ANALYSIS OF STATCOM FOR POWER FLOW IN THE SYSTEM

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ABSTRACT : Power flow control, voltage stability in distribution line, plays a vital role in Power System area. This thesis presents the STATCOM which FACTS device for the control of voltage and the power flow in distribution line. This device is used in different locations such as sending end of the distribution line, middle and receiving end of the distribution line. Simulations were carried out using MATLAB Simulink. The suitable location and the performance of the proposed model were examined. Based on a voltage-sourced converter, the STATCOM regulates system voltage by absorbing or generating reactive power.

Key Words: **FACTS device, STATCOM, MATLAB Simulink.**

I. INTRODUCTION

In modern era the applications of the power electronics devices in power systems are very much augmented. It is an urgent need to control the power flow, in a distribution line. The FACTS devices are introduced in the power system for the reduction of the distribution line losses and also to increase the transfer capability. STATCOM is VSC based controller to regulate the voltage by varying the reactive power in a distribution line [6]. In this paper performance strategy were conducted on STATCOM at different locations such as sending end, middle and the receiving end of the distribution line. In every part of the location the power flow is tested with and without compensation strategy. The simulink model of the standard system is developed and tested using MATLAB Simulink environment.

II. OPERATING PRINCIPLE

A STATCOM consists of a coupling transformer, an inverter and a DC capacitor is shown in figure 1.[12] In ideal steady state analysis, it can be assumed that the active power exchange between the AC system and the STATCOM can be neglected, and only the reactive power can be exchanged between them. STATCOM is usually used to control transmission voltage by reactive power shunt compensation [10]. Based on the operating principle of the STATCOM, the equivalent circuit can be derived, which is given in Figure2. In the derivation, it is assumed that (a) harmonics generated by the STATCOM are neglected; (b) the system as well as the STATCOM are three phase balanced. Then the STATCOM can be equivalently represented by a controllable fundamental frequency positive sequence voltage source V_{sh} .In principle, the STATCOM output voltage can be regulated such that the reactive power of the STATCOM can be changed[1][2].

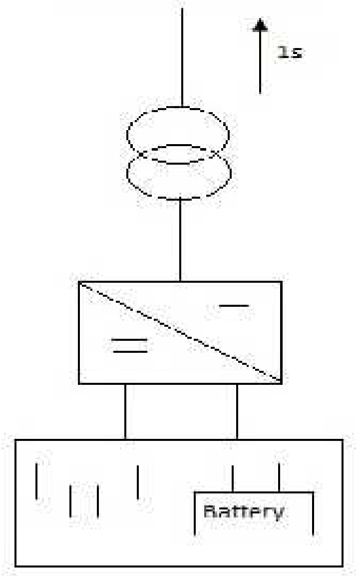

Fig. 1 Structure of STATCOM

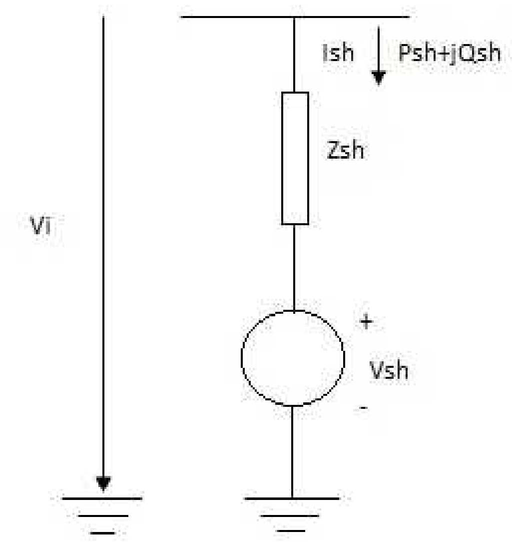

Fig. 2 Equivalent Circuit of STATCOM

Let V1 be the voltage of power system and V2 be the voltage produced by the voltage source (VSC). During steady state working condition, the voltage V2 produced by VSC is in phase with V1 (i.e.=0) in this case only reactive power is flowing. If the magnitude of the voltage V2 produced by the VSC is less than the magnitude of V1, the reactive power is flowing from power system to VSC(the STATCOM is absorbing the reactive power). [3] If V2 is greater than V1 the reactive power is flowing from VSC to power system (the STATCOM is producing reactive power) and if the V2 is equal to V1the reactive power exchange is zero. [1] The amount of reactive power can be given as

Q = Vs (Vs-Vstatcom) / X

Where,
V s: Magnitude of system Voltage.
V statcom : Magnitude of STATCOM output voltage.
X: Equivalent impedance between STATCOM and the system.

