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Reactive Power Flow Control using Static VAR Compensator to Improve Transmission System

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Abstract - *This paper presents the expected utilizations of flexible AC transmission system (FACTS) controllers, for example, the static VAR compensator (SVC), utilizing the most recent innovation of power electronic switching devices in the fields of electric power transmission frameworks with controlling the voltage and power flow, and improving the voltage regulation. Again, the static VAR compensators are being increasingly applied in electric transmission frameworks financially to improve the post- disturbance recuperation voltages that can lead to system instability. A SVC performs such system enhancements and advantages by controlling shunt reactive power sources, both capacitive and inductive, with innovative power electronic switching devices. This work is introduced to take care of the issues of poor dynamic performance and voltage regulation in a 115KV and 230KV transmission system utilizing SVC.*

Key Words: Power system network; reactive power; static VAR compensator; transmission line; voltage stability.

1. INTRODUCTION

Everyday, requests on the transmission network are expanding a result of the expanding number of non-utility generators and heightened competition among utilities themselves. Expanded demand on transmission system, absence of long term arranging and the need to give open admittance to power producing organizations and customers; all together have made tendencies toward a reduction of security and diminished nature of supply. The AC power transmission system has diverse limits, delegated static limits and dynamic limits. These characteristic limits the power transaction, which lead to the under usage of the existing transmission resources. Generally, fixed or precisely switched shunt and series capacitors, reactors and coordinated generators were being utilized to take care of quite a bit of these issues. However, there are a few limitations concerning the utilization of these conventional devices. Wanted execution was being not able to accomplish successfully. Wear and tear in the mechanical segments and moderate reaction were the serious issues. Accordingly, it was required for the elective innovation made of strong state electronic gadgets with quick reaction attributes. The necessity was further fuelled by overall rebuilding of electric utilities, expanding ecological and effectiveness regulations and trouble in getting permit and option to proceed for the development of overhead force transmission lines. This, along with the innovation of semiconductor thyristor switch, opened the door for the advancement of FACTS controllers. The way from historical thyristor based FACTS controllers to modern innovatively progressed voltage source converters based FACTS controllers, was gained conceivable because of fast progress in high power semiconductors switching devices. A static VAR compensator (SVC) is an electrical device for giving effective reactive power compensation on high voltage transmission networks and it can add to improve the voltages profile in the transient state and subsequently, in improving the quality performances of the electric administrations. A SVC is one of FACTS controllers, which can handle at least one variables in a power system. The powerful idea of the SVC lies in the utilization of thyristor devices (for example GTO, IGCT). The thyristor, generally found inside in a "valve house", can switch capacitors or inductors in and out of the circuit on a per-cycle basis, taking into consideration quick predominant control of system voltage. The compensator concentrated in the current work is comprised of a fixed reactance associated in series to a thyristor controlled reactor (TRC) based on bi-directional valves-and a fixed bank of capacitors in corresponding with the combination reactance-TRC. The thyristors are turned on by a suitable control that regulates the magnitude of the current.

2. Literature Survey

1) "Voltage Stability Profile Betterment and Reactive Power Quantity Adjustment with the Assistance of Static VAR" by A Siva Lakshmi, N Aparna, Ch. Pavan kumar in IJARSET Vol. 6, Special Issue , August 2019. In this paper they discussed about, the impacts of Static VAR Compensator (SVC) on voltage soundness of a power system. Power systems comprising of huge number of producing units and interconnected system of transmission lines. The voltage steadiness is a prime significance in this perplexing force system organizes since the demand for electric power is expanding enormously. The control of wattles power in the transmission lines will improve the voltage strength of the power system arrange. This paper shows the structure and

execution of the Static VAR Compensator (SVC) in the transmission lines for receptive power stream control to better the voltage solidness. The model depends on speaking to the controller as factor impedance those changes with the terminating edge of the TCR. The proposed technique distinguishes consequently the suitable number of SVCs required for the control of receptive power. The point by point recreation study has been done in MATLAB/Simulink condition.

2) "Comparative Analysis of STATCOM and SVC for Reactive Power Enhancement in A Long Transmission Line" by Nunna Sushma in IJCSE Vol.-6, Issue-6, Jun 2018. In this paper they said that, 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 & SCV 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 revels that STATCOM performs better than SVC in Volt /VAR control.

3) "Mid-Point Siting of FACTS Devices in Transmission Lines" by B.T. Ooi M. Kazerani R. Marceau. Wolanski F.D. Galiana D. McGillis G. Joos in IEEE Transactions on Power Delivery, Vol. 12, No. 4, October 1997. In this paper they discussed about, Many controllers of Flexible AC Transmission Systems (FACTS), such as the STATCOM, the Unified Power Flow Controller (UPFC), the PWM asynchronous dc link, the Thyristor-Controlled Series Capacitor (TCSC) and the PWM Series Static *VAR* compensator have stabilized ac voltage support. Thus, they can be sited at the mid-point of the transmission line, which has been proven by the late E.W. Kimbark, as the optimum location for shunt capacitor compensation. This paper points out that the ability to double the power transfer of the uncompensated line applies also to the aforementioned FACTS devices. The mid-point siting also facilitates the independent control of reactive power at both ends of the transmission line.

