4.2 Static Var Compensator (SVC)

A SVC is an electrical device for providing fast acting reactive power on high-voltage electricity transmission networks. SVCs are part of the FACTS device family and regulating voltage and stabilizing the system. Unlike a synchronous condenser which is a rotating electrical machine a SVC has no significant moving parts and prior to the invention of the SVC power factor Compensation was the preserve of large rotating machines such as synchronous condensers or switched capacitor banks. The SVC is an automated impedance matching device designed to bring the system closer to unity power factor.

SVCs are used in two main situations:

- Connected to the power system, to regulate the transmission voltage.
- Connected near large industrial loads, to improve power quality.

In transmission applications the SVC is used to regulate the grid voltage. If the power system‘s reactive load is capacitive (leading) the SVC will use thyristor controlled reactors to consume vars from the system lowering the system voltage. Under inductive (lagging) conditions the capacitor banks are automatically switched on thus providing a higher system voltage and by connecting the thyristor-controlled reactor which is continuously variable along with a capacitor bank step and the net result is continuously-variable leading or lagging power. In industrial applications SVCs are typically placed near high and rapidly varying loads such as arc furnaces where they can smooth flicker voltage.

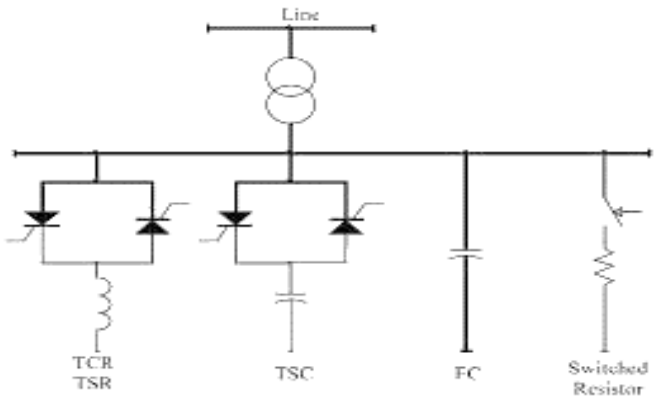

Figure 4.2.1 Schematic diagram of TCR, TSR, FC

[Source: “HVDC Power Transmission Systems” by K.P.Padiyar, page164]

Description:

The elements which may be used to make an SVC typically include:

- Thyristor Controlled Reactor (TCR) where the reactor may be air or iron cored.
- Thyristor Switched Capacitor (TSC).
- Harmonic filter(s).
- Mechanically switched capacitors or reactors.

Connection:

This reduces the size and number of components needed in the SVC although the conductors must be very large to handle high currents associated with the lower voltage.The dynamic nature of the SVC lies in the use of thyristors connected in series and inverse-parallel forming ―thyristor valves‖ and the disc-shaped semiconductors usually several inches in diameter are usually located indoors in a ―valve house‖.

Prevention of Voltage Stability

Voltage instability is caused by the inadequacy of the power system to supply the reactive-power demand of certain loads, such as induction motors. A drop in the load voltage leads to an increased demand for reactive power that, if not met by the power system, leads to a further decline in the bus voltage. This decline eventually leads to a progressive yet rapid decline of voltage at that location, which may have a cascading effect on neighboring regions that causes a system voltage collapse.

Principle of SVC Control

The voltage at a load bus supplied by a transmission line is dependent on the magnitude of the load, the load-power factor, and the impedance of the transmission line. Consider an SVC connected to a load bus, as shown in Fig. The load has a varying power factor and is fed by a lossless radial transmission line. The voltage profile at the load bus, which is situated at the receiver end of the transmission line, is depicted in Fig. For a given load-power factor, as the transmitted power is gradually increased, a maximum power limit is reached beyond which the voltage collapse takes place.

V-I Characteristics of SVC

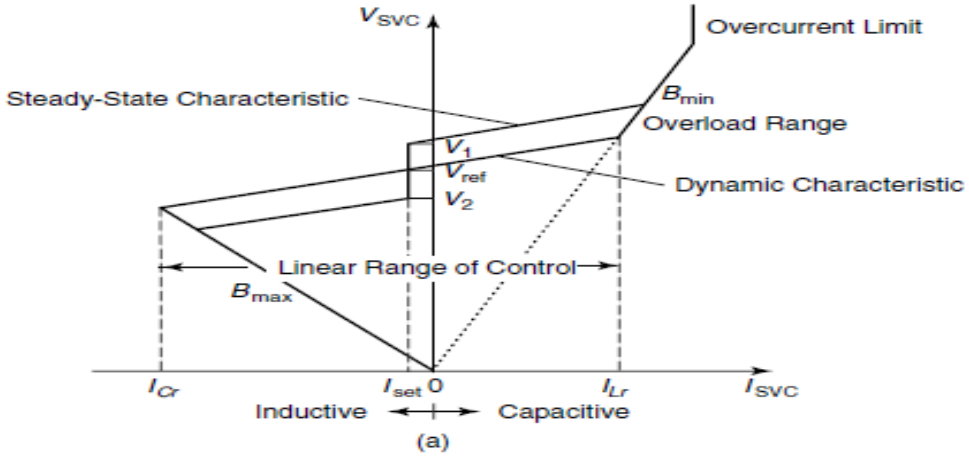

Figure 4.2.2 Control characteristics of SVC

[Source: "HVDC Power Transmission Systems" by K.P.Padiyar, page167]

The steady-state and dynamic characteristics of SVCs describe the variation of SVC bus voltage with SVC current or reactive power. V_{ref} : This is the voltage at the terminals of the SVC during the floating condition, that is, when the SVC is neither absorbing nor generating any reactive power. The reference voltage can be varied between the maximum and minimum limits—V_{ref} max and V_{ref} min—either by the SVC control system, in case of thyristor-controlled