Comparative Analysis of STATCOM and SVC for Reactive Power Enhancement in A Long Transmission Line

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Abstract - In recent power system scenario, the main concern is about the maximum power transfer capability from generating station to the distribution station. But between these, the transmission system i.e. transmission of power from generating station to distribution grid is the most vital thing. So in order to have a reliable and quality power transmission FACTS controllers (Flexible AC Transmission System) are introduced in the transmission system. FACTS are an emerging technology which motivates towards power quality improvement and increased control flexibility of power system. Generally FACTS controllers are of series type, shunt type and combined series-series and combined series-shunt type. In this paper a shunt type controllers i.e. STATCOM (Static Synchronous Compensator) and a SVC (Static VAR Compensator) have been considered. Here the variation of voltage and reactive power by the introduction of STATCOM & SVC at middle of long transmission line has been investigated. All these analysis is carried out by the mat lab simulink models of STATCOM & SVC. This comparison output reveals that STATCOM performs better than SVC in Volt /VAR control.

Keywords: FACTS, power quality, STATCOM, SVC.

I. Introduction

Now a day the power system is approaching towards greater complexity. This is due to the increasing demand of good quality power by consumers. To maintain a good quality of power the system needs a optimal control strategies for the generation, transmission and distribution of electric power [1-8]. It’s being a huge responsibility of transmitting power from one station to other with lowest cost of generation. So current power system wants a flexible system which can anyhow provides increased control flexibility, maximum power transfer capability [9], grid flexibility and compensation at the time of need. All these strategies can be achieved by the emerging technology of FACTS. FACTS stand for flexible AC transmission system. FACTS are the combination of various power electronics based controllers. These controllers may be of shunt or series connected types or combination both [1-6]. Shunt connected controllers are connected in parallel to the transmission line and injects current to the system at the point of connection. SVC & STATCOM are some examples of shunt controllers. Series connected controllers are connected in series with the transmission line and injects voltage to the line at the time of need [7-4]. SSSC, TCSC, TSSC, TSSR are some examples of series connected controllers.

In this work SVC and STATCOM has considered for reactive power enhancement. Simulation has been done separately for SVC and STATCOM, voltage and current profiles are compared between SVC and STATCOM. Finally STATCOM has the edge in better performance for the enhancement of reactive power compensation.

II. List of Devices Considered for the Study

The study has been carried out by introducing STATCOM and SVC in long transmission line.

A. STATCOM (Static Synchronous Compensator)

The Static Synchronous Compensator (STATCOM) is a shunt device of the Flexible AC Transmission Systems (FACTS) family using power electronics to control power flow and improve transient stability on power grids [11-16]. The STATCOM regulates voltage at its terminal by controlling the amount of reactive power injected into or absorbed from the power system. When system voltage is low, the STATCOM generates reactive power (STATCOM capacitive) [12-14]. When system voltage is high, it absorbs reactive power (STATCOM inductive). STATCOM is represented in fig 1.

The variation of reactive power is performed by means of a Voltage-Sourced Converter (VSC) connected on the secondary side of a coupling transformer. The VSC uses forced-commutated power electronic devices (GTOs, IGBTs or IGCTs) to synthesize a voltage V2 from a DC voltage source [13]. The principle of operation of the...
STATCOM is explained on the figure below showing the active and reactive power transfer between a source V1 and a source V2[15]. The system voltage to be controlled and V2 is the voltage generated by the VSC.

![STATCOM Diagram](image1)

**Fig 1:** STATCOM.

**B. SVC (Static VAR Compensator)**

Static VAR Compensator is “a shunt-connected static VAR generator or absorber whose output is adjusted to exchange capacitive or inductive current so as to maintain or control specific parameters of the electrical power system (typically bus voltage)” fig 2. SVC is based on thyristors without gate turn-off capability. The operating principal and characteristics of thyristors realize SVC variable reactive impedance [10]. SVC includes two main components and their combination: Thyristor-controlled and Thyristor-switched Reactor (TCR and TSR); and Thyristor-switched capacitor (TSC) [3].

![SVC Diagram](image2)

**Fig 2:** Static VAR Compensators (SVC): TCR/TSR, TSC, FC and Mechanically Switched Resistor.

### III. System Considered for Simulation

The power network consists of two 500 KV equivalents (respectively 3000 MVA and 2500 MVA) connected by a 600 Km transmission line as shown in Fig.3. The SVC and STATCOM is located at the midpoint of the line (bus B2). The parameters of the system are listed in Table I.

<table>
<thead>
<tr>
<th>Table 1. System Parameters</th>
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<tr>
<td>STATCOM</td>
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<td>DC voltage</td>
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![Simulation Diagram](image3)

**Fig 3:** Simulation block diagram of the power system with a shunt FACTS device in Matlab simulink.
IV. Simulation Results

The simulation results of the power system using the shunt FACTS controller has been discussed in this section. The measured voltage in the compensator bus on SVC (red trace) and the STATCOM (black trace) is shown in fig 4. It is observed that the STATCOM is very effective during the power system disturbances.

The measured reactive power generated by the SVC (red trace) and the STATCOM (black trace) is shown in fig 5. We can see the duration of fault of 10 cycles, the reactive power generated by the SVC is -0.51pu and the STATCOM is 0.35pu.

![Voltage comparison between SVC and STATCOM](image1)

**FIG 4: Voltage comparison between SVC and STATCOM, (X-axis represents time(sec), Y-axis represents voltage(pu)).**

![Reactive power comparison between SVC and STATCOM](image2)

**FIG 5: Reactive power comparison between SVC and STATCOM, (X-axis represents time(sec), Y-axis represents reactive power(pu)).**

V. Conclusion

Comparative Analysis of STATCOM and SVC for Reactive Power Enhancement has been conducted for long transmission line of 600km with voltage range of 500KV in MATLAB/Simulink platform. Real and reactive power flows have been taken accordingly with reference to the point of installation of FACTS devices in the long transmission line. At first analysis has been done for a compensated system when STATCOM was installed at middle of the transmission line. Similar type of analysis has been performed by introducing of SVC in transmission line. Comparison of voltage and reactive power has done between two models. The comparison output shows that STATCOM performs better than SVC in Volt /VAR control.

References


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