RESEARCH ARTICLE   OPEN ACCESS

Allocation of Svcs & Ipfcs in an Electrical Power System Using PSO

M.V.Ramesh, Dr. V.C. Veera Reddy
M.Tech Associate Professor,Dept, EEE Priyadarashini college of Engg & technology,Nellore, AP, India
PhD Professor & Head of the S.V.University,Tirupathi, AP, India

Abstract
The proposed method is used to place SVCs & IPFCs optimally in an electrical power system to reduce active power losses and as well as to improve voltage profile in different load and contingency conditions using Partial Swarm Optimization Technique. The simulations are performed on an IEEE 14-bus system and results are presented.
Keywords: SVC, IPFC, Different load, Contingency, Power loss, Voltage profile, PSO, IEEE 14 bus.

I.   Introduction

The main objective of an electrical engineer is to generate, transmit, and distribute power at rated voltage and rated frequency. In generally, the load is uncertain. Hence, voltage and power are violating the limits. This can be overcome by using different type of techniques such as generator voltages, transformer taps, fixed capacitor and reactive power distribution. In this paper, reactive power distribution is provided using different types of power electronic based FACTS devices.

In previews, the research engineers are found an optimal location of FACTS devices like SVC, TCSC, and UPFC at different load conditions [1,3, 4].

In this paper, a new research method is implemented on an optimal location of SVC and IPFC in normal and as well as contingency conditions.

In normal operating conditions, the power system losses are the minimum and voltages are prescribed limits. The power system may be collapse due to the following reasons such as outage of a generating unit or of a line, sudden increasing or decreasing of the power demand. Most of the times, the system may remains as it original state i.e. within the limitations of voltage & power. But sometimes, it does not become to its original state i.e. its limits are violating. This phenomenon is called contingency.

In recent decades, different types of biological optimization techniques like GA, PSO, AC, EP etc are implemented. In this research, PSO technique is used to optimal location of devices. The simulations are performed on a modified IEEE 14 bus system and results are presented at different contingency conditions.

Problem Formulation: The power flow through any transmission line can be obtained by using the equation

$$P_{ij} = \frac{\left(V_i V_j \sin \theta_{ij} \right)}{X_{ij}}$$

$$Q_{ij} = \frac{V_i \left(V_i - V_j \cos \theta_{ij} \right)}{X_{ij}}$$

Where
P_{ij} is the active power flow through the transmission line from i to j
Q_{ij} is the reactive power flow through the transmission line from i to j
V_i & V_j are the bus voltage magnitudes
X_{ij} is the reactance of the transmission line
θ_{ij} is the phase angle between i and j buses.

The power flow through the transmission line can be controlled by changing any one of the above mentioned parameters using different types of FACTS devices. In this paper two types of FACTS devices are used one is SVC, and other is IPFC.

Mathematical models of FACTS devices: The main aim of this objective is to perform a best utilization of the existing transmission lines in normal and contingency conditions by an optimal location of FACTS devices in a network.

Static VAR Compensator: The Static VAR compensator is a shunt type of FACTS devices, which absorbs or injects reactive power at which it is connected. The size of the SVC is depends on the rating of current and reactive power injected into the bus.
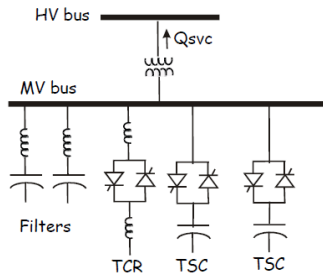
Fig: Circuit Diagram of Static VAR Compensator

II. INTERLINE POWER FLOW CONTROLLER

The IPFC is a series-series type of FACTS device, which is used to exchange reactive powers in between two or more transmission lines those are connected to the same bus.
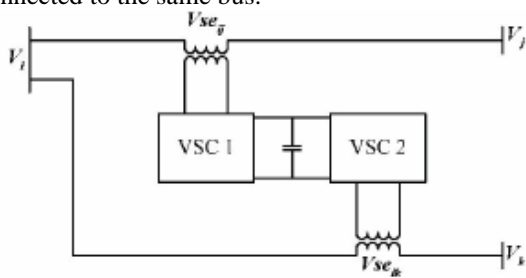

