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Study of Reacive Power Compensation using Statcom

Nitesh Kumar[1] and Ram Avtar Jaiswal[2]

[1]M.tech-EE UIET, KUK.
[2]EE- Dept. UIET, KUK
E-mail: [1]niteshjatain@gmail.com, [2]ramavtar.jaiswal@gmail.com

Abstract—*In this paper, we study the FACTS controller, the STATCOM, and how it helps in the utilization of a network operating under normal conditions. Then we look at the various FACTS devices being used for both series and shuntcompensation. The study of STATCOM and its operation and control, and, are carried also discuss the D-STATCOM and study its both type is that push pull inverter and voltage source inverter.The D-STATCOM is a shunt connected FACTS device which supplies reactive power to the load to improve the voltage stability of the load busses.In this paper, we also discuss D-STATCOM simulaton model which are mostly used for reactive power compensation of wind turbine.*

Keywords*: FACTS Devices, STATCOM, Reactive power compensation, VSI, Push pull inverter.*

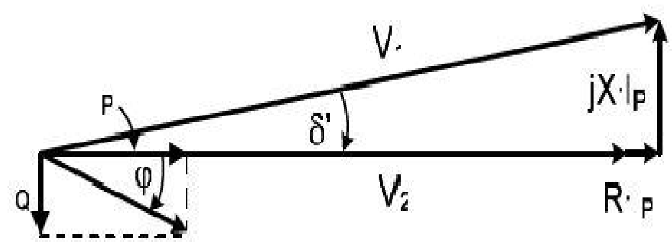
1. INTRODUCTON

One of the main components of power generation and distribution is to form a major part is the reactive power in the system. It is required to maintain the voltage to deliver the active power through the lines. Loads like motor loads and other loads require reactive power for their operation. To improve the performance of ac power systems, we need to manage this reactive power in an efficient way and this is known as reactive power compensation. There are two aspects to the problem of reactive power compensation: load compensation and voltage support. Load compensation consists of improvement in power factor, balancing of real power drawn from the supply, better voltage regulation, etc. of large fluctuating loads. Voltage support consists of reduction of voltage fluctuation at a given terminal of the transmission line. Two types of compensation can be used: series and shunt compensation. These modify the parameters of the system to give enhanced VAR compensation. In recent years, static VAR compensators like the STATCOM have been developed. These quite satisfactorily do the job of absorbing or generating reactive power with a faster time response and come under Flexible AC Transmission Systems (FACTS). This allows an increase in transfer of apparent power through a transmission line, and much better stability by the adjustment of parameters that govern the power system i.e. current, voltage, phase angle, frequency and impedance.

2. COMPENSATION TECHNIQUES

The principles of both shunt and series reactive power compensation techniques are described below:

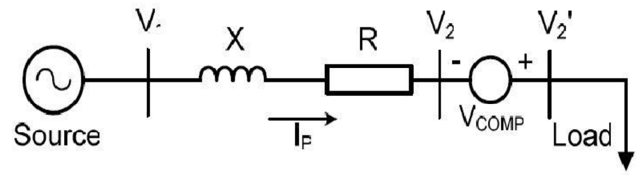
1. Shunt compensation-

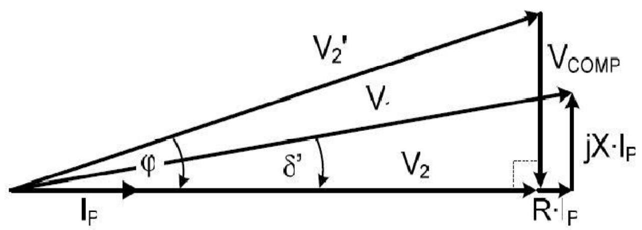


The figure show the source voltage V1, a power line and an inductive load. The figure shows the system without any type of compensation. The active current Ip is in phase with the load voltage V2. Here, the load is inductive and hence it requires reactive power for its proper operation and this has to be supplied by the source, thus increasing the current from the generator and through the power lines. Instead of the lines carrying this, if the reactive power can be supplied near the load, the line current can be minimized, reducing the power losses and improving the voltage regulation at the load terminal. In this case, a current source device is used to compensate Iq, which is the reactive component of the load current. In turn the voltage regulation of the system is improved and the reactive current component from the source is reduced or almost eliminated. This is in case of lagging compensation. For leading compensation, we require an inductor. Therefore we can see that, a current source or a voltage source can be used for both leading and lagging shunt compensation, the main advantages being the reactive power generated is independent of the voltage at the point of connection.