III. SIMULATION OF DISTRIBUTION SYSTEM

The power grid consists of two 11-KV equivalents, respectively 100 MVA and 50 MVA, connected by a 20 km distribution line. When the STATCOM is not in operation, the "natural" power flow on the distribution line is 1.23 MW from bus B1 to B3. STATCOM has a rating of +/- 3 MVAr. This STATCOM is a phasor model. In this circuit the power is directly measured in the 20 km at the three stages like B1,B2 and B3 and also tabulated the result in table1. Explains about the circuit diagram when STATCOM is connected at the sending end of the distribution line. Similarly the connections are made when the STATCOM is connected at the middle and receiving end of the Distribution line. BusB1 as sending end , bus B2 is middle of system & bus B3 as receiving end.

Here, we described subsystem, in the subsystem , we take three phase instantaneous active & reactive power block for getting a directly active & reactive power. Figure3 explains about the circuit diagram without compensation. In this circuit the power is directly measured in the distribution line at the three stages like B1,B2 and B3 and also tabulated the result in table1.

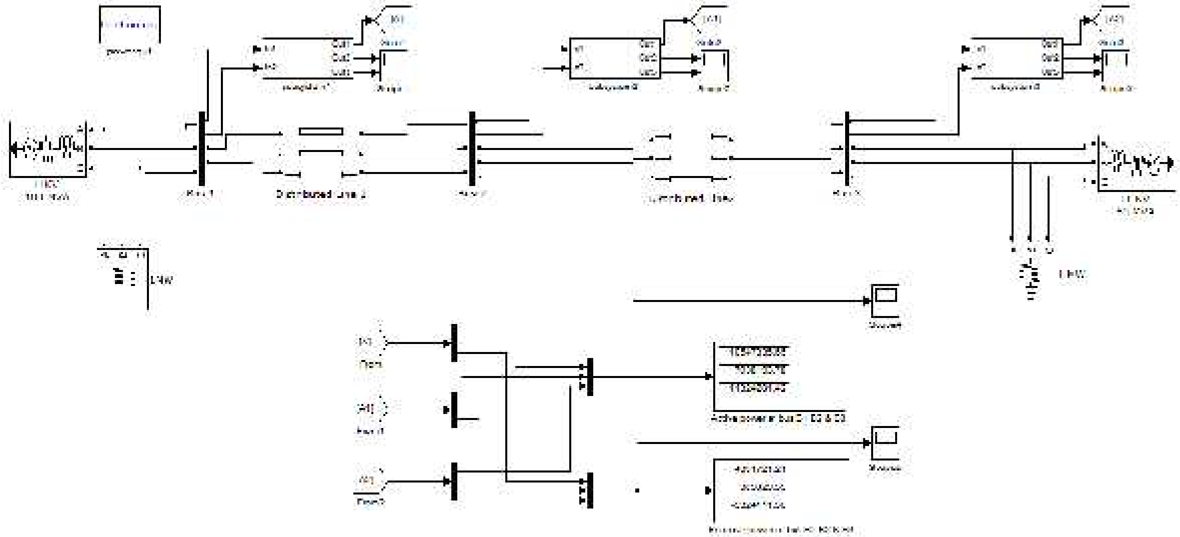

Fig. 3 Distribution System without STATCOM

IV. SIMULATION RESULTS

The results were obtained with and without compensation and also the numerical results were tabulated in table 1. Figure4 and Figure5 the Active and reactive power control at the three stages when the STATCOM is not connected i.e. without compensation.

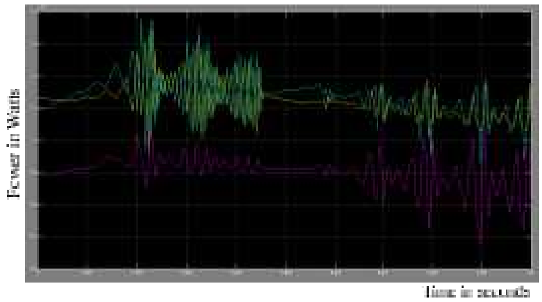

Figure 4. Active Power at B1,B2 & B3 without compensation

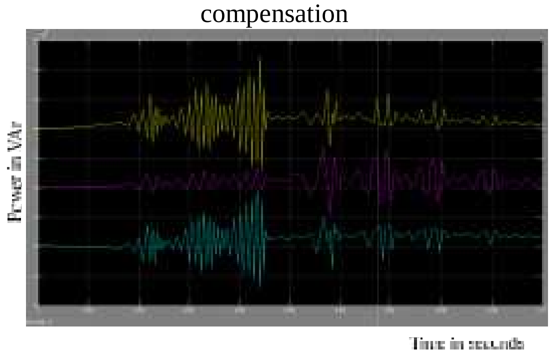

Figure5. Reactive Power at B1,B2 & B3 without compensation

Figure6, Figure7 and Figure8 exhibits the active power at the three stages of the Distribution line when STATCOM is connected at the sending end, middle and receiving end.

