© June 2023| IJIRT | Volume 10 Issue 1 | ISSN: 2349-6002

Investigate the Role of Facts Devices to Improve Voltage Magnitude and Reduce Power Losses ay using SVC and STATCOM

Jai Prakash Dansena[1], Ritesh Diwan[2], Mithilesh Singh[3]
[1]M.Tech. Scholar, RITEE
[2]RITEE, Raipur
[3]SRU Raipur

Abstract: The FACTS known as flexible ac transmission systems devices are solid state converters designed on voltage source converter and now the approach of engineers towards planning and operations of power systems by the implementation of FACTS devices. It is flexible in the sense that it can modified the impedance of line, control the voltage magnitude, power flow in designated routes and phase angle at chosen bus. It has the benefit of FACTS controller to enhance the power transmission capacity, secure loading up to their thermal capability of lines, power flow control flexibility and enable better utilization of available generation. The FACTS devices to be applied in series, shunt or series – shunt with the transmission line to control the operation parameters of electric power circuits. It has applications in power flow control, enhancement in power transfer capability, reduce the power losses, voltage control, reactive power compensation, stability improvement, improve the security, power quality improvement and interconnections of renewable and distributed generations. Optimal placement of FACTS devices can significantly reduce costs of generation re-dispatch in a Balancing Market, and thus improve system efficiency. The proposed methods are applied on IEEE 14 bus system and results are analyzed.

Key words: FACTS, Power flow, Power quality

I.INTRODUCTION

For a stable power system transmission system losses within limit by voltage and reactive power control otherwise various power quality problems may occur due to reactive power flow. The demand of good quality of power with higher reliability at lowest environmental effect as well at lower cost is always challenging job for electric power network. The developed countries used various task for system stabilization and lowest voltage regulation to apply ability within the existing power networks of larger resources by new lines and installing new substations. When power systems operates very close to instability region voltage collapse occur. Therefore efficient and economically justified methods can be developed to solve the lack of voltage instability problems. The optimum active and reactive power transfer and new volt-amp reactive sources are installed at exact location of buses can minimize the transmission losses, increase the voltage profile and voltage stability. The power networks may be saved from fall down in voltage by FACTS controller at appropriate locations [1-2].

FACTS Technology:

The flexible ac transmission system categorized in to series controller, shunt controller and series-shunt controller. The most popular FACTS controller are static var compensator (SVC), static compensators (STATCOM), thyristor series controller (TCSC) and unified power flow controller (UPFC) [3-4].

The FACTS technological developments classified based on Thyristor and IGBT controllers which includes static var compensators (STATCOM) and Unified Power Flow Controller (UPFC).

The aim of this research work is to employ the FACTS to develop an economical-based productivity approach to reduce the power system losses and improve the voltage profile with Optimal Power Flow (OPF) to improve the Power Quality of whole Power System. The STATCOM and SVC are shunt operated device which supply or absorb the reactive power when needed. In this thesis work test the proposed methodology by classical technique to improve the power quality of power systems through simulation studies on IEEE 14 and 57 bus tests system and compare the performance by optimal placement of FACTS devices.

The voltage stability of power system mainly reliant on active power, voltage profile and the angle also it will be controlled. The main objective of this research is to Power Quality improvement by implement the FACTS appliance in power system with optimal power flow (OPF) that covers the real time operation on IEEE bus test system. The FACTS devices can manage power flows in the network by varying transmission line parameters.

III.METHODOLOGY

The power flow problem give relationship between voltages, powers and reactive volt amperes that will be mathematically formulated and flow of power and vars is found out at all lines of network. The power flow equations are nonlinear and solved by iterative methods. The Newton-Raphson power flow solution is preferred compared to other as it has more efficient, solve the practical problem, less computation time and convergence characteristics are very fast.

The solutions of flow of power are probably the most accepted kind of computer-based calculations carried out by planning and operation engineers. The efficient and logical way to study models and methods for the representation of FACTS controllers in power flow studies for power quality improvement is the aim of this work.

STATIC VAR COMPENSATORS (SVC) and Static Var compensator (STATCOM)

SVC has susceptance model and firing angle model shown in figure 2.1. In susceptance model Bsvc fundamental frequency correspondent susceptance of all modules making up SVC. In firing angle model susceptance Beq which is a function of firing angle α made up of parallel arrangement of thyristor controlled reactor correspondent impedance (TCR) and permanent capacitance susceptance [5-7]. The SVC is operating within the limits as shown in figure 2.2 under low loading conditions.

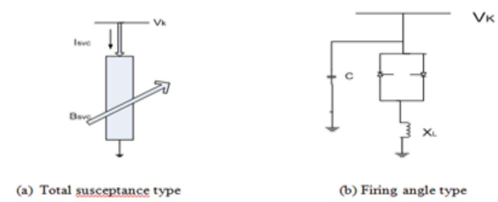


Figure 2.1. Model of S.V.C.

