[Sharmila*, 5(1): January, 2016] ISSN: 2277-9655
(I2OR), Publication Impact Factor: 3.785

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

OPTIMAL LOCATION OF TCSC AND SVC DEVICES TO ENHANCE POWER SYSTEM SECURITY

D.Sharmila*, Dr.R.Medeswaran

PG Student Dept of power system engineering Thiagarajar College of Engineering Madurai, TamilNadu, India.

Assistant Professor Dept of Electrical Engineering Thiagarajar College of Engineering Madurai, TamilNadu, India.

ABSTRACT

Contingency analysis in power system security is an important tasks in emerging energy management systems. Contingency ranking using the performance index value is a method for the line outages in a system, which ranks the first highest performance index line and proceeds in a descending manner based on the calculated PI values for all the line outages. Contingencies results in voltage limit violations and overloading of lines. FACTS devices are used to enhance the security of power system by minimizing or eliminating the number of lines overloaded and violating the bus voltage limit. It is necessary to optimally locate these devices in the power system because of the high capital investment cost. In this paper, single contingency analysis for the considered test system has been performed, based on which the contingency ranking is done. Based on contingency ranking, locations of TCSC and SVC are chosen, and the effects of these FACTS devices after contingency condition have been studied. The effect of the proposed controller has been tested on Modified IEEE 30 bus system using MATPOWER 5.1.

.

KEYWORDS: Contingency analysis; TCSC; SVC; Modified IEEE 30 bus system.

INTRODUCTION

The ability of power system to operate in normal state even with occurrence of specified contingencies is called power system security [23]. Power system consists of more of electrical based devices and is a complex circuit network in itself. Failure in any of these devices during operating condition hampers the continuity of operation, security, safety and thus leads to line outages, thus take into security of power system. Thus power system security is a main part of power system. The most important aspect is evaluation of contingency, which leads to bus limit violations, transmission line overloads during the operating conditions. Critical contingencies must be identified firstly and fast to ensure secure, consistent and endless operation. As a key and main part of power system security, operational engineers need to study the effect of transmission line outages and contingency taking place power system in terms of severity.

Flexible Alternating Current Transmission System (FACTS) devices are solid-state converters [16] that have the capability of control of different electrical parameters in transmission circuits [10] [6]. FACTS devices contain Thyristor controlled series compensator (TCSC), static VAR compensator (SVC), unified power flow controller (UPFC), static compensator (STATCOM), etc. TCSC is connected in series with the transmission line conductor to reimburse for the inductive reactance of the line. The SVC can be made to generate or absorb reactive power by way of thyristor [12] controlled elements. These devices are controlling the power flows in the network helps in reducing the flows in heavily loaded lines, resulting increased system load ability, fewer system loss and enhance security of the system.

Optimal location of several types of FACTS devices in the power system has been attempted using Contingency analysis and ranking process determine the highest transmission line outage contingencies, considering transmission lines overloaded and bus voltage limit violations by means of a performance index, is performed. The best optimal location of FACTS devices in order to reduce the production cost along with the device's cost using performance index Contingency ranking using the performance index is a method for the transmission line outages in a power system, which line ranks the highest performance index value first and proceeds in a descending manner based on the calculated PI for all the line outages. This helps to take the precaution to keep the system secure. In the existing work the Newton Raphson load flow method [8] [5] is used for the power system contingency ranking for the line outage based on the performance index. The use of power flow solution in contingency analysis is that it gives active, reactive power flows and magnitudes of bus voltage. In power system contingency ranking approach, line outage case has been considered and the ranking is given based on the severity measured using the performance index. These indices are calculated using the load flow (Newton Raphson Method) for each contingency. Based on the performance index gained the contingencies are ranked with the highest value of PI. The highest value of PI got first rank. The FACTS devices such as TCSC and SVC located at which line has highest value of PI.

MODEL OF FACTS DEVICES

Objectives for optimal location of FACTS devices

1. Minimize the overloaded lines and excess power flow
2. Increase the power transfer capability.
3. Improvement in voltage level.
4. Reduce the transmission line severity

Model of TCSC

TCSC (Thyristor controlled series compensator) is the series connected FACTS device. In this FACTS device a capacitor is inserted directly in series with the transmission line to be compensated and a Thyristor-controlled inductor is coupled in parallel with the capacitor [14]