4) "Improved Harmony Search Algorithm for Optimal Placement and Sizing of Static Var Compensators in Power Systems" by Reza Sirjani & Azah Mohamed in 2011 IEEE. In this paper they said that, Static Var compensator (SVC) is normally used in Power system to improve voltage profile and reduce system Power losses. In this paper, a relatively new optimization Technique named as the improved harmony search algorithm (IHS) is applied to determine optimal location and size of SVC Devices in a transmission network. A multi-criterion objective Function comprising of both operational objectives and Investment costs is considered. The results on the 57-bus test System showed that the IHS algorithm give lower power loss And better voltage improvement compared to the particle Swarm optimization technique in solving the SVC placement And sizing problem.

5) "Voltage Stability Enhancement by Optimal Placement of UPFC" by M.Kowsalya, K.K.Ray, Udai Shipurkar and Saranathan in Journal of Electrical Engineering & Technology Vol. 4, No. 3, pp. 310~314, 2009. In this paper they said that, the improvement of the voltage profiles of power system networks by the inclusion of Unified Power Flow Controller (UPFC). The mathematical model of the UPFC is incorporated in the load flow algorithm and the L-index is calculated for the different values of the control parameter r and γ. The positioning of the UPFC device is changed to minimize the sum of the squares of the L-indices at all load buses. The test cases considered for the improvement of voltage profile with the WSCC 9-bus and IEEE 30 bus system. With the best position of UPFC along with the control parameters the improvement in voltage profile of the power system networks are obtained. The results obtained are quite encouraging compared with other techniques used to identify the best location of UPFC.

3. STATIC VAR COMPENSATOR

a) Configuration of SVC

SVC gives a great wellspring of rapidly controllable reactive shunt compensation for dynamic voltage control through its usage of rapid thyristor switching /controlled devices. A SVC is typically made up of coupling transformer, thyristor valves, reactors, capacitance (often tuned for harmonic filtering).

b) Advantages of SVC

The primary benefit of SVCs over simple mechanically switched compensation schemes is their near-instantaneous response to change in the system voltage. For this reason they are often operated at close to their zero-point in order to maximize the reactive power correction. They are in general cheaper, higher-capacity, faster, and more reliable than dynamic compensation schemes such as synchronous compensators (condensers). In a word:

1) Improved system steady-state stability.
2) Improved system transientstability.
3) Better load division on parallel circuits.
4) Reduced voltage drops in load areas during severe disturbances.
5) Reduced transmission losses.
6) Better adjustment of line loadings.

c) Control Concept of SVC

A SVC is a controlled shunt susceptance (B) as characterized by control settings that infuses reactive power (Q) into the system dependent on the square of its terminal voltage. Fig. 1 outlines a TCR SVC, including the operational idea. The control objective of the SVC is to keep an ideal voltage at the high-voltage bus. In the steady-state, the SVC will give some steady-state control of the voltage to maintain the high-voltage bus at a pre-characterized level.

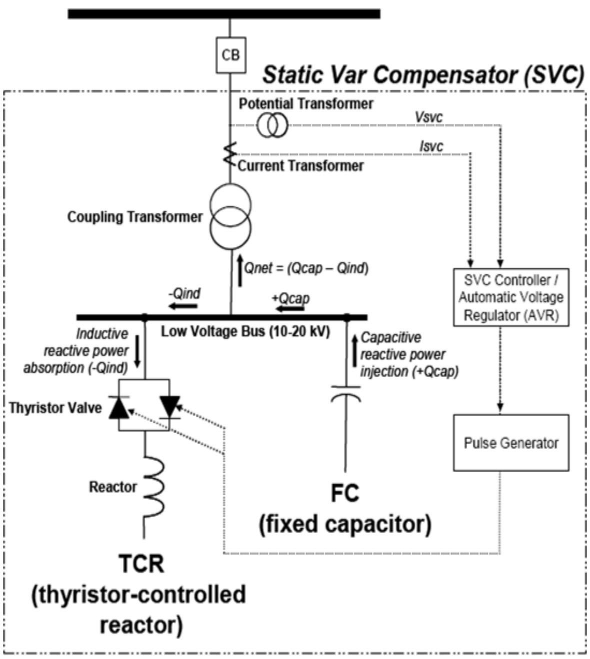

Fig-1 : SVC with control concept

If the high-voltage bus begins to fall below its set point range, the SVC will inject reactive power (Qnet) Into thereby increasing the bus voltage back to its net desired voltage level. If bus voltage increases, the SVC will inject less (or TCR will absorb more) reactive power, and the result will be to achieve the desired bus voltage. From Fig. 1, +Qcap is a fixed capacitance value, therefore the magnitude of reactive power injected into the system, Qnet, is controlled by the magnitude of –Qind reactive power absorbed by the TCR. The fundamental operation of the thyristor valve that controls the TCR is described here. The thyristor is self-commutates at every current zero, therefore the current through the reactor is achieved by gating or firing the thyristor at a desired conduction or firing angle with respect to the voltage waveform.

4. CONCLUSION

In this paper, a SVC has been proposed for the improvement of voltage stability in the transmission network of the power system dependent on the reactive power flow control utilizing the phase locked loop based control. Proposed SVC is competent to control the voltage variations in the power system events like varieties in the amplitude of voltage, switching of the large and small loads etc. The proposed SVC is capable to control the reactive power according to requirement of the system via naturally switching on the number of TSC in the circuit.

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