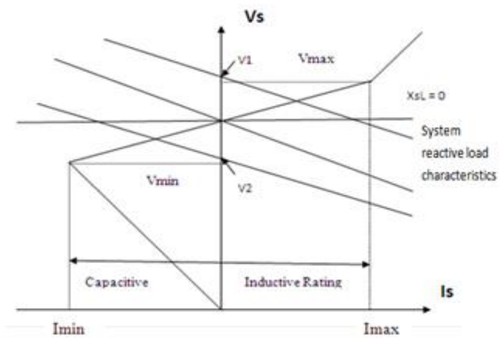


Figure 2.2 Voltage Current characteristics of Static var compensators (P. Kundur)

In 1995, Voltage Source Converter called STATCOM with SVC come in to operation. It has a characteristic similar to the synchronous condenser, but it is superior to the synchronous condenser in several ways, that it has no inertia, better dynamics, a lower investment, operating and maintenance costs. The turn-off capability of GTO or IGBT is the heart of STATCOM [8-10 . The operational characteristic and structures of STATCOM is shown in figure 3.0.

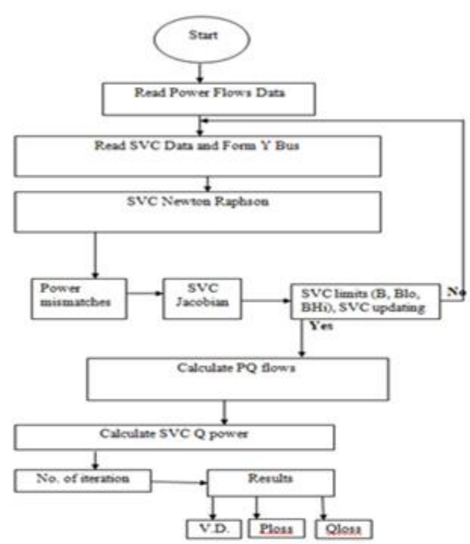
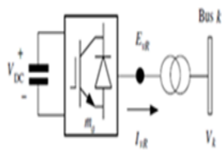
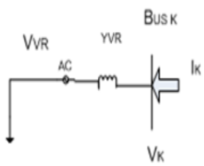


Figure 2.3 SVC Power flow solutions flow chart

The reactive power provision is independent from the actual voltage on the connection point is the advantage of STATCOM and for the maximum currents being independent of the voltage in comparison to the SVC in figure 3.0 (a) and (b).



(a) AC network via a shunt-connected transformer connected with Voltage source converter



(b) shunt connected solid-state voltage source

Figure.3.0 STATCOM system

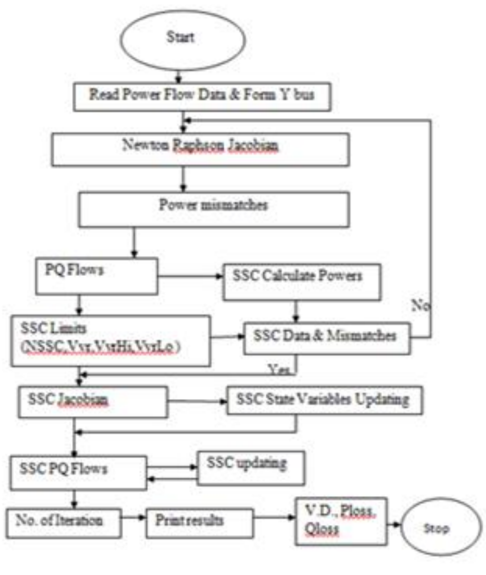


Figure 3.1 STATCOM Power flow chart

RESULTS AND DISCUSSION

Case 1: Without any FACTS device

Simulation of power flow data for IEEE 30 bus test system without FACTS devices the result obtained are shown in Table I.

Table I. Simulation results for variation of Power loss and Voltage deviation at IEEE 14 bus system without FACTS devices

System	P_{loss}	Q_{loss}	Voltage Deviation
IEEE 14 Bus	0.0731	0.10581	0.1851

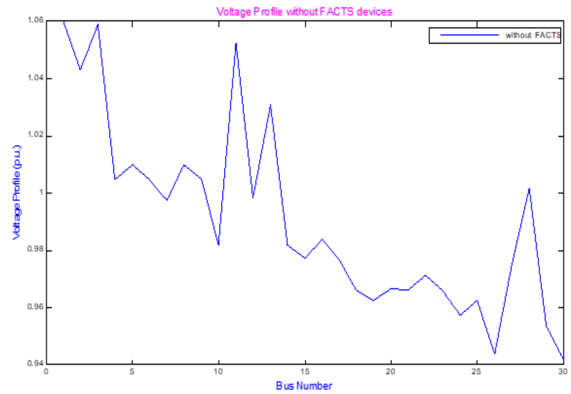


Figure 4.0 Voltage profile without FACTS devices

Case 2. With FACTS Devices

Simulation of power flow for IEEE 30 bus test system with various FACTS devices placement. The voltage profile improvement after placement of SVC is shown in fig.4.1

