IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE)
e-ISSN: 2278-1676,p-ISSN: 2320-3331, Volume 10, Issue 3 Ver. II (May – Jun. 2015), PP 48-54
www.iosrjournals.org

Enhancement of Power Quality by Improving Voltage Stability Using D-STATCOM

Kiran Rani[1], Mohini[2], Nancy[3] ,Dr.Sakshi Kalra
[1,2,3](Research Scholar/YMCA university of Science and Technology, Faridabad, India)
[4] (Assistant Professor, YMCA University of Science and Technology, Faridabad, India)

Abstract: *Now a days with increasing verity of load and awareness of consumers, quality of power is becoming very important issue. Whenever load is either switched on or off, the impedance of line changes. This change in impedance causes unbalance in total power supplied and total power demand. As power is directly proportional to square of voltage, so the magnitude of voltage is affected. As load in power system changes at rapid rate, the magnitude of voltage also changes at the same rate .This regular change in magnitude of voltage causes distortion in standard waveform of voltage. For the better power quality there are two things to consider that voltage waveform should be undistorted and magnitude should be constant. So it can be said that quality of power gets distorted at continuous basis .The lack of power quality can cause loss of damage of equipment, loss of production or even can lead system towards instability. So the design of the power system should be such that stability of the system is maintained by overcoming all these variations..This paper presents enhancement of voltage stability thus indirectly improving power quality using D-STATCOM. . Power quality aspects like voltage regulation, active and reactive power supplied are discussed and implemented using STATCOM simulated in MATLAB version R2009b.*

Keywords*: DSTATCOM, Voltage Source Inverter(VSI), voltage stability*

I. Introduction

In early days of development of power system, the demand and utility was far less than modern days of globalization and privatization of system. In modern scenario the use of electricity is increasing. The effect of which is in terms of increasing demand from the system. Because of environmental and economical reasons there is shortage of power. To meet the required demand there are two ways- one is to enhance the power generation and other is to utilize the available power in better way. The former is less possible because of limited resources available. Thus main emphasis lies on the latter technique. One method is to stop malfunctioning of loads connected to the system .With introduction of new technologies, loads are becoming more sensitive towards quality of power supply and consumers are becoming more aware of power quality. To implement the said proposal and to meet consumers expectations the power quality of system should be improved. With the introduction of power electronics devices in the field of controlling and handling the power quality issues, the systems are becoming more reliable and stable. FACTS devices which are fast in operation and have no rotating parts are such power electronics converters widely used to improve power quality issues. Distribution static compensator (D-STATCOM) is one of the FACTS devices used to enhance power system stability and quality.

II. Working Principle Of D-Statcom

STATCOM consist of a inverter made up of IGBT or GTO acting as self commutated switches , a DC voltage source an interconnecting transformer, and controller which controls the switching time of various switches in inverter legs. The STATCOM is capable of generating continuously variable inductive or capacitive shunt compensation at a level up its maximum MVA rating. The STATCOM constantly checks the line waveform with respect to a reference ac signal, and therefore, it can provide the correct amount of leading or lagging reactive power compensation to reduce the amount of voltage fluctuations. if the output voltage of the voltage source converter is greater than the system voltage then the DSATCOM will act as capacitor and generate reactive power otherwise it will act as inductor to absorb reactive power. The working principle of DSTATCOM is shown in Fig.1.