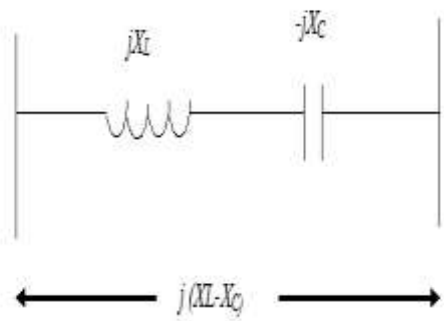

Fig 1.Model of TCSC

10 percentage of compensation means,

X_C = 10 percentage of X_L

Xnew = X_L – 10% of X_L

Xnew = X_L (1-0.1)

Xnew =0.9 X_L

Where

X_L - Transmission line reactance

Some of the advantages [19] of TCSC include:

1. It reduces the overloaded condition.
2. Improvement in voltage level.

Model of SVC

Static Var Compensator (SVC) [14] is a parallel 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

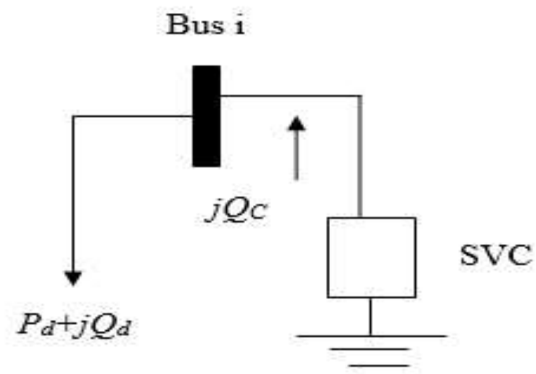

Fig 2. Before placing of SVC

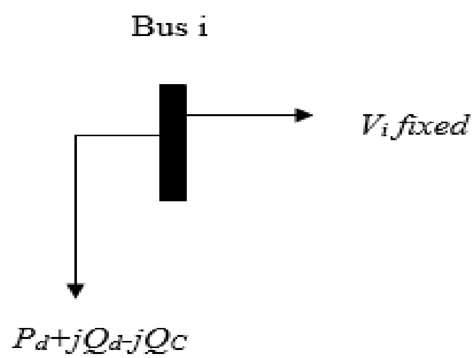

Fig 3. After placing of SVC

During low voltage at heavy load condition, SVC supplies reactive power and during high voltage at low load condition, SVC absorbs reactive power [10] [12]. When high voltage following an outage it absorbs reactive power and prevent overloaded condition, during low voltage following an outage it supplies reactive power and prevent the overloaded condition. When reactive power limit of the static var compensator varies from -100Mvar to 100Mvar.Some advantage of SVC as follows

1. It can regulate active and reactive power flow.
2. It reduce power losses and improve voltage profile.
3. It can remove transmission overloading.
4. It can improve the stability of the network and support the voltage.
5. It have fast and flexible control characteristics.
6. It possess continuous compensating capability.

PROBLEM FORMULATION

Different FACTS devices and their different location have varying advantages. The optimization of location of FACTS devices depends on the amount of local load, the location of the devices, their types, their sizes, improvement stability, the line loading and system initial operating conditions. There are several methods for finding optimal locations of FACTS devices. For optimal placement of TCSC, single line outage contingencies are simulated in the sample power system and to evaluate the severity of a contingency, Performance Index (PI) has been used.

Performance index

Performance index = $\sum_{i=1}^{NB} \frac{W_i}{2m}\left[\left|V_{inew} - V_{ibase}\right| / \Delta V_{i\lim}\right]^{2m}$

Where,

V_{inew} - voltage at after contingency

V_{ibase} - voltage at before contingency

Δ|Vilim| - value set by the utility engineers indicating how much they wish to limit a bus voltage from changing on outage case

W - Weighting factor =1

NB - number of buses.

m -Penalty function=1

FACTS devices constraints

1. $-0.8\, X_L \leq XTCSC \leq 0.5X_L$
2. -100 MVAR≤QSVC≤100MVAR

TCSC reactance are varies from -0.8 X_l to 0.5 X_l and reactive power of SVC varies from -100 MVAR to 100MVAR

RESULTS AND DISCUSSION

MATPOWER

MATPOWER is a simulation tool within MATLAB. It is simply to use and modify [15]. MATPOWER consists of a multitude of m-files, each of these designed for a different purpose. MATPOWER has a number of possibilities which can be changed by modifying the m-file. These options vary the performance and characteristics of MATPOWER to suit the needs of the user. The standard method used is Newton's method.

