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Use of STATCOM for voltage Profile Improvement *: An Approach to Reactive Power Compensation*

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Abstract—
This paper proposes the voltage profile improvement in transmission line by making use of STATCOM, and how it is useful for Reactive power compensation. as we also carry out a study of the transient stability of power systems, and how it is useful in determining the behavior of the system under a fault. As an example, a three bus system is studied. First this is done without the STATCOM and then the STATCOM is implemented and the characteristics of faults at various buses are seen. It is tried to show the application of STATCOM to a bus system and its effect on the voltage of the buses. Next the graphs depicting the implemented STATCOM bus are analyzed. It show a changed characteristic under the influence of the STATCOM.
***Index Terms*—Statcom, Compensation, stability, faults**

I. INTRODUCTION

During the past two decade, demand of electrical energy is increases for household purposes and industrial field. Now to fulfil this energy demand they needed the power plant, substation and transmission line [3]. In today's power grid most commonly used devices is mechanically controlled circuit breaker. Damping out of transient oscillation and handling smooth changes in load voltage quickly by power grids become difficult due to the discrete operation and large switching period. In order to supplement these drawbacks, redundancies and large operational margin are maintained to prevent the system from fault recoveries and dynamic variation. This not only increases the cost and lowers the efficiency, but also control and augments difficulty level of operation and increases the complicity of system. Recently several severe blackout take place in power grid worldwide and these revealed that traditional transmission system cannot cope with variable power flow and complicated interconnection.

Due to this, investigation become compulsory part of the stability and security studies of power grid now a day's number of approach is used to increase the security and stability of power system such as phase shifting and the reactive power compensation. Increasing demand of higher system stability, faster response of changes in system parameter and lower power losses have stimulated the developing of the era of FACTS. Due to the glorious success in the research field of advance controlled technology and power electronics switching devices, FACTS technologies [4] become the choice in the field of transient and steady state stabilization, reactive / active power flow control and voltage control. That improves the function and operation of existing power distribution and transmission system. The achievements o f the studies minimize the operating cost, enlarge the efficiency of existing generation unit and reduce the overall fuel consumption and generation capacity.

II. VOLTAGE STABILITY

Load stability is a major trouble in power system, which cause due to the shortage of reactive power, fault occurrence or heavy load condition at output. We can analyse voltage stability nature [5] by auditing the consumption, transmission and production of reactive power. The trouble of load stability related with the whole power system although it usually has large participation in one crucial area of the power system.

Exception to a few very special occasions, generally electrical energy is remained in a AC form at every stage such as distribution, transmission, generation and utilization. However electrical energy in the form AC has number of considerable disadvantages. One of them is inevitability of reactive power. We have to always provide reactive power along with the active power. The nature of reactive power can be lagging or leading and it does not give any contribution to energy but unavoidable part of the ''total power''. At the same time active power has important contribution to the energy transmission or consumption.

Almost every component of transmission system is either consumed or generated the reactive power, such as distribution, transmission and generation. In an AC system impedance of each and every circuit branch has two component reactance and resistance. Where Reactance can be consist of either capacitive or inductive load. Generally in day to day life loads used are of inductive type, where we need to compensate these loads by lagging reactive power. It is economically feasible to provide this reactive power in load vicinity of a distribution system.

In today's era of technological development every day brings the rapid changes in the field of solid state electrical switching devices. One of the such triggers is the invention of FACTS. Idea of FACTS is basically depend on power-electronic controllers. We can use the FACTS capacity to improve the value of transmission networks. As operating speed of these controllers is very high, they extend the safe operating limits of a transmission system without any risk. Day by day increasing use of the FACTS was given birth to new era of controlling systems.

III. STATCOM

STATCOM is classified under shunt-connected static synchronous compensator group, whose capacitive or inductive output current will be controlled without the AC voltages of system. FACTS controller is used for compensation of reactive power of system but economical point of view STATCOM is better than that of other FACTS controller such as SVC and at the same time it will overcome the technical limitations of SVC such as less transient stability, large size and high harmonic generation. The STATCOM controller composed of a solid-state voltage source converter with transformer or GTO (Gate Turn- Off) thyristor switches, other high performance semi-conductor switches and a DC capacitor. In shunt converter the transformer and solid-state voltage source converter is connected in parallel with the power system.

Development in the field of semiconductor devices over the past decade improve the power handling capabilities of GTO which led to the development of utilizing electronic switching converter technology for manufacturing of controllable reactive power sources . Additionally, these technologies provide numerous benefits over the existing technologies in terms of performance and space reductions. based on the switchin g converter technology the solid-state shunt reactive compensation equipment is designed which will be enable by GTOs.