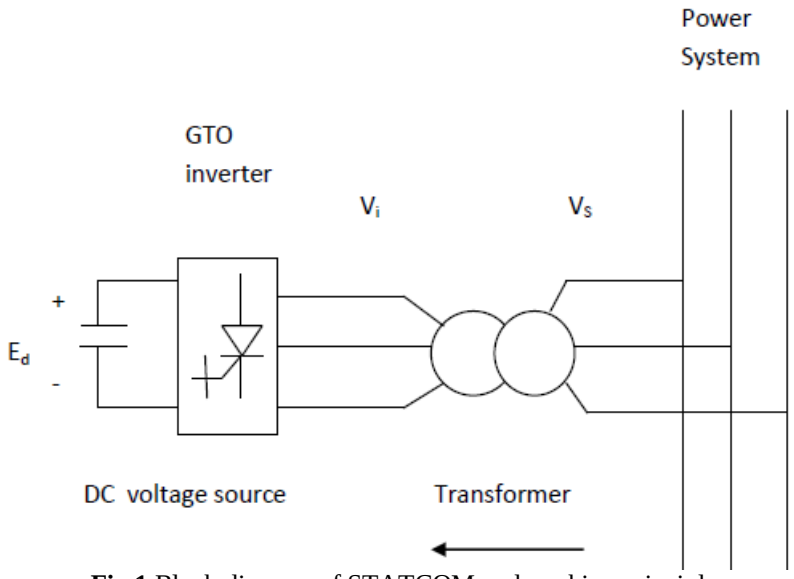

Fig.1 Block diagram of STATCOM and working principle

III. Matlab/Simulink Model Of D-Statcom

The models are developed and simulated in MATLAB using simulink and power system block set (PSB) tool boxes. A four bus system with two generating units, nonlinear load and LG faults modeled in MATLAB. Two generators of 2100MVA and 1400MVA,two transformers of 2100 MVA, 13.8kv/500kv and 1400MVA, 13.8kv/500kv are connected in the system. Two loads each of 250 ohm are connected at bus1 and bus3. A single phase fault is shown to occur at line L3 between bus3 and bus4. Data acquisition is done to observe the variation of voltage, active power, reactive power and to see the results, scope is connected in both the cases when STATCOM is not connected and when it is connected. The simulink diagrams and results are shown in this paper.