Modified IEEE 30 Bus System

The modified IEEE 30 bus [15] [23] system consists of 30 buses, 41 transmission lines. Slack bus is taken as a reference bus. Five generator buses such as 2, 13, 22, 23,27.load bus 3, 4,5,6,7,8,9,10,11,12,14,15,16,17,18,19,20,21,24,25,26,27,28,29,30. The contingency ranking is done in the order of their severities which uses the performance index (PI). The computation of performance indices are calculated based on the load flow analysis carried out using conventional method Newton Raphson method [8] under MATALB in MATPOWER environment

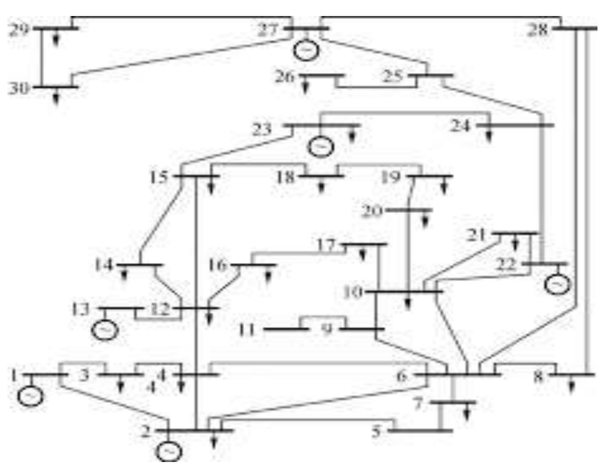

Fig 4. Modified IEEE 30 bus system

The solutions for optimal location of FACTS devices to minimize the severity of transmission line and improve the voltage level closer to 1 p.u. The simulation studies were carried MATPOWER environment. Test system is considered as a modified IEEE 30 bus system

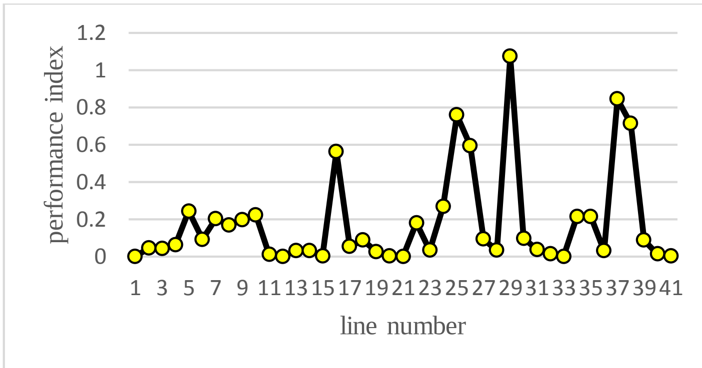

Fig 5. Contingency ranking before Placing of FACTS devices

Figure 5 shows that the transmission line 29 has highest performance index value and line number 29 got first rank. The transmission lines were arranged by descending manner corresponding to their performance index value

