ISSN 2229-5518

Analysis the Optimal Location for Installing SVC in a 6-Bus System using Mi-Power Simulation

Swarnendu Patra[1], Shovan Ghosh[2], Sayed Aktar[3], Sharmadeb Jana[4], Shaon Paul[5]

Abstract— This paper gives the retdection for finding out optimal location for installed SVC in a ^bus system and also deals with transmission loss minimization by installing SVC in different buses for the given system. This paper also helps to determined various power losses in different buses. It also portrays different bus voltages and reactive power compensate by connecting SVC in the different buses for the given 6 bus system.

Keywords – Active Power Loss; Reactive Power; Voltage instability; SVC; Trial and Error Method.

———————————— ◆ ————————————

1 INTRODUCTION

Present day in the world, voltage collapse problems in power systems have been of permanent concern for electric utilities and a subject of great importance due to the events of voltage instability. Voltage instability typically occurs on power systems that are heavily loaded, faulted and/or have reactive power imbalance. Therefore, the voltage instability problem is closely related to a reactive-power planning problem including contingency analyses, where suitable conditions of reactive-power reserves are necessary for secure operations of power systems. In case, if the system voltage touches the instability point of the system then it becomes completely unstable. Due to the voltage instability the losses of the system are gained. Now we can reduce the load or fault or draw the reactive power out of the system or we have to inject reactive power from outside source to compensate as per requirement of the system. Power engineers uses the FACTS devices for control the reactive power.

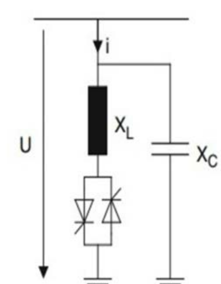
The Flexible AC Transmission System (FACTS) devices, which can provide direct and flexible control of power transfer, can be very helpful in the operation of power networks. Both the power system performance and the power system stability can be enhanced by utilizing FACTS devices. Consequently, such kinds of devices are able to improve power system security under contingency situations. However, the focus of this paper is on the placement of SVC, for compensate the system loss & control the reactive power flow of a transmission line a.c power system network. It is very effective in improving the voltage profile, to support the bus voltage reactive power is injected (absorbed), reducing the line loadings and line losses and enhancing the stability of the system. They can as well be used with the existing lines in order to enhance their power transfer capability. The power flow through the network can be controlled without modifying the generation and carrying out any switching operations in the network. In order to achieve maximum benefits through the installation of the FACTS devices, devices of suitable ratings need to be installed at optimal locations.
SVC (Static Var Compensator) was the first FACTS device to be released in the market, when the concept of generating controllable reactive power through switching power converters was introduced. It is a shunt connected device and is installed parallel with a bus. It has the ability to generate or absorb reactive power at the point where it is connected. More than 800 SVC's are being installed worldwide both for utility and industrial purposes.(especially in electric arc furnace and rolling mills).

In this paper, Static VAR Compensator (SVC) which is a kind of shunt FACTs device, is selected and installed at all viable location alternatively to find out the optimal location using Trial and Error Method.

2 BASIC DESCRIPTION OF SVC

Static VAR Compensator (SVC) is one of the key FACTs controllers. It is normally a static synchronous generator functioning as a Static Synchronous Compensator. A Static VAR Compensator (SVC) is a shunt connected Static VAR generator or absorber whose output is adjusted to exchange capacitive or inductive current to maintain or control specific parameters of the electrical power system (typically, the bus voltage).

Fig. 2.1 Single-phase equivalent circuit of the shunt SVC (TCR)



Typical SVCs can be classified on Thyristor-Controlled Reactor (TCR), Thyristor-Switched Reactor (TSR) or Thyristor-switched capacitors (TSCs). Figure2.1 shows a TCR single-phase equivalent circuit in which the shunt reactor is dynamically controlled from a minimum value (practically zero) to a maximum value by means of conduction control of the by-directional thyristor valves. By this controlled action the SVC can be seen as a variable shunt reactance established by the parallel connection of the shunt capacitive reactance XC and

ISSN 2229-5518

the effective inductive reactance XL controlled by the thyristor switching[2].

VSC: Its AC output voltage is controlled such that the required reactive power flow can be controlled at the load bus with the device is connected.

Due to the presence of DC voltage source capacitor, the voltage- source converter converts its voltage to ac voltage source and control the bus voltage.