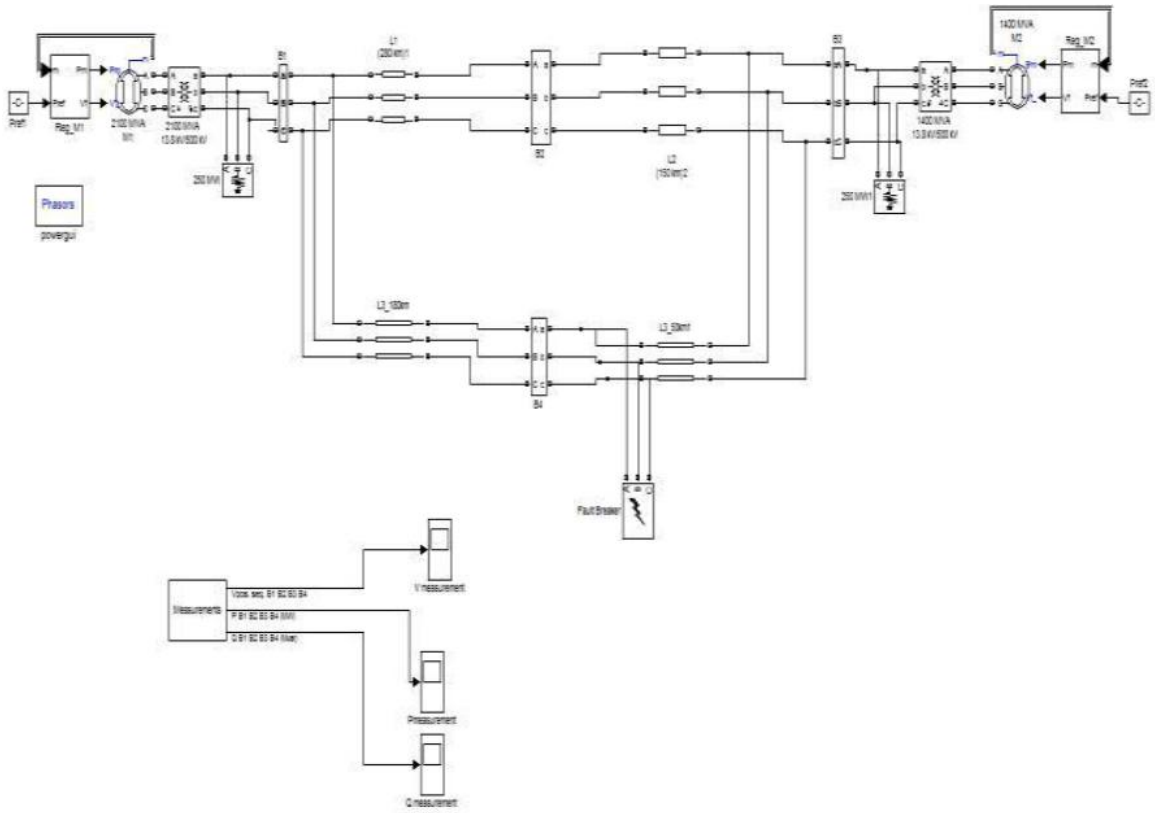

Fig.2 Simulink model of system with fault and without STATCOM

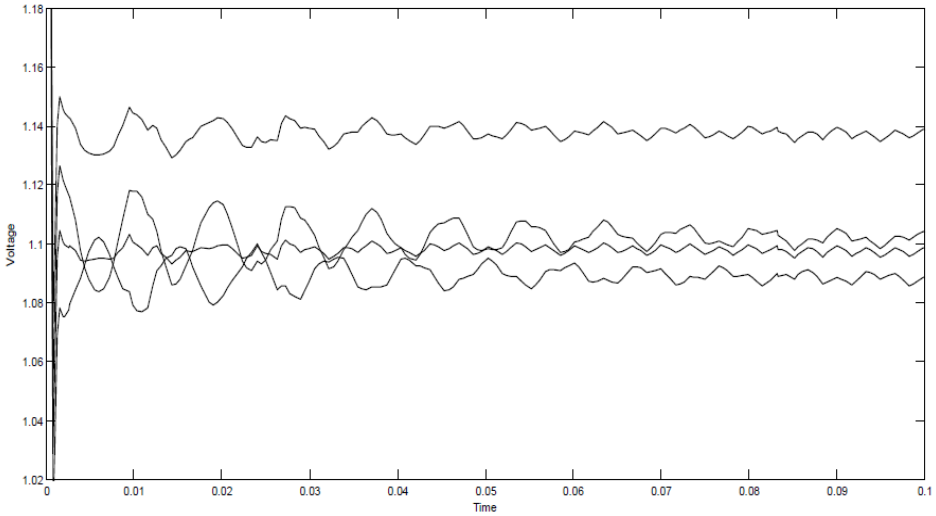

Fig.3 Voltage profile at all buses without STATCOM

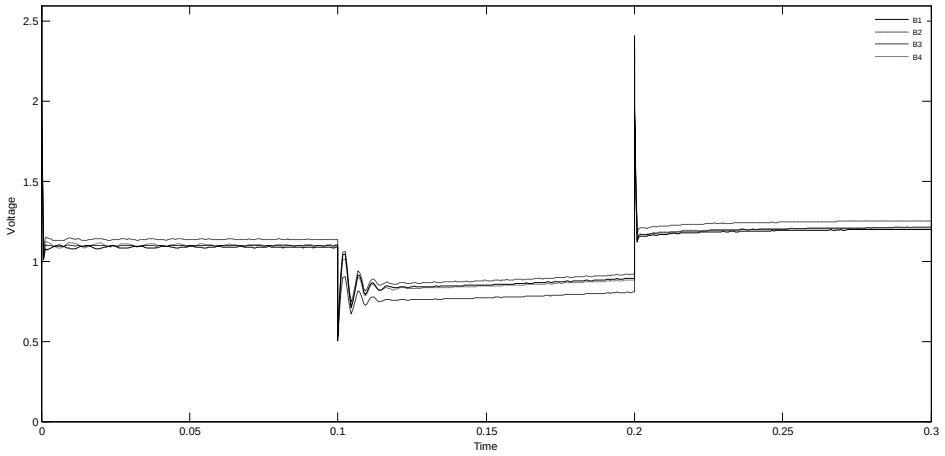

Fig.4 Variation of voltage in faulty condition without STATCOM

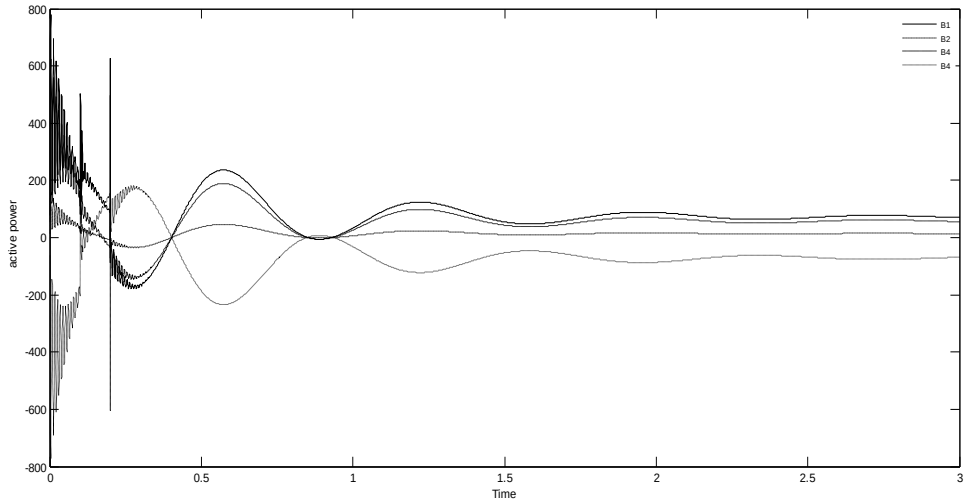

Fig.5 Active Power transferred without STATCOM

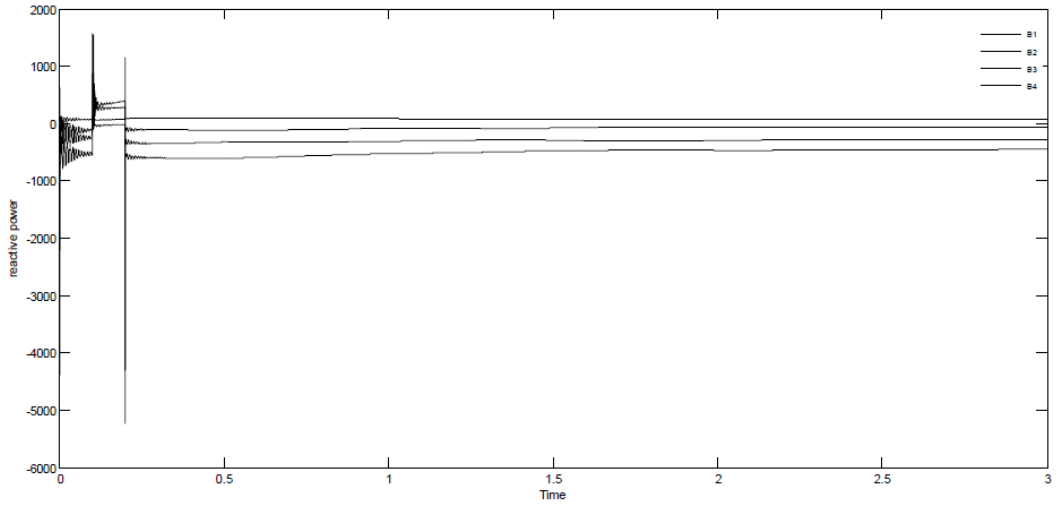

Fig.6 Rective power transferred without STATCOM

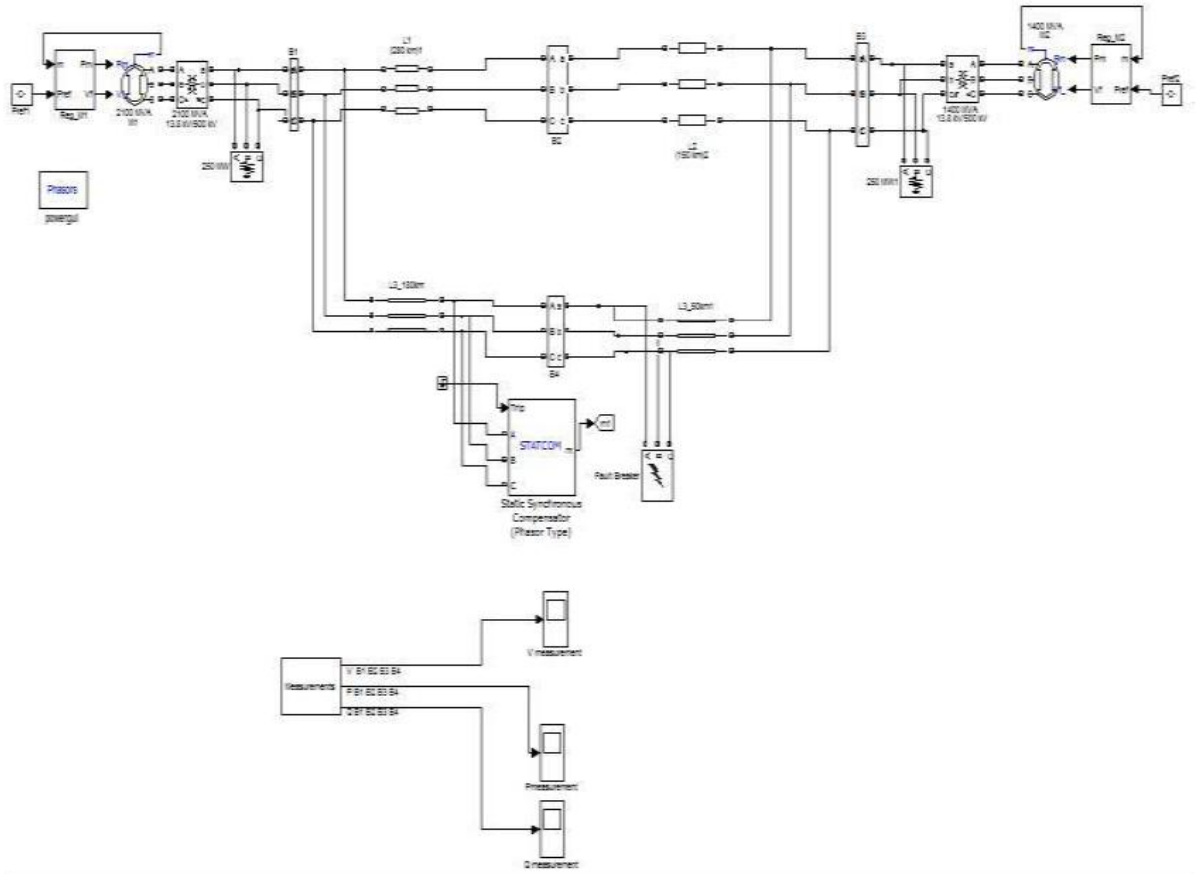