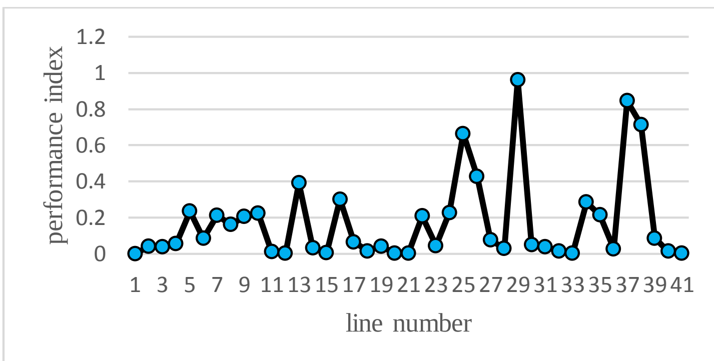

Fig 6. Contingency ranking after Placing of TCSC

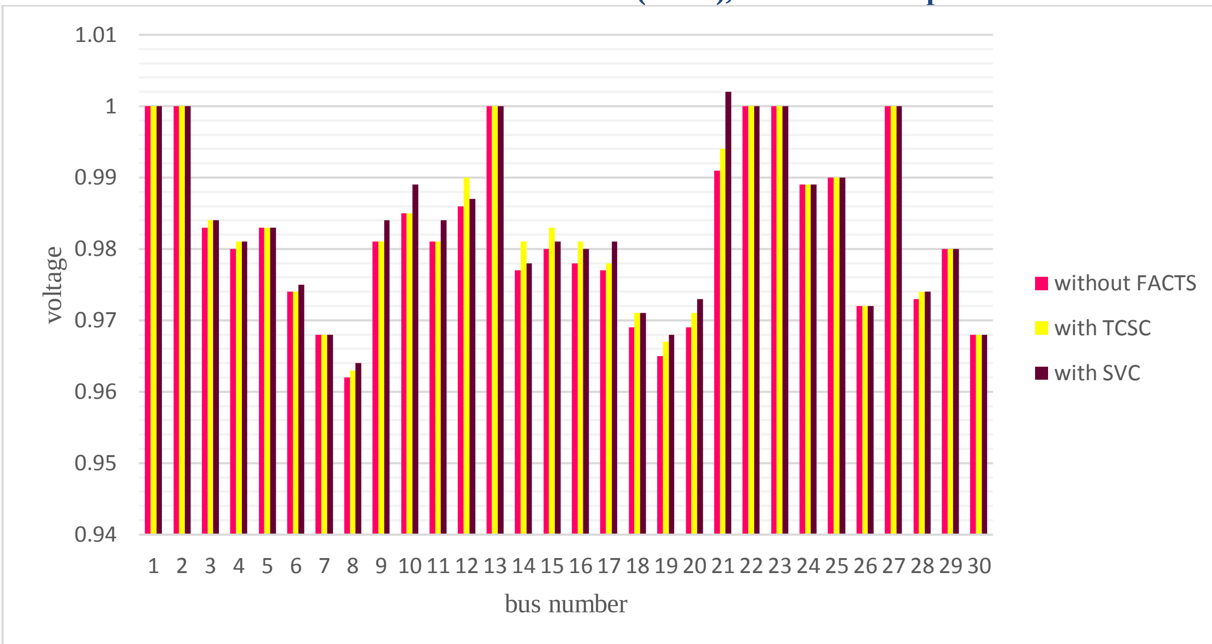

Fig 7. Bus voltage level of different FACTS devices

When TCSC had placed in rank 1, the performance index value little bit reduced and does not changes in voltage level. Then TCSC has placed in rank 2,3,4,5 there is no changes in PI value and voltage level. After the TCSC had placed in rank 6, the performance index value reduced to 0.961 in figure 6

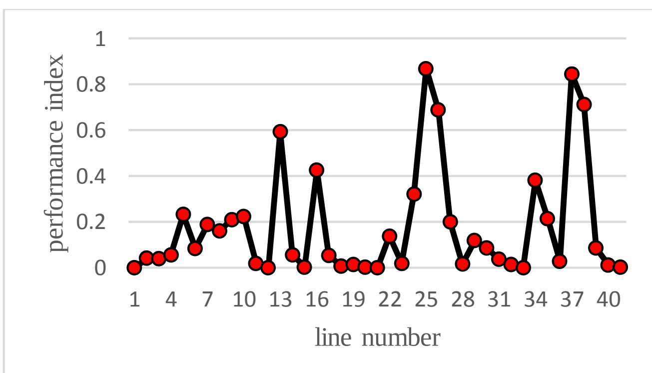

Fig 8. Contingency ranking after Placing of SVC

The line number 29 has connected between bus number 21 and 22.SVC is connected at bus only especially from bus. SVC is connected at bus 21. The highest PI value of the line number 29 was 1.0732 before placing the SVC device and this has been reduced to 0.8688 after placing the SVC in figure 6.

Figure 7 shows that voltage level for without FACTS, with TCSC, with SVC. TCSC is placed in line 16. The bus voltage has been improved in many number of buses. The voltage at bus number 12, 14, 16, 18, 20, 21 has been improved to 0.994 p.u from the value 0.991 p.u.

CONCLUSION

In this work**, s**ingle contingency analysis for the considered test system has been performed, based on which the contingency ranking is done. Based on contingency ranking, locations of TCSC and SVC are chosen, and the effects of these FACTS devices after contingency condition have been studied. Modified IEEE 30 bus system is considered as test system.

TCSC is placed in line 16. The highest PI value of the line number 29 was 1.0732 before placing the TCSC and this has been reduced to 0.961 after placing the FACTS devices. The bus voltage has been improved in many number of buses. The voltage at bus number 12, 14, 16, 18, 20, 21 has been improved to 0.994 p.u from the value 0.991 p.u SVC is connected at bus 21. The highest PI value of the line number 29 was 1.0732 before placing the SVC device and this has been reduced to 0.8688 after placing the SVC. The bus voltage has been improved in many number of buses. The voltage at bus number 16, 17, 18, 20, 21 has been improved to 1.002 p.u from the value 0.991 p.u.

The result exhibit the effectiveness of FACTS in terms of improved system voltage after contingency condition.