3 6-Bus Test System

Table I. Load Bus Data of Test System

Bus No.	Voltage (kV)	Real Power (MW)	Reactive Power (MVAR)
2	220	21.7	12.7
3	220	94.2	19

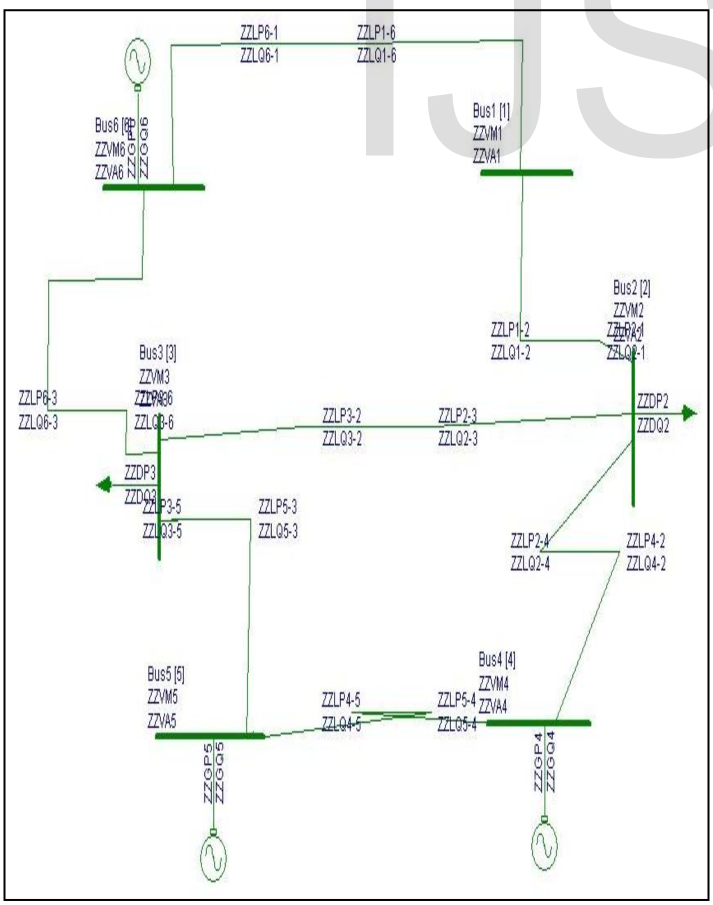


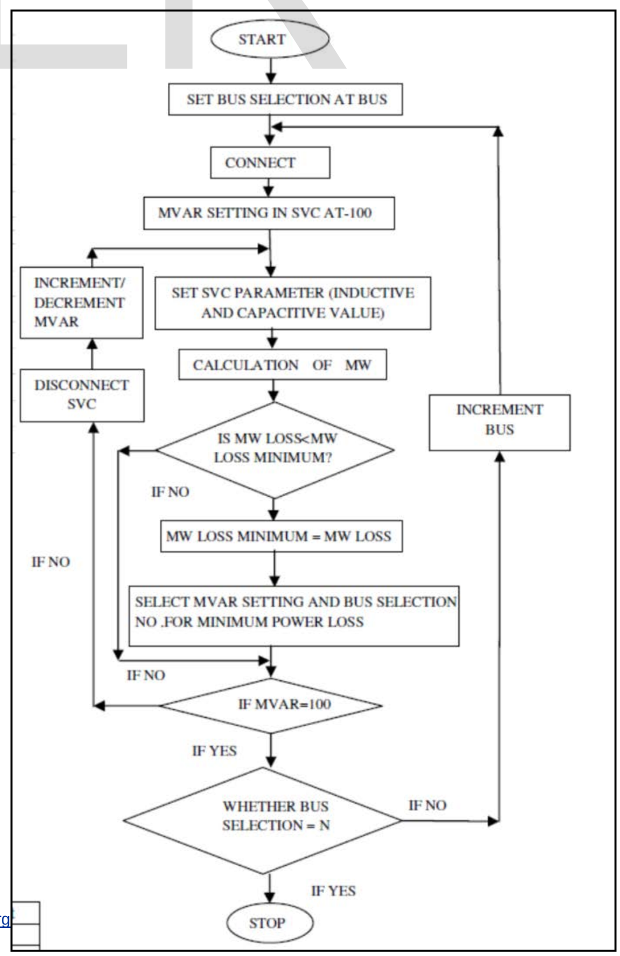
Fig.2. IEEE 6-Bus Test System

Table II. SVC Model Data

Sl. No.	Parameter	Value	Unit
2	Voltage Reference	as required	p.u.
3	Slope	0.1	p.u.
4	Tolerance	0.001	p.u.
5	Maximum Inductive	100	MVAR
7	Maximum Capacitive	100	MVAR
8	Rated Voltage	as required	kV

4 Methodology

To perform the experimental work, a flow chart [7] is given in Fig.3 which renders the methodology.



5 Test Result

The losses of the network when SVC are not connected

Active Power Loss = 6.895MW

Reactive Power Absorption = 14.8765 MVAR.

Now, SVC is being connected at different buses independently, total losses of the network have been measured in each case by Trial and Error Method. Table III shows the overall MW loss and MVAR loss of the network.