Fig.7 Simulink model of system with LG fault and D-STATCOM

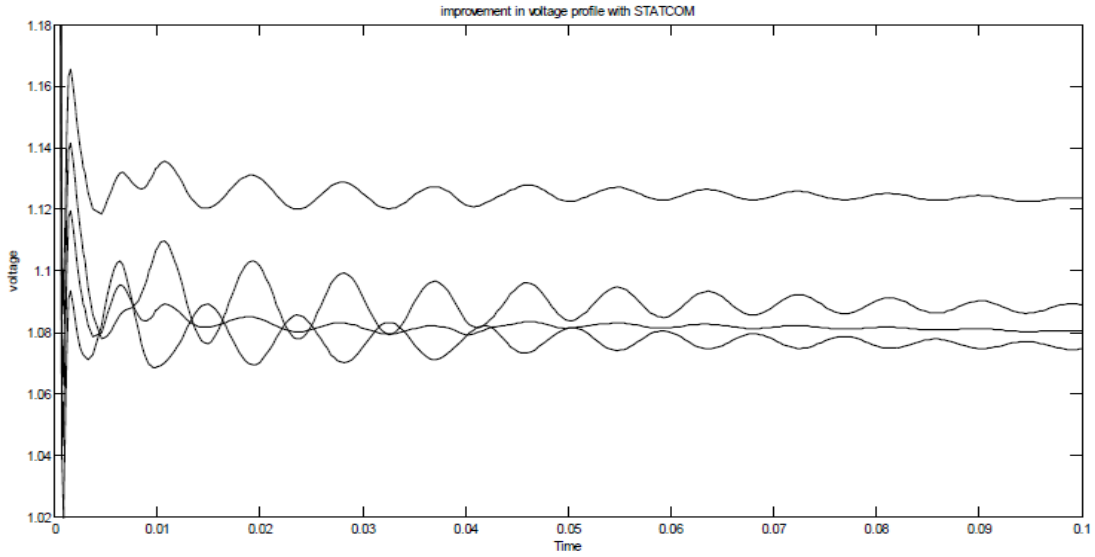

Fig.8 Voltage profile at all buses with STATCOM

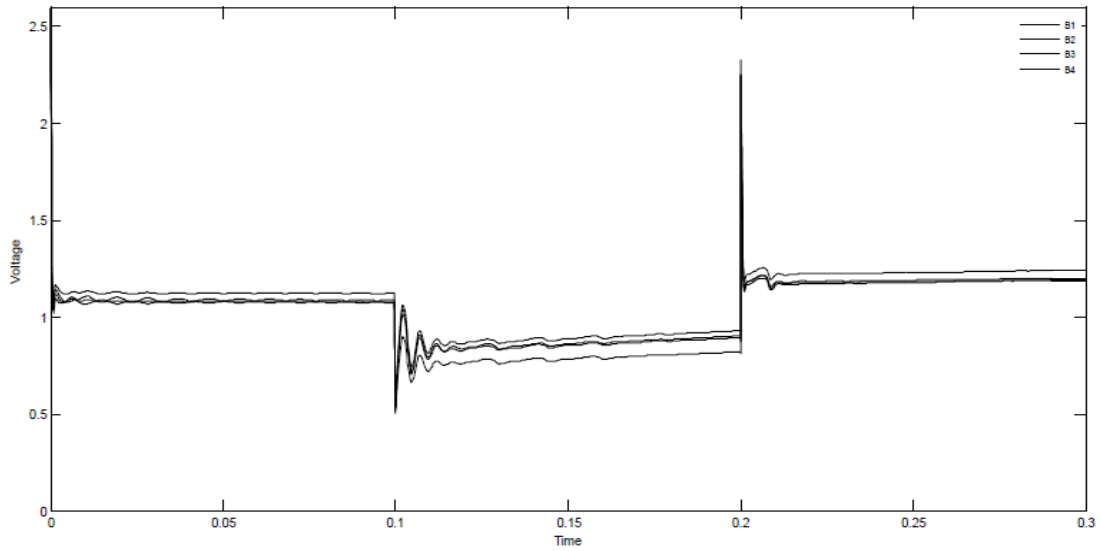

Fig.9 Variation of voltage with STATCOM

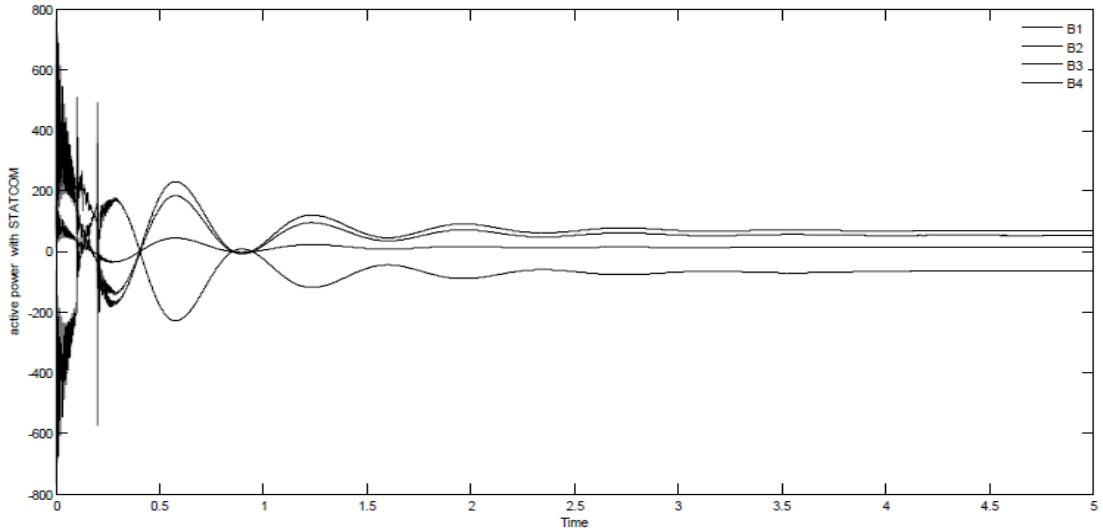

Fig. 10 Active power transferred with STATCOM

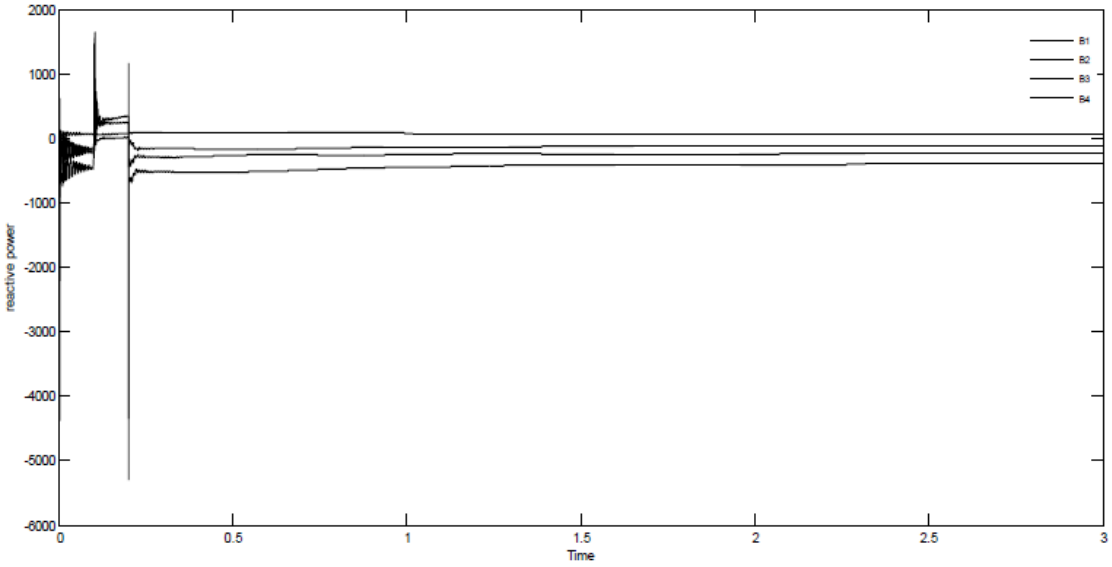

Fig. 11 Rective power transferred with STATCOM

IV. Interpretations

The reading of all the parameters with and without STATCOM are as here under when the MATLAB simulated models are studied closely.