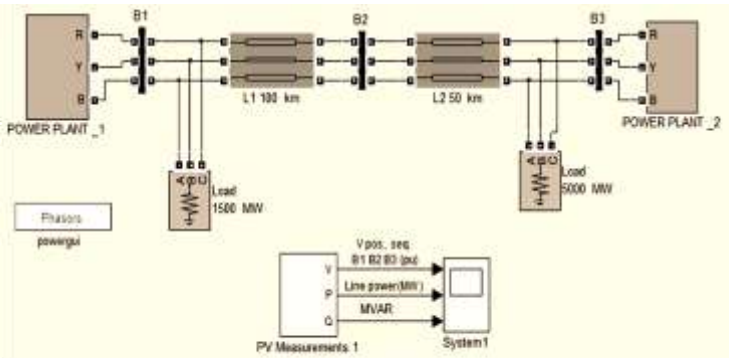


Figure 1. Simulink model without STATCOM

In Figure 1 power plant 1 and power plant 2 was connected by 3 phase transmission line, where bus1 bus2 and bus3 are connected in between this two power plant. L1 is the length of transmission line which is present between B1 and B2 and L2 is the l length of transmission line which is present between B2 and B3.load of 1500 MW is connected between B1 and B2 and load connected between B2 and B3 is of 5000MW

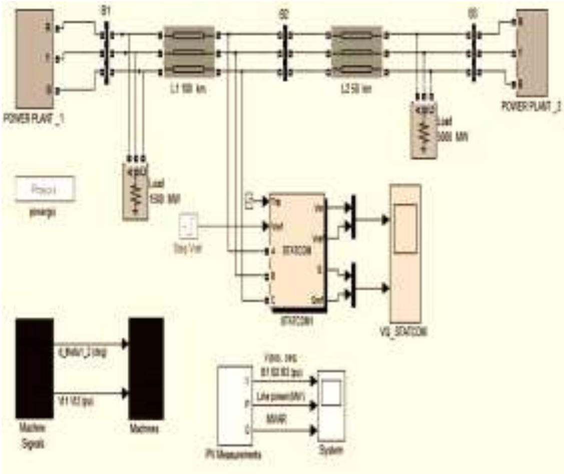


Figure 2: Simulink model with STATCOM

Whereas in Figure 2 we connect the STATCOM between B1 and B2 to improve the reactive power and remaining arrangement is keep same as that of Figure 1. STATCOM connected here will absorb the reactive power when it is present in excess and in case of shortage of reactive power in transmission line it will provide the same to transmission line.

IV. EXPERIMENTAL RESULTS

In this section, we give a results of experiments carried out on a Matlab sumulink platform with windows 7 as an operating System. We plot the voltage of BUS1 BUS2 and BUS3 in Figure 3 without STATCOM. At the same time in Figure 4 we plot the voltages of BUS1 BUS2 and BUS3 when we connected the STATCOM between B1 and B2

Table 1: Voltage at BUS B1,B2 & B3 without STATCOM.

Time (sec)	Voltage of BUS1	Voltage of BUS2	Voltage of BUS3
0.5	0.967	0.92	0.891
1	0.956	0.923	0.902
1.5	0.935	0.937	0.933
2	0.925	0.936	0.94
2.5	0.942	0.947	0.944
3	0.952	0.953	0.948
3.5	0.957	0.959	0.956
4	0.963	0.966	0.963

