Modelling and simulation of Multilevel Inverter Based STATCOM for compensation of reactive power

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Abstract: In the world of the power system, the most important thing is to maintain the stability. Stability of the system means not only concern with synchronism of the different machinery but also the things which are micro but affects in valuable results. Due to the unpredictable saviour situation which may came into the stable power system, it become necessary to have the precautionary measures which regulates the necessary term. One of the most impact able term is voltage regulation. Measures such as Static Synchronous Compensator used as a voltage regulator & again it will correct the power factor at PCC. Here we deals with power factor correction mode & Total Harmonic Distortion. This paper represents how analytical approach for cascaded H bridge multilevel STATCOM regulates the voltage in power system during voltage variations. Verification is made by employing the proposed controller in the MATLAB/SIMULIK software.

Keywords: STATCOM, power factor correction, Total Harmonic Distortion, logic controller etc.


1 Introduction

Day by day the electronic instruments becomes useful in regular practices. Flexible AC Transmission System devices are coming into the picture & plays capital role due to the fast development of electronic industries. These devices become attractive for power system applications. Here we are going to discuss about the device, which now taken a grand position & increase use in the most of the power system for the stability purpose. Reactive power provision, support for voltage regulation purpose & improves transient stability of power system are some important roles of the STATCOM. STATCOM shows its attractive stead state performance & improved operating characteristics when have been well studied in the past years. The position of STATCOM is parallel to the power network devices. Because it generates control able ac voltage source behind a transformer leakage reactance due to which the reactance voltage difference produces active & reactive power exchange between STATCOM & the power system transmission network. The efficiency for utilization of STATCOM can be improve by using an appropriate control system. Proper control strategies can improve the performance which meets the expectations during operating conditions. Various control techniques are used such as SPWM, Fuzzy logic, Direct control, Hysteresis loop control etc. Depending upon the requirement & performance characteristics various controllers are implemented accordingly. PI controller deteriorates their performance when disturbance occur & is very easy & simple in design. Fuzzy logic controller can be able to tolerate uncertainty & imprecision to a greater extent. They can give positive results at different varying operating conditions & changing system parameters.

II) System Configuration And The Basic Operation:

STATCOM covers coupling transformer, a voltage source inverter, a control system & a dc capacitor. Fig. 1 shows a systematic diagram of the STATCOM which shows the covering devices. FACTS family give the name as primary shunt device. Power flow control & transient stability on power grids can be achieve by the use of power electronics. Depending upon the situation STATCOM various its output. Output is nothing but injected reactive power or absorbed power from the system. For purely reactive power flow, the three phase voltages of the STATCOM must be maintained in phase with the system voltage. This can be done by the use of VSC which is coupled the transformer. It uses power electronic devices such as GTO’s & IGBT’s which are forced commutated. The operating principle is very simple. If the range of the output voltage of the STATCOM is greater than the system voltage then current starts flowing from the convertor to the system. Again if the range of the output voltage of STATCOM is smaller than the system voltage then current starts flowing towards the converter by absorbing reactive power. The equilibrium position is nothing but there is no exchange of reactive power. Following equation shows the amount of exchanged power between converter & the system.

\[ P = V_{sys} (V_{sys} – V_{stat})/ X_{s} \]

Where, \( V_{sys} \) = Magnitude of system voltage.
\( V_{stat} \) = Magnitude of STATCOM output voltage.
\( X_{s} \) = Impedence value.
The improvement in the system performance can be observed which STATCOM shows like:

1) The dynamic voltage control in transmission & distribution systems,
2) The power-oscillation damping in power transmission system,
3) The transient stability,
4) The voltage flicker control,
5) The control of not only reactive power but also active power in the connected line, requiring a dc energy source.

III) Reactive Power Control:

The various equipments are used in the different stages in the power system & they have their own ratings. It is always beneficial to operate the equipment up to its rating & not to exceed its limit. This can be achieved by maintaining the voltage levels within the range. Voltage & reactive power flow are strongly dependent on each other. Due to this relationship, maintaining voltage range limits are important. Sudden load impacts or load demands under contingency operating conditions, when one or more tie line circuits may be out of service, results in short time or prolonged voltage dips. Voltage regulation is the ratio of exchanged reactive power to the level of the short circuit which is shown in the following equation:

$$\Delta Es/E \approx \Delta Er/E = \Delta Q/Ssc$$

Where, Es= Sending end voltage.
Er= Receiving end voltage
Q= Reactive power
Ssc= Short circuit level of system.

The ability to produce full capacitive current at low voltage makes it ideally suitable for improving the transient stability.

IV) Sag Mitigation:

Voltage sag is the reduction in voltage value. It can be called as voltage dip which is for short term. Shunt connected devices are more advantageous as compared to series devices when their performances are compared for sag mitigation. Shunt devices can be used for steady state voltage control, load power oscillation damping & as a backup power source.

V. Simulation Results Simulation Circuit:

The results are observed for the system with STATCOM and without STATCOM. It is observed that surely it is very helpful while voltage fluctuation situations. Because it gives or absorb power during such conditions. But also it affects the Total Harmonic Distortion value also. Mainly it is observed that as the levels of the inverter controller is increased the percentage value of THD goes on decreasing. Again fuzzy logic controllers provides winning applications in industries. They can be used in a number of complex and non-linear processes. F-STATCOM is compared with conventional SVC controller and F-STATCOM is effective.

9 Level Output
Conclusion:
Faster response can be able to give for deviated power system and can avoid any saviour situations which may came. This instrument may become an helping hand for the system engineers which are doing research on power quality or power disturbance problems, because it can shows the values of the deviated parameters. Again as said earlier the THD results are also remarkable by increasing the levels of the inverter. Switching losses are reduced in the power system. STATCOM have very bright scope in future.

References