BUS NO.	Voltage (pu)	Active power (pu)	Reactive power (pu)
1	1.0222 to1.0228	66.01	-424.67
2	1.0230 to 1.0234	12.75	72.87
3	1.0255 to 10260	51.5	-67.25
4	1.0302 to 1.0308	-64.5	-263.7

Table 1 Simulation results without STATCOM

BUS NO.	Voltage (pu)	Active power (pu)	Reactive power (pu)
1	1.01	65.8 to 66.2	-422.34 to-425.65
2	1.02	12.68to12.72	70.87 to 73.61
3	1.02	51.8 to 52.2	-66.43 to-69.50
4	1.03	-64 to -65.6	-260.4 to -263.90

Table 2 Simulation results with STATCOM

It is observed that voltage regulation is done using STATCOM . Without STATCOM , the voltage was deviating between 1.0222-1.0228 for bus 1 ,whereas using STATCOM the voltage stabilizes at 1.01 pu. Similarly it can be observed that voltage across all the buses is regulated to 1 pu. The STACOM supplies active or reactive power to the system to stabilize the voltage .hence it is observed that when STATCOM was not there in the system, active power transferred from one point to the other is constant. And when STATCOM is used it transferred active power according to the requirement. The power transferred deviates between a range.

V. Conclusion

Based on obtained simulation results the performance of STATCOM has been examined in multimachine system . It has been found that STATCOM maintains the active and reactive powers to regulate the voltage profile of the system. The voltage profile and hence power quality of the system is improved using DSTATCOM.

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