonic domain Simulations are attended in Matlab/Simulink surrounding for the two-area multi-machine power grid script with and without

STATCOM. Aanalyze the impression of STATCOM on harmonic consummation of the system under the unlike requirement with and without nonlinear load. The simulation results determine the efficacious and robustness of the recommended 48 Pulse STATCOM on harmonic reduction of the system for the nonlinear load.

References

[1] S.S.Kanojia, V.K.Chandrakar," Coordinated Tuning of POD and PSS Controllers with STATCOM in Increasing the Oscillation Stability of Single and Multimachine Power System",Institute of Technology, Nirma university, Ahmedabad.

[2] K.D.Joshi, V.K.Chandrakar," Damping of Power System Oscillation using STATCOM Integrated with SMES", International Journal of Computer Applications, Volume 119 – No.8, June 2015.

[3] Devendra M Holey, V K Chandrakar," Harmonic Domain Modelling of Space Vector Based STATCOM", Energy and Power Engineering, 2016, 8, 195-203

[4] Bhim Singh,Kadagala Venkata Srinivas, 'Three-Level 48-Pulse STATCOM with Pulse Width Modulation",Journal of the institution of engineers.

[5] Madhyama V. Wankhede, V.K.Chandrakar," for the improvement of the Electrical System performance with Non Linear load using static synchronous compensator",International Journal of Power Systems, Volume 1, 2016.

[6] K.D.Joshi, V.K.Chandrakar," Static Synchronous Compensator (STATCOM) with Energy Storage," Second International Conference on Emerging Trends in Engineering and Technology, ICETET-09,

[7] V.K.Chandrakar, A.G. Kothari," Comparison of RBFN and Fuzzy based STATCOM Controllers for Transient Stability improvement,"

[8] Kantilal D Joshi, V K Chandrakar," Power Oscillation Damping using Ultracapcitor and Voltage Source based FACTS controllers," 2017 Internationa.

[9] H S Dalvi, V K Chandrakar," Voltage improvement using STATCOM for prototype hardware model, using synchronous and induction type generator," Emerging Trends in Engineering and Technology (ICETET), 2010 3rd.

[10] D M Holey, V K Chandrakar, "Harmonic Analysis Techniques of Power System-A Review ".

[11] P Domkawale, V K Chandrakar, "Voltage Stability Enhancement in Large Power System by using STATCOM".

[12] PK Gaurkhede, VK Chandrakar, "SVPWM Based STATCOM for Power Quality Improvement".

[13] V K Chandrakar, A G Kothari, "Ann-based Static Synchronous Compensator for improving transient stability performance,"International Journal of Power and Energy Systems 28 (2) 170.

[14] V K Chandrakar, A G Kothari, "Optimal location for line compensation by shunt connected FACTS controller,"Power Electronics and Drive Systems, 2003. PEDS 2003. The Fifth …

[15] V K Chandrakar, A G Kothari, "Comparison of RBFN based STATCOM, SSSC and UPFC Controllers for Transient Stability improvement," Power Systems Conference and Exposition, 2006. PSCE'06. 2006 IEEE PES, 784-791.

[16] Chanchal katariya, Rakesh Shrivastav , "Power Quality Improvement By Using D-STATCOM: Review", IOSR Journal of Electrical and Electronics Engineering e-ISSN : 2278-1676, p-ISSN : 2320-333 PP 15-20 www.iosrjournals.org

[17] A bhargav , p s kavya, "Power quality improvement using STATCOM with renewable energy sources", Power Electronics (IICPE), 2012 IEEE 5th India International Conference.

[18] Banothu Raju, Fatima Azra," Power Quality Improvement Using D-STATCOM with PI and Fuzzy Logic Controller", nternational Journal of Computational Science, Mathematics and Engineering Volume 3, Issue.9, 2016 ISSN-2349-8439.

[19] Sharad S. Pawar ; A.P. Deshpande ; Meera 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.

[20] Gilbert sybil, pieree giroux," Modeling and simulation of a distribution STATCOM using Simulink's Power System Blockset", Industrial Electronics Society, 2001. IECON '01. The 27th Annual Conference of the IEEE, Volume: 2.