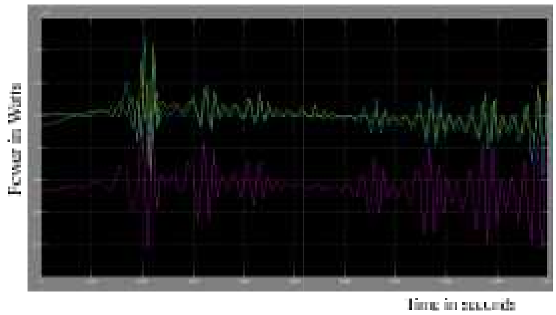

Figure 6. Active Power when STATCOM at sending end

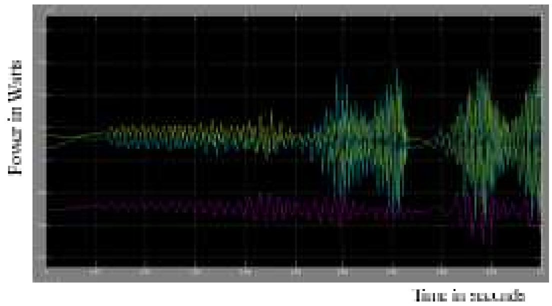

Figure 7. Active Power when STATCOM at middle

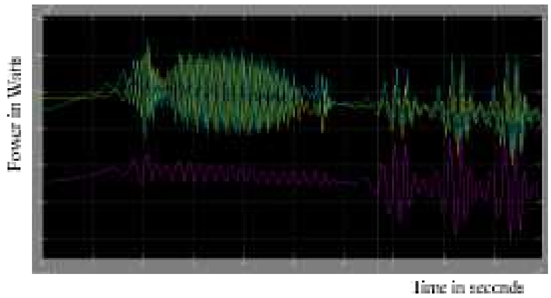

Figure 8. Active Power when STATCOM at receiving end

Similarly the reactive power at the three stages B1,B2 and B3 when STATCOM is connected to the sending end, middle and receiving end are shown in Figures 9,10 and 11.

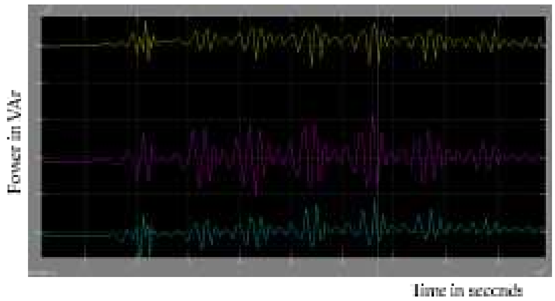

Figure 9. Reactive Power when STATCOM at sending end

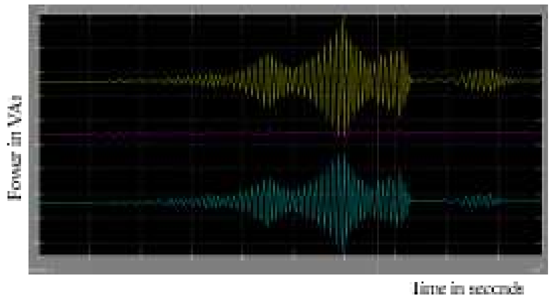

Figure 10. Reactive Power when STATCOM at middle

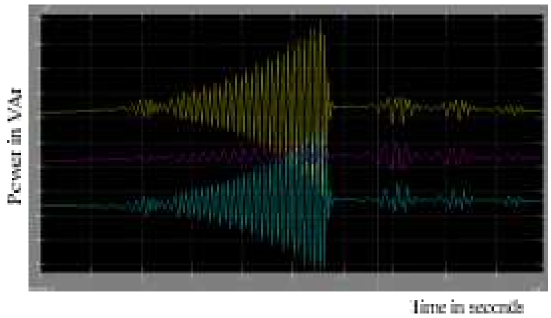

Figure 11. Reactive Power when STATCOM at receiving end

Comparison of active & reactive power. at the three stages of the distribution line when STATCOM is connected at the sending end, middle and receiving end which is shown in table 1.

Position of STATCOM	Bus 1		Bus 2		Bus 3	
	P in MW	Q in MVAr	P in MW	Q in MVAr	P in MW	Q in MVAr
Without	10.54	4.30	7.93	0.30	11.32	-3.32
Sending (Bus1)	10.78	4.59	8.75	0.67	10.30	-3.04
Middle (Bus2)	10.64	5.20	8.39	0.96	10.29	-4.55
Receiving (Bus3)	11.40	6.14	9.00	0.06	11.56	-3.76

Table 1 . Comparison of active & reactive power.

V. CONCLUSION

The vital role of STATCOM, which are connected in distribution lines, are to improve the power transfer capability and also to control the power flow in the power system network. The reactive power generated is better at the sending end of the distribution line when compared with the other places of the distribution line. Which is shown in MATLAB simulation results.

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