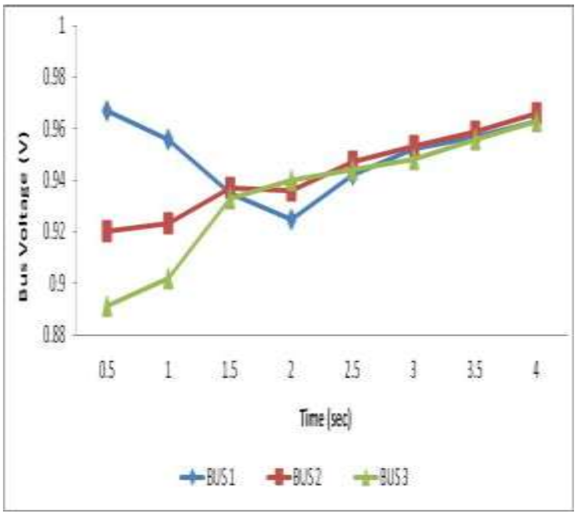
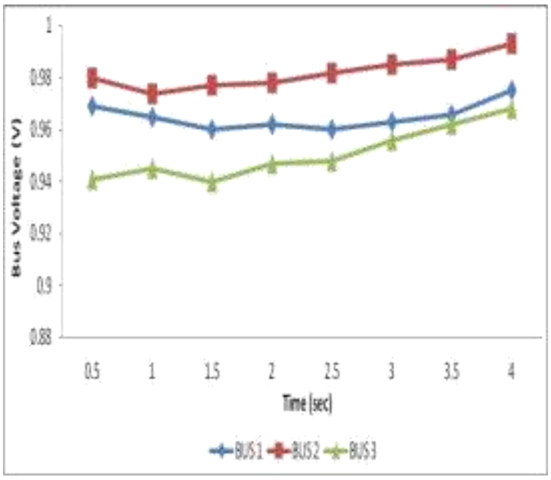


Figure 3:Bus voltages without STATCOM

Table 2: Voltage at BUS B1,B2 & B3 with STATCOM.

Time (sec)	Voltage of BUS1	Voltage of BUS2	Voltage of BUS3
0.5	0.969	0.98	0.941
1	0.965	0.974	0.945
1.5	0.96	0.977	0.94
2	0.962	0.978	0.947
2.5	0.96	0.982	0.948
3	0.963	0.985	0.956
3.5	0.966	0.987	0.962
4	0.975	0.993	0.968

Figure 4: Bus voltages with STATCOM



V. CONCLUSIONS

We can conclude from the results that system voltage performance will be improved by STATCOM both for light load conditions and heavy load conditions . Whereas STATCOM will be helpful for obtaining variation of voltage profile in a specified limit and also useful in a receiving end calculation of reactive power management.

As for future we can place STATCOM in transmission line to improve the maximum voltage at particular location. Which will play a key role in regulating a reactive power flow of the power network and also helpful in maintaining transient stability and voltage fluctuations and also useful to ameliorate the voltage at fault time like LL, LG, LLL, LLG faults.

REFERENCES

[1] IEEE TASK FORCE:' Proposed terms and definitions for flexible AC transmission systems (FACTS)' *IEEE Trans. on power delivery,* Vol.12, No.4, 2005.

[2] L.A.S. Pilotto, et al., "Determination of Needed FACTS Controllers That Increases Asset Utilization of Power Systems," IEEE PES Paper 96-WM 0901 PWRD,

[3] Gyugi.L, "Unified power-flow control concept of flexible AC transmission system': *IEE Proc-C,* Vol.139, No.4, 2000.

[4] N.G.Hingorani and L.Gyugyi, Understanding FACTS, Concepts and Technology of Flexible AC ransmission Systems, Piscatawat, NJ:IEEE Press. 2000.

[5] K. P. Kessel and H. Glavitsch, 'Estimating the voltage stability of power system', *IEEE Trans. Power eliv.,* PWRD-1 (1986), 346–351.

[6] Sushanta Kumar Sethy, and Pratap Chandra Pradhan" Design and Simulation of Current and Voltage Linear Controller of a STATCOM for Reactive Power Compensation using variation of DC link voltage"Int. J. of Intelligent Computing and Applied Sciences Vol. 1, Issue 1, pp. 50-64 2013.

[7] Pranesh Rao , M. L.Crow , Zhiping Yang "STATCOM Control for Power System Voltage Control Applications" IEEE Trans. on power delivery, vol. 15, no. 4, pp. 1131-1137 , October 2000.

[8] J.S.Siva Prasad, Tushar Bhavsar, Rajesh Ghosh, G. Narayanan "Vector Control of three phase AC/DC front end converter"Sadhana vol.33, part 5, pp. 591-613October 2008

[9] G.C.Cho, N.S.choi,C.T.Rim,and G.H.Cho, " Modelling, Analysis and Control of STATIC VAR Compensator using three level inverter ", IEEE, Ind. Society, Annual Meet, pp. 837-843, 1992.

[10] J. K. Moharana,M. Sengupta, A. Sengupta "Design , Analysis and Implementation of a Small Signal Control Strategy on a 10 kVA STATCOM Prototype Connected to Inductive Load "J. Inst. Eng. India Ser. pp. 61–69 B (March–May 2013).

[11] Annapurna Bhargava, Vinay Pant and Biswarup Das "An Improved Power Flow Analysis Techniquewith STATCOM" IEEE conf. pp.1 2006