Fig: Schematic diagram of two converter IPFC

Algorithm: The step by step procedure for the proposed optimal placement of SVC and IPFC devices using PSO is given below:
Step 1: The number of devices to be placed is declared. The load flow is performed.
Step 2: The initial population of individuals is created satisfying the SVC & IPFC constraints.
Step 3: For each individual in the population, the fitness function is evaluated after running the load flow.
Step 4: The velocity is updated and new population is created.
Step 5: If maximum iteration number is reached, then go to next step else go to step 3.
Step 6: Print the best results.
Step 7: stop.

III. A CASE STUDY

The PSO based optimal location of SVC & IPFC devices was implemented at contingency conditions using MATLAB 7.5. Here the modified IEEE 14-bus system was tested.
. The following parameters are used for PSO based optimal location of FACTS devices.
- Population =50
- Maximum iterations=50
- Wmax=0.9 and Wmin=0.4
- Acceleration constants C1=1.4 and C2=1.4

The type of the device, the location and rating of the devices are found in normal, different load and contingency conditions. The results are presented in two cases.
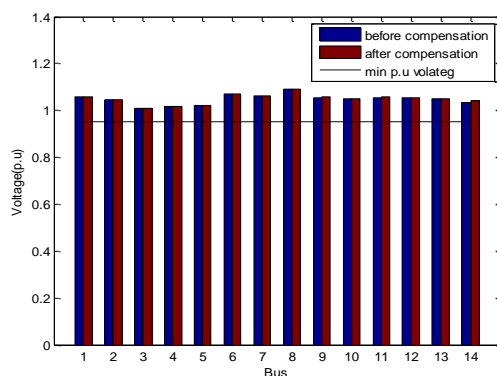
Case 1: Optimal location of SVCs:

Loading condition	Real power Losses without SVC (MW)	Loc. of SVC	Ratin g of SVC (MV AR)	Real power Losses with SVC (MW)
Normal loading	13.393	5 14	5.560 7 5.623 7	13.316
125% loading	22.636	5 14	15.52 5 9.073 8	22.061
150% loading	35.011	5 14	32.79 9 8.412 4	33.894
175% loading	51.295	5 14	56.44 6 8.227 3	49.217
Contingenc y (12-13)	13.401	5 14	5.578 7 6.232 8	13.321

Case 2: Optimal location of SVCs & IPFCs:

Loadi -ng condit ion	Real power Losse s (MW)	Loc . of SV C	Ratin g of SVC	Loc. of IPF C	Ratin g of IPFC (MV AR)	Real power losses with SVC & IPFC (MW)
Norm al loadin g	13.39 3	5 14	4.641 4 3.037 9	2-4 & 2-5	10.88 6	13.09 6
125% loadin g	22.63 6	5 14	13.88 11.39	2-4 & 2-5	17.63 2	21.68 5
150% loadin g	35.01 1	5 14	33.60 11.71	2-4 & 2-5	18.25 1	33.50 6
175% loadin g	51.29 5	5 14	28.97 15.20	2-4 & 2-5	17.69 0	49.60 6
Conti ng-ency (12-13)	13.40 1 (12-13)	5 14	0.856 3.823	2-4 & 2-5	11.85 2	13.10 8

Voltages profile in normal conditions:

Bus no	Before compensation Voltage (p.u)	Case 1 Voltage (p.u)	Case 2 Voltage (p.u)
1	1.0600	1.0600	1.0600
2	1.0450	1.0450	1.0450
3	1.0100	1.0100	1.0100
4	1.0183	1.0202	1.0192
5	1.0200	1.0227	1.0213
6	1.0700	1.0700	1.0700
7	1.0608	1.0633	1.0621
8	1.0900	1.0900	1.0900
9	1.0541	1.0583	1.0563
10	1.0495	1.0530	1.0513
11	1.0561	1.0579	1.0570
12	1.0550	1.0565	1.0558
13	1.0501	1.0528	1.0516
14	1.0343	1.0462	1.0407

By comparing the above cases, the total power losses of the system are reduced and voltage profiles are improved by the optimal location of FACTS devices.