2. Series Compensation

Compensation can be implemented like shunt compensation, i.e. with a current or a voltage source as shown in figure. We can see the results which are obtained by series compensation through a voltage source and it is adjusted to have unity power factor at V2. However series compensation techniques are different from shunt compensation techniques, as capacitors are used mostly for series compensation techniques. In this case, the voltage Vcomp has been added between the line and the load to change the angle V2'. Now, this is the voltage at the load side. With proper adjustment of the magnitude of Vcomp, unity power factor can be reached at V2.



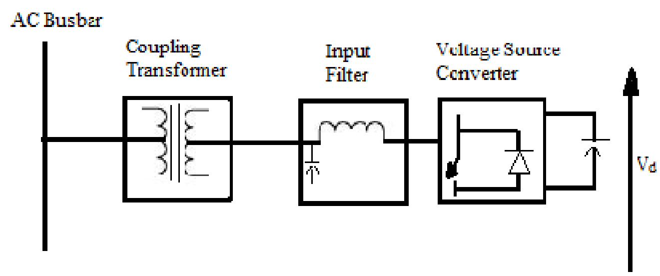


3. NEED FOR REACTIVE POWER COMPENSATION

The main reason for reactive power compensation in a system is: 1) the voltage regulation; 2) increased system stability; 3) better utilization of machines connected to the system; 4) reducing losses associated with the system; and 5) to prevent voltage collapse as well as voltage sag. The impedance of transmission lines and the need for lagging VAR by most machines in a generating system results in the consumption of reactive power, thus affecting the stability limits of the system as well as transmission lines. Unnecessary voltage drops lead to increased losses which needs to be supplied by the source and in turn leading to outages in the line due to increased stress on the system to carry this imaginary power. Thus we can infer that the compensation of reactive power not only mitigates all these effects but also helps in better transient response to faults and disturbances. In recent times there has been an increased focus on the techniques used for the compensation and with better devices included in the technology, the compensation is made more effective. It is very much required that the lines be relieved of the obligation to carry the reactive power, which is better provided near the generators or the loads. Shunt compensation can be installed near the load, in a distribution substation or transmission substation.

4. STATIC SHUNT COMPENSATOR: STATCOM

One of the many devices under the FACTS family, a STATCOM is a regulating device which can be used to regulate the flow of reactive power in the system independent of other system parameters. STATCOM has no long term energy support on the dc side and it cannot exchange real power with the ac system. In the transmission systems, STATCOMs primarily handle only fundamental reactive power exchange and provide voltage support to buses by modulating bus voltages during dynamic disturbances in order to provide better transient characteristics, improve the transient stability margins and to damp out the system oscillations due to these disturbances. A STATCOM consists of a three phase inverter (generally a PWM inverter) using SCRs, MOSFETs or IGBTs, a D.C capacitor which provides the D.C voltage for the inverter, a link reactor which links the inverter output to the a.c supply side, filter components to filter out the high frequency components due to the PWM inverter. From the d.c. side capacitor, a three phase voltage is generated by the inverter. This is synchronized with the a.c supply. The link inductor links this voltage to the a.c supply side. This is the basic principle of operation of STATCOM.



For two AC sources which have the same frequency and are connected through a series inductance, the active power flows from the leading source to the lagging source and the reactive power flows from the higher voltage magnitude source to the lower voltage magnitude source. The phase angle difference between the sources determines the active power flow and the voltage magnitude difference between the sources determines the reactive power flow. Thus, a STATCOM can be used to regulate the reactive power flow by changing the magnitude of the VSC voltage with respect to source bus voltage

A) D-STATCOM WITH VOLTAGE SOURSE INVERTER-

The basic principle is to use a voltage source inverter that generates a controllable AC voltage source behind a leakage reactance. The voltage difference across the transformer reactance produces active and reactive power flows with the network. The exchange of reactivepowerwith the network is obtained by controlling the magnitude Vand the exchange of active power results from a control of the phase shift w. The exchange of active power is only used to control the DC voltage [8]. Under steady state conditions and ignoring the losses the exchange of active power and thus the DC current are zero . A complete STATCOM generally combines several converters. Alternative inverter structures are being designed, for example using single-phase bridges in series. The most common methods used for controlling the AC voltage generated by the inverter are: DC variable voltage with a full wave inverter, sometimes called Pulse Amplitude Modulation