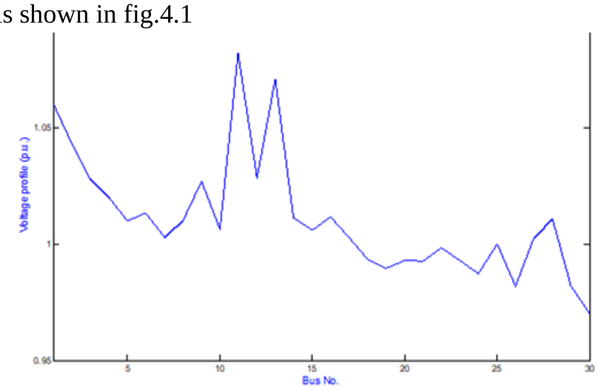


Figure 4.1. Voltage profile after SVC placement at buses

The real and reactive power loss before as well as after STATCOM placement at various load bus and the voltage deviation after STATCOM placement is shown in figure 4.2

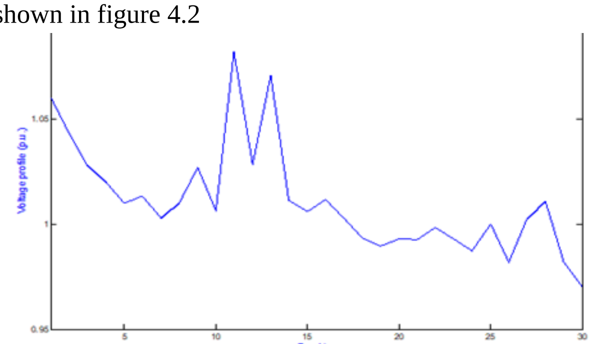


Figure 4.2 Voltage profile after STATCOM placement at various buses

CONCLUSIONS

The results of proposed method are obtained for various types of FACTS devices by their placement in IEEE 14 bus test system at all buses of the network to decrease real power loss, reactive power loss as well as improve the voltage magnitude.

It will be found that after placement of FACTS devices he power losses are reduced and voltage deviation is decreased at all buses. The real power loss saving in addition to voltage profile is improved after the placement of FACTS devices.

While comparing the results of optimal placement of FACTS devices the performance of STATCOM is better than SVC both are shunt connected FACTS device for minimize real power loss and voltage profile improvement.

REFERENCE

[1] Bhattacharyya B. and Kumar S., (2016), Vol. 10, Iss. 11, pp. 2802–2809, IET Generation Transmission & Distribution, "Approach for the solution of transmission congestion with multi-type FACTS devices".

[2] Ghahremani Esmaeil, Kamwa I., (2013), iet gtd0316,pp 1-17,IET Generation, Transmission & Distribution, ISSN 1751-8687, " Analyzing the effects of different types of FACTS devices on steady state performance of Hydro- Quebec network".

[3] Hingorani N.G., Gyugi L, IEEE press 2000, 'High Power Electronics and Flexible AC Transmission Systems', IEEE Power Engineering Review, Understanding FACTS: concept and technology of flexible AC transmission systems.

[4] Rahmat Allah H., Morshed M.J., Parastegari Moein, (2015), Vol.28, pp 57-68, Applied Soft Computing, Elsevier, " Congestion management by determining optimal location of series FACTS devices using bacterial forging and Nelder Mead algorithm".

[5] Rajasekar N, Sathiyasekar K., Senthilnathan N., Sarjila R., Edward J Belwin., (2013), Vol.52 622–628, ISA Transactions, ELSEVIER, "An enhanced bacterial foraging algorithm approach for optimal power flow problem including FACTS devices considering system loadability",.

[6] Ranganathan S., Kalavathi M. S., C. A. Rajan C., (2016), Vol. 10, Issue. 11, pp. 2576–2584, IET Generation, Transmission & Distribution, "Self-adaptive firefly algorithm based multi-objectives for multi-type FACTS placement.

[7] Mishra A., V. N. Kumar G. and Venkateswara Rao Bathina, (2016) April, Vol. 10, Iss. 10, pp. 2327–2335, IET Generation, Transmission & Distribution, real power performance index and line stability index-based management of contingency using firefly algorithm.

[8] Niazi K.R., Phadke A.R., Fozdar Manoj, (2012) Vol.40, pp 46, Electrical Power and Energy systems, "A new multi objective fuzzy GA formulation for optimal placement and sizing of shunt facts controller".

[9] Wadhwa C.L., (2010), pp. 591-717,New Age International publishers, sixth edition, ISBN No. 978-81-224-2839-1, "Electrical Power Systems".

[10] Y. Xiao, Y.H.Song, Y.Z.Sun, November 2002, Vol.17, No.4, IEEE transaction on Power system, "Power Flow control approach to power systems with embedded FACTS devices".