

Comparative Performance Analysis of a Grid Connected System during Fault Occurrence: STATCOM V/S SVC

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Abstract: Voltage Constancy is a strategic factor for the unwavering activity of a grid connected system during fault imposition and grid disturbances. This paper investigates the implementation and comparison of devices like STATCOM and SVC for the voltage stability issue for grid connected systems. The system model is simulated in MATLAB / SIMULINK and the results show that the STATCOM is better than SVC for the stable operation of a grid connected system to remain in service during grid faults.

Keywords: SVC, Thyristor, STATCOM.

INTRODUCTION

Description of Svc: It is a variable impedance device where the current through the reactor is controlled using back to back connected thyristor valves. The application of thyristor valve technology to SVC is an offshoot of the developments in HVDC technology. The major difference is that thyristor valves used in SVC are rated for lower voltages as the SVC is connected to an EHV line through a step down transformer or connected to an EHV line through a step down transformer or connected to an EHV line through a step down transformer or connected to an EHV line through a step down transformer or connected to an EHV line through a step down transformer or connected to the tertiary winding of a power transformer ¹⁻⁶. The application of SVC was initially for load compensation of fast changing loads such as steel mills and arc furnaces. Here the objective is to provide dynamic power factor improvement and also balance the currents on the source side whenever required ^{7-9.}

Description of STATCOM



A STATCOM is a device for reactive power control and is connected in parallel to the electric network with a transformer. STATCOM has a VSC (Voltage Source Converter) interface, and the DC-voltage support is provided with capacitors of relatively small energy storage, so the active power exchange is zero in steady-state. In practice there will be a little active power interchange due to losses. The basic principle of operation for the STATCOM is to compare the voltage in the system and the terminal voltage on the VSC, and control the phase angle and amplitude on the voltage drop over the transformer inductance^{10-12.}

When the voltage in the electric system is lower than the terminal voltage on the VSC, the STATCOM will generate reactive power, the STATCOM works in capacitive mode. If the voltage on the VSC is lower than the voltage in the electric network, the STATCOM will absorb reactive power, the STATCOM works in inductive mode. If the voltage of the electric network and the terminal voltage on the VSC are equal, there will not be any reactive flow in the STATCOM. This paper discusses how STATCOM can support power factor and voltage regulation. The results from the simulation in MATLAB support the theory about the STATCOM. This simulation results show that a STATCOM can be used in electrical grid for stabilization of reactive power and the voltage. This device can serve the best solution for meeting the grid code demands^{13, 14.}

The continuous increase of installed wind power seen during recent years has forced the transmission system operators (TSO) to tighten their grid connection rules – also known as Grid Code - in order to limit the effects of power parks on network quality and stability. These new rules demand that power plants of any kind support the electricity network throughout their operation. Key issues are steady state and dynamic reactive power capability, continuously acting voltage control and fault ride through behaviour. Some commonly used turbine designs have some limits in terms of achieving Grid Code compliance in several countries^{15-16.}

For parks based on such turbines, additional equipment is needed. The medium voltage STATCOM (Static Synchronous Compensator) technology adds the missing functionality to wind parks in order to become Grid Code compliant. The STATCOM as a pure static device with no switched passive components provides outstanding performance for both steady state and dynamic operation. Based on medium-voltage converter platforms widely used for industrial applications, STATCOMs are supplied to the wind power industry in order to integrate wind parks into grids with demanding connection requirements.

Fault Analysis: One of the major criteria, deciding the power system operation is its stability. Stability of the power system is the ability to maintain the machines connected to the system in synchronism. But disturbances always occur either due to the sudden addition or removal of load,

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short circuit of lines; lightning etc. The phenomenon of voltage instability is characterized by a progressive fall in voltage magnitude at a particular location or at a particular area, and may finally spread out in the entire network causing system voltage collapse.

This phenomenon may be attributed to the inability of the power system to meet a certain load demand of reactive power. Voltage instability being primarily a steady state phenomenon, transient voltage instability has also been observed in recent years. It is characterized by a sharp and sudden fall in system voltage and is possibly governed by the situation of the load bus when the system experiences voltage swings, and by the dynamics of induction motor loads. A large induction motor is one of the commonest loads constituent that shows a fast increase of reactive power demand due to voltage drops even of relatively small values.

This enormous and fast increase of reactive power demand results in further deterioration of voltage indicating complete voltage collapse, if proper action is not taken immediately. The role of induction motors has also been highlighted, that for the induction motor predominant load buses, the critical clearing time is important to ensure stable operating voltage. Till the System state does not enter the 'impasse' surface; it is possible to regain the bus voltage following the fault clearing. Once the system voltage enters into that zone, any attempt to restore the normalcy of bus voltage does not serve the purpose of maintaining voltage stability. Hence it is evident that the voltage collapse depends not only on the load behaviour and system reactive power limitation, but also on the critical clearing time for the system to regain voltage stable state.

Advancements in semi-conductor electronics have helped in the development of new control technologies for stability enhancement, which includes the use of FACTS controllers. Today's changing electric power systems create a growing need for flexibility, reliability, fast response and accuracy in the fields of electric power generation, transmission, distribution and consumption. Flexible Alternating Current Transmission Systems (FACTS) are new devices emanating from recent innovative technologies that are capable of altering voltage, phase angle and/or impedance at particular points in power systems. Their fast response offers a high potential for power system stability enhancement apart from steady state flow control. Static Var Compensator (SVC) and Static Synchronous Compensator (STATCOM) provides fast acting dynamic reactive compensation for voltage support during contingency events which would otherwise depress the voltage for a significant length of time. Static Var Compensator SVC and STATCOM also dampen power swings and reduce system losses by optimized reactive power control.



Model Simulated in MATLAB

Comparative...

SVC v/s STATCOM during fault Manifestation: In the above model, STATCOM and SVC having the same rating are compared. SVC and STATCOM are connected to the same type of power grids. A remote fault will be simulated on both systems using a fault breaker in series with fault impedance. During the event of fault occurrence, a key difference between the SVC and the STATCOM can be observed. The reactive power generated by the SVC is -0.48 pu and the reactive power generated by the STATCOM is -0.71 pu. (As can be seen from simulated waveforms given below) It can also be observed that the maximum capacitive power generated by a SVC is proportional to the square of the system voltage (constant susceptance) while the maximum capacitive power generated by a STATCOM decreases linearly with voltage decrease (constant current). This ability to provide more capacitive power during a fault is one important advantage of the STATCOM over the SVC. In addition, the STATCOM will normally exhibit a faster response than the SVC because with the voltage-sourced converter, the STATCOM has no delay associated with the thyristor firing (in the order of 4 ms for a SVC).



Simulation Results

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