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Performance operation and Control of EHV Power Transmission System

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***Abstract*— This paper investigates the effects of Static Var Compensator and Static Synchronous Compensator on voltage Collapse of a power system. The effect of Critical Fault Clearing Time of the system due to facing the fault, to prevent permanent voltage instability has been analyzed. Comparative performance evaluation of SVC and STATCOM has been examined. A Power System Computer Aided Design /Electromagnetic Transients including DC is used to carry out simulations of the system under study and detailed results are shown to access the performance of SVC and STATCOM on the voltage collapse of the system.**

***Keywords*— STATCOM, SVC, stability, voltage collapse.**

I. Introduction

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, 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. 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 behavior 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. Flexible Alternating Current Transmission Systems 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

II. SVC

Over the years static Var compensators of many different designs have been built. Nevertheless, the majority of them have similar controllable elements. The most common ones are:

(a) Thyristor controlled reactor
(b) Thyristor switched capacitor
(c) Fixed capacitor, Thyristor controlled reactor scheme.
(d) Thyristor switched capacitor Thyristor controlled reactor Scheme.

1. The TSC-TCR compensator shown in Fig. 1.usually comprises n TSC banks and a single TCR that are connected in parallel. The rating of the TCR is chosen to be 1/n of the total SVC rating. The capacitors can be switched in discrete steps, whereas continuous control within the reactive-power span of each step is provided by the TCR. Thus the maximum inductive range of the SVC corresponds to the rating of the relatively small interpolating TCR. As the size of TCR is small, the harmonic generation is also substantially reduced. The TSC branches are tuned with the series reactor to different dominant harmonic frequencies. To avoid a situation in which all TSCs and, consequently, the associated filters are switched off, an additional non switch able capacitive-filter branch is provided.

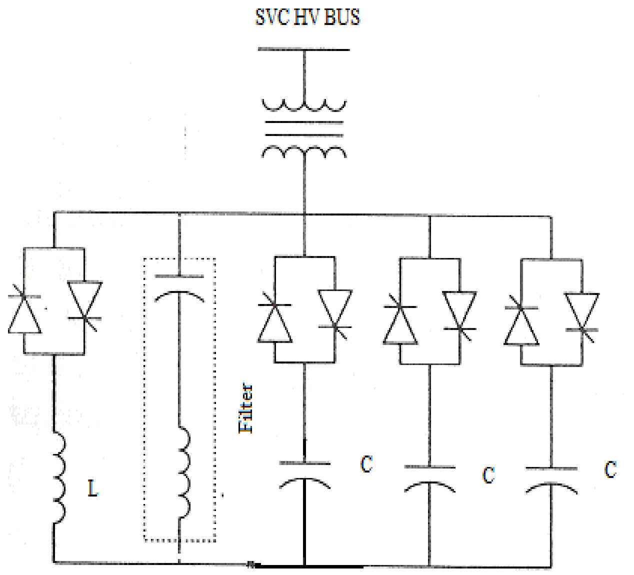

Fig. 1. A General TSC-TCR SVC

III. STATCOM

The STATCOM is shunt-connected reactive-power compensation device that is capable of generating and absorbing reactive power and in which the output can be varied to control the specific parameters of an electric power system. It is in general a solid-state switching converter capable of generating or absorbing independently controllable real and reactive power at its output terminals when it is fed from an energy source or energy- storage device at its input terminals. The dc voltage is provided by an energy-storage capacitor. A single-line STATCOM power circuit is shown in Fig.2 where a VSC is connected to a utility bus through magnetic coupling. The exchange of reactive power between the converter and the ac system can be controlled by varying the amplitude of the 3-phase output voltage, ES of the converter. That is, if the amplitude of the output voltage is increased above that of the utility bus voltage. Et then a current flow through the reactance from the converter to the ac system and the converter generates capacitive-reactive power for the ac system. If the amplitude of the output voltage is decreased below the utility bus voltage, then the current flows from the ac system to the converter and the converter absorbs inductive-reactive power from the ac-system. If the output voltage equals the ac system voltage, the reactive-power exchange becomes zero, in which case the STATCOM is said to be in a floating state [3].