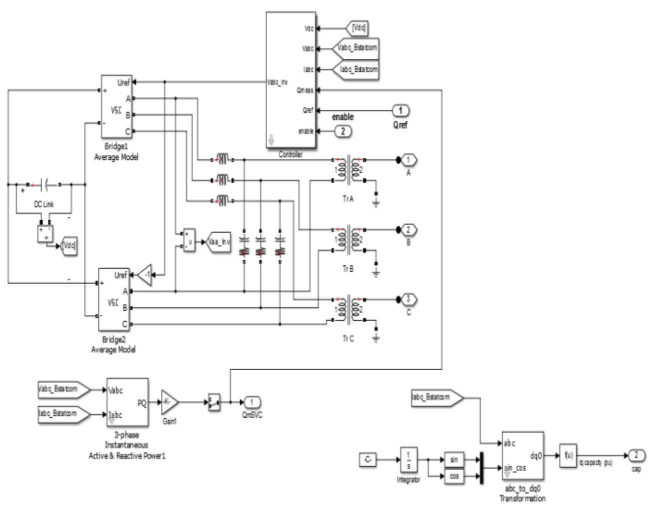
(**PAM**). Constant DC voltage with a pulse-width modulated inverter (**PWM).** The STATCOM supplies reactive powers to the AC system if the magnitude of Vi is greaterthan that of Vt. It draws reactive power from the AC system if the magnitude of Vt is greater than that if Vi

B) D-STATCOM WITH PUSH PULL INVERTER-

The push-pull inverter circuit comprising a transformer with a power output end coupled to a load and two power input ends. A power driver unit is connected between the two power output ends. A power supply unit, and the power driver unit receives a power signal and outputs two sets of drive signals having same frequency.This is also called parallel inverter.

5. SIMULATION MODEL

A Simulation model of D-statcom with two voltage source converter is shown in which refrence volage are given to the both converter and both converter are connected via dc link and both covter are connected to the refrence voltage in that way if one is on othe is disconnected.These converter comare the value until desired voltage is obtained.



When this simulaton model is connected to the wind turbine then reactive power is compensated and use as active power.

6. SIMULATION RESULT

The simulation result show the 3-phase instantaneous active and reactive power which are given to the controller that is measured reactive power then it compare to the refrence.and this operaion is continous until desired voltage is obtained.

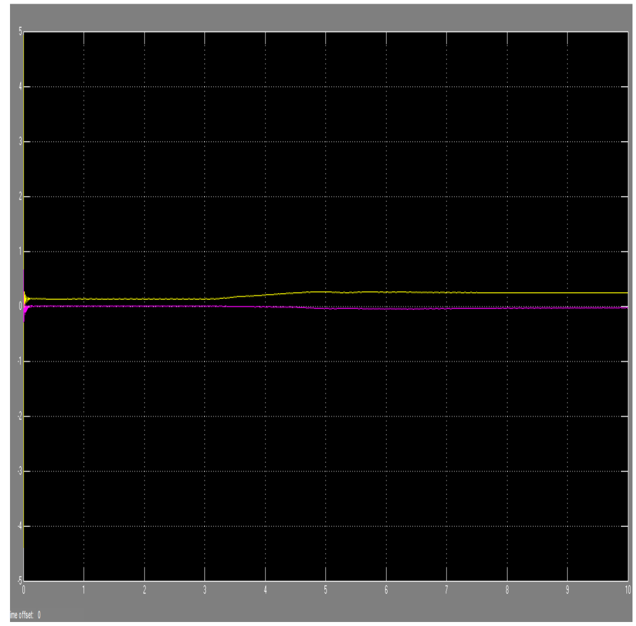


Fig. 3: phase instantaneous Active and Reactive power

7. CONCLUSION

The study of the basic principles of the STATCOM is carried out as well as the basics of reactive power compensation using a STATCOM. VSI and Push Pull inverter based DSTATCOM systems are compared. Voltage stability is improved by using both types of D-STATCOM. This system has improved reliability and power quality. Push Pull inverter system is superior to VSI based system.

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