Table III. MW Loss And MVAR Absorption With SVC

Bus No.	MW Loss	MVAR Absorption
1	6.895	14.8765
2	6.111	14.0459
3	6.005	14.0911
4	6.878	13.0520
5	6.619	14.0913
6	6.895	11.5685

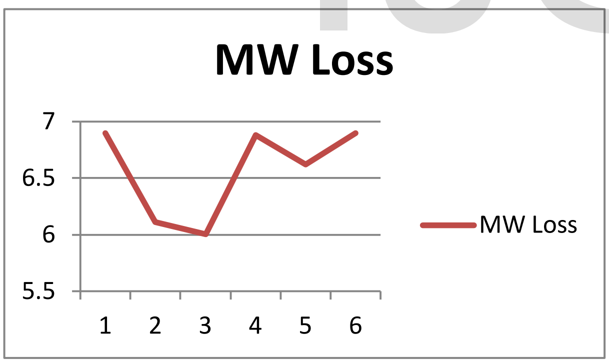


Fig. 4 (a).MW loss at different buses after installing SVC

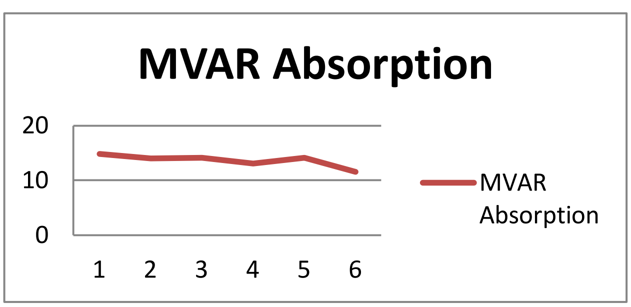


Fig. 4 (b).MVAR loss at different buses after installing SVC

Fig. 4(a) and 4(b) are the graphical representation of the MW loss and MVAR absorption after connecting SVC From Table III, it is evident that minimum active power loss is 6.005MW when SVC is connected at bus number 3. Also, it has been observed that minimum reactive power absorption is 11.5685 MVAR when SVC is connected at bus number 6.

6 Conclusion

In this paper, the optimal location of SVC was used in order to improve voltage stability & reduce power losses in the a,c transmission line. Simulation performed on IEEE 6 bus test system indicates that the proposed method is able to provide optimal locations of these kinds of FACTS devices to achieve voltage security enhancement.

It has been noticed from the above research works that Static Var Compensator (SVC) is very useful to reduce active power loss with optimum reactive power in an AC transmission line. Using Trial and Error method, it is found that bus no. 3 is the optimal location to reduce the active power loss.

It is found from section no. 5 that without SVC, the overall active power loss of the system is 6.895MW and reactive power demand of the system is 14.8765MVAR. Now, after installing the SVC at a particular bus (no. 3) in Table III, the active power loss of the overall system is 6.005 MW. So, by installing SVC at bus no. 3, it shall be possible to save energy of 7,796.4 MWh/year for a particular load mentioned in Table I.

7 Acknowledgment

We are greatful to the dept. of Electrical and specially to Shaon Paul for granting us the opportunity to work on this interesting topic & guiding us in the study and completion of this paper. We would like to thank the faculty of Dept. Electrical engineering, for their help and co-operation.

8 References

[1] M. Kowsalya, K. K. Ray, D. P. Kothari. 2009. Positioning of SVC and STAT COM in a Long Transmission Line. International Journal of Recent Trends in Engineering,vol. 2 (5), November 2009.

[2] Mi-power installation & maintenance manual – power research and development consultants' pvt.ltd.

[3] L. J. Cai, I. Erlich, G. Stamtsis. 2004. Optimal Choice and Allocation of FACTS Devices in Deregulated Electricity Market using Genetic Algorithms. IEEE/PES Power Systems Conference and Exposition, Vol. 1, pp. 201 - 207.

[4] P. Bhasaputra, W. Ongsakul. 2002. Optimal Power Flow with Multi-type of FACTS Devices by Hybrid TS/SA ApproachIEEE International Conference on Industrial Technology, Vol. 1, pp. 285 – 290.

[5] Larsen EV, Sanchez-Gasca J J, Chow J H. 1995. Concept for Design of FACTSS Controller to Damp Power Swings.IEEE Trans on PWRS, 1995, vol. 10(2), 948-956.

[6] P. Wu, X. Qun, J. Gu, Y. Tao. 2012. Distribution Power flow Calculation Based on the Load Monitoring System. China International Conference on Electricity Distribution (CICED 2012), Shanghai.

[7] S. Sarkar, A. Mitra, A. Chakrabarti. 2013. A Case Study of Optimal Location for Installing SVC in IEEE 30-Bus System. National Conference on Power System

Emergencies.