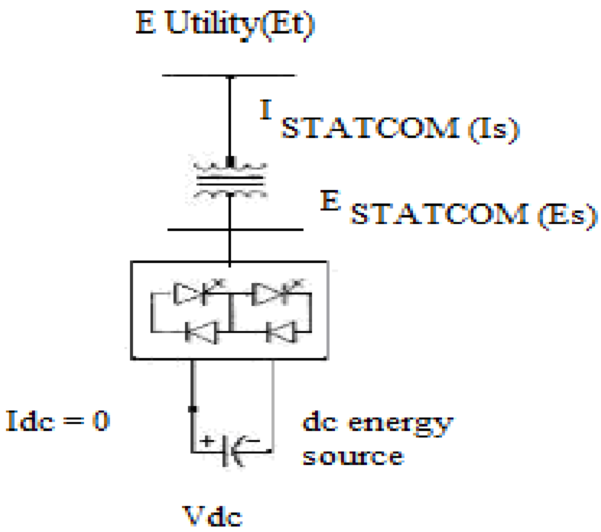

Fig. 2. A single-line STATCOM power circuit

IV. SIMULATION RESULTS

The four stations exchange power via transmission lines. Station1 connected with bus 1, is composed of two parallel 300 km long lines feeding at bus 6 with a load of 74.6 kW induction motor and a single 300km long line leading to other area i.e. station 3 through bus 3.A SVC or a STATCOM is installed at bus 6, i.e. the midpoint of a long transmission line for improving the voltage stability. In Fig. 3 it is reported that during the time of fault Without FACTS controllers' voltage level is 0.66 P.U. But at the presence of SVC this voltage level is 0.98 P.U. and due to presence of STATCOM is 1.02 P.U. it is seen that without FACTS controllers the voltage level enters in voltage instability zone even if the fault is cleared. But due to presence of an SVC or a STATCOM this type of instability can be avoided.

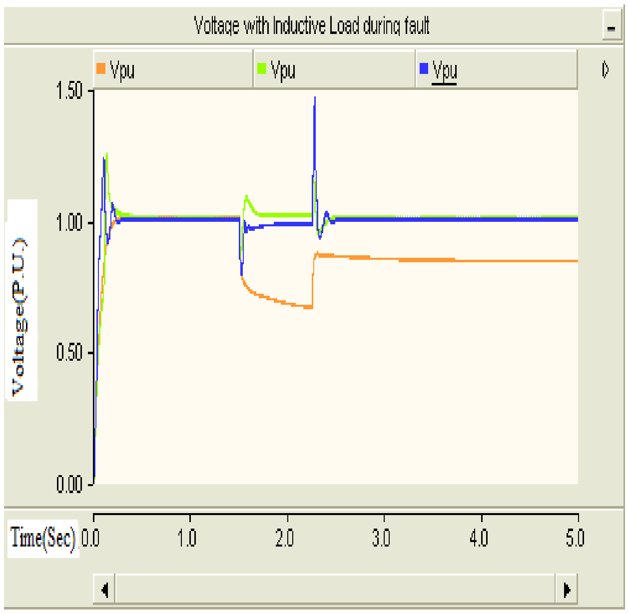

Fig. 3. Voltage characteristics graphs during voltage collapse

From the Fig. 4 it is cleared that the critical fault clearing time is important to ensure stable operating voltage for the Induction Motor predominant load buses.

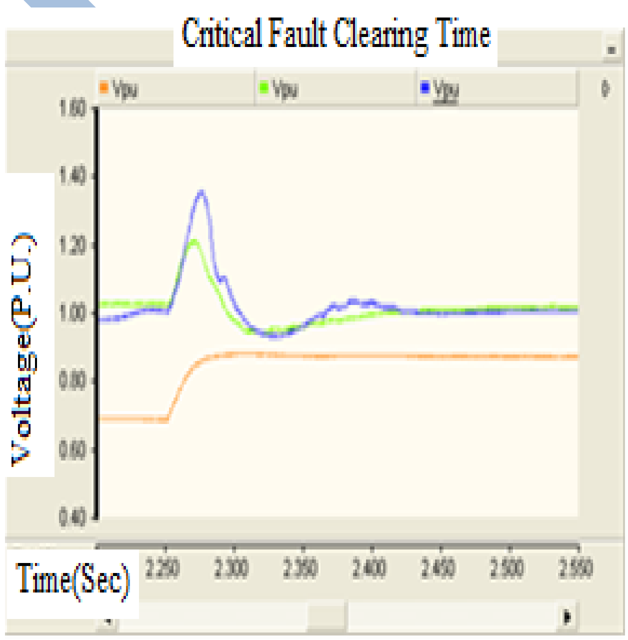

Fig. 4. Critical fault clearing time graph

V. CONCLUSION

In this paper, SVC and STATCOM operation on voltage collapse are described The Critical Fault Clearing Time obtained for the different FACTS Controllers are compared. Simulations carried out confirmed that Static Var Compensator and Static Synchronous Compensator could provide the fast acting voltage support necessary to prevent the possibility of voltage reduction and voltage collapse at the bus to which it is connected.

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