IV.   Conclusion

In this paper, the optimal location of IPFC and SVC are studied at normal, different overload, contingency conditions and various parameters such as voltage profile and real and reactive power flow in transmission lines are investigated using PSO.

In this paper, we have proposed a PSO algorithm to place a combination of both SVC and IPFC devices. The future scope of this paper is a complete cost benefit analysis has to be carried out to justify the economic viability of the SVC and IPFC using different combination of optimization techniques.

References

[1]   S.Gerbex, R.cherkaoui, and A.J.Germond, "Optimal Allocation of FACTS Devices by Using Multi-Objective Optimal Power Flow and Genetic Algorithms". IEEE trans.power system, vol.16, pp.537-544, August 2001.

[2].   M.V.Ramesh, Dr. V.C. Veera Reddy " Optimal Allocationof FACTS Devices in Different Over Load Conditions" International Journal of Electrical Engineering & Technology, volume 4, issue 1, Jan-Feb 2013, pp-208-222.

[3]   L.J.Cai, I.Erlich, G.Stamtsis "Optimal Choice and Allocation of FACTS Devices in Deregulated Electricity Market using Genetic Algorithms" IEEE transactions on 2004.

[4]   H.R.Bahaee, M.Jannati, B.Vahidi, S.H.Hosseinnian, H.Rastager: Improvement of voltage stability and reduce power system losses by optimal GA-base allocation of Multi-Type FACTS devices. The 11th international IEEE conference on May 2008,OPTIM 2008.

[5]   K.Sundareswaran, P.Bharathram, M.siddharth, Vaishavi.G, Nitin Anand Srivastava, Harish Sharma: Voltage Profile enhancement through optimal placement of FACTS devices using Queen Bee Assisted GA. The 3rd international conference on power systems, Kharagapur, December 2009.

[6]   S Teerathana, A. Yokoyama, "An Optimal Power Flow Control Method of Power System using Interline Power Flow Controller (IPFC)", IEEE Transactions on Power Delivery, Vol. 23,pp. 343-346, Aug. 2004.

[7]   P. Subburaj, N. Sudha, K. Rajeswari, K. Ramar,and L. Ganesan, "Optimum Reactive Power Dispatch Using Genetic Algorithm," Academic Open Internet Journal, Vol.21, 2007, p6

[8]   B.Geethalakshmi, T. Hajmunisa and P. Dhananjayan, "Dynamic characteristics analysis of SSSC based on 48 pulse inverter", The 8th International Power Engineering Conference (IPEC) pp. 550-554, May 2007.

[9].   A.V.Naresh Babu, S.Sivanagaraju, Ch.Padmanabharaju and T.Ramana "Multi-Line Power Flow Control using Interline Power Flow Controller (IPFC) in Power" Transmission Systems International Journal of Electrical and Electronics Engineering 4:7 2010

Authors:

M.V.Ramesh: B.Tech(EEE) from S.V.H.College of Engineering, Machilipatnam in 2000. M.Tech in Power Electronics from J.N.T. University, Hyderabad (Autonomous) in 2005. Pursuing PhD in J.N.T. University, Hyderabad.

Dr. V.C.Veera Reddy: B.Tech(EEE) from J.N.T. University in 1979. M.Tech in power systems & operation control from S.V. University in 1981. Completed PhD from S.V. University in 1999.