REFERENCES

[1] J. Achaea, M. Gitizadeh, M. Kanji "Placement and operation strategy of FACTS devices using optimal continuous power flow" Sciatica Ironical (2012) 19 (6), 1683–1690
[2] Ajilly Ann John, Tibin Joseph, Sasidharan Sreedharan, "Allocation of FACTS Devices For Congestion Relief Using Particle Swarm Optimization" International Journal of Engineering Research & Technology (IJERT) Vol. 2 Issue 8, August – 2013 ISSN: 2278-0181
[3] N.Ashok kumar M.Rathinakumar M.Yogesh J.Dinesh" Comparative Study on the Effectiveness of TCSC and UPFC FACTS Controllers" International Journal of Computer Applications (0975 – 8887) Volume 67– No.5, April 2013
[4] Ali Abdulwahhab Abdulrazzaq "Contingency ranking of power systems using a performance index" International Research Journal of Engineering and Technology Vol 02, Is. 2, May-2015
[5] Bindeshwar Singh, Abhiruchi Srivastava, Manisha," Applications of FACTS Controllers" Journal of Automation Engineering (8-1), 2014
[6] Gagmen Isa Rasheed, Yuan hang Sun by "Optimal Placement of Thermistor Controlled Series Compensation for Enhancing Power System Security Based on Computational Intelligence Techniques" Procedia Engineering 15 (2011) 908 – 914
[7] Gassan Abdullah Salman," Power System Security Improvement by Optimal Location of FACTS Devices" International Journal of Engineering Research & Technology ISSN: 2278-0181 Vol. 4 Issue 02, February-2015
[8] N. G. Hingorani, "Flexible AC transmission systems", IEEE Spectrum Vol. 30 pp. 40-45, April 1993.
[9] Kusum Arora, Dr. S.K. Agarwal , Dr. Narendra Kumar , Dharam Vir," Analysis of Power Flow Control in Power System Model using Thyristor Controlled Series Capacitor (TCSC)" International Journal of Engineering Research and Applications Vol. 3, Issue 3, May-Jun 2013, pp.821-826
[10] R.M. Mathur, R.K. Varma, "Thyristor Based FACTS Controllers for Electrical Transmission Systems", John Wiley & Sons Inc., 2002.
[11] K.Praveena kumari, V.Srikanth Babu "Optimal Location of STATCOM for Voltage Security Enhancement Using PSO" International Journal of Advanced Trends in Computer Science and Engineering, Vol.3, No.5, Pages: 72-76 (2014)
[12] Ranjit Kumar Bindal,"A Review of Benefits of FACTS Devices in Power system" International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249– 8958, Volume-3, Issue-4, April 2014
[13] Ray D. Zimmerman Carlos E. Murillo-Sanchez Matpower 5.1 User's Manual ,March 20, 2015
[14] M. Saravanan , S. Mary Raja Slochanal, P. Venkatesh, J. Prince Stephen Abraham," Application of particle swarm optimization technique for optimal location of FACTS devices considering cost of installation and system loadability", Electric Power Systems Research 77 (2007) 276–283
[15] G. Sasank Das, B. Mohan "Optimal Allocation of FACTS Device with Multiple Objectives Using Genetic Algorithm"International Journal of Modern Engineering Research (IJMER) Vol. 4, Is. 2, Feb. 2014, 162
[16] Shraddha Udgir, Sarika Varshney & Laxmi Srivastava "Optimal Placement and Sizing of SVC for Improving Voltage Profile of Power System" International Journal of Power System Operation and Energy Management, ISSN (PRINT): 2231–4407, Volume-1, Issue-2, 2011
[17] S.V Jethani, V.P. Rajderkar ," Sensitivity based optimal location of TCSC for improvement of power system security" International Journal of Research in Engineering and Technology Vol. 3, Issue 4, April 2014

[18] Mr. Vinod K. Shende, .P.P.Jagtap" Optimal Location and Sizing of Static Var compensator (SVC) by Particle Swarm Optimization (PSO) Technique for Voltage Stability Enhancement and Power Loss Minimization" International Journal of Engineering Trends and Technology" Volume4 Issue6 June 2013

[19] Vireshkumar G. Mathad, Basangouda F. Ronad Suresh H. Jangamshetti " Review on Comparison of FACTS controllers for Power System Stability Enhancement" International Journal of Scientific and Research Publications, Volume 3, Issue 3, March 2013

[20] ThanhLong Duong, Yao JianGang, VietAnh Truong "Application of min cut algorithm for optimal location of FACTS devices considering system loadability and cost of installation" Electrical Power and Energy Systems 63 (2014) 979–987

[21] P. S. Vaidya and V. P. Rajderkar "Enhancing Power System Security by Proper Placement of Thyristor Controlled Series Compensator (TCSC)" International Journal of Enginnering and Technology ,Vol.4, No.5,October 2012.