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ORIGINAL ARTICLES

IPFC Using For The Congestion Management Lines In Electricity Market Restructured On The System Ieee 14-Bus

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ABSTRACT

In this paper, location optimal IPFC for congestion management market power transmission lines is used. For Placement Optimization IPFC, PSO algorithm and genetic algorithm is used. A simulation on the system IEEE 14 bus has been done and the results are compared. Simulations have been conducted in three stages. First, regardless of IPFC simulation has been done and secondly Placement IPFC with genetic algorithm has been done and the third stage Placement IPFC with PSO algorithm has been done.

Key words: location optimization, Genetic, congestion management, IPFC, PSO

Introduction

Transmission congestion, when overload occurs in transmission lines, appears. In traditional systems, the system operator is aware of the production cost per unit. And the operator was using the optimal power flow for power distribution. The restructuring of power systems, with separate Production, transmission and distribution congestion management is difficult and complex. Transmission congestion management, system security is maintained and Take advantage of the network reaches its maximum value. To achieve this goal, several methods are presented And include that the contract path method and critical factors, and cost transfer pricing method, method of using FACTS devices, etc.

Restructuring of power systems in many countries following income had an important and has led to the use of common equipment to be more FACTS day. Since the power transmission network limitations essentially controlled flow removable or network is reduced, so use of these elements density for the management seems very useful. The application issues FACTS, a place for the true and accurate to maximize profits FACTS expensive equipment and management is optimum density lines.

The most important studies done in the field of FACTS devices for the management, density, IPFC can be used in different ways to manage the density. These methods based on market and generally are used in Europe. Based method, divided into geographic market and the use of FACTS elements between areas divided according to specific methods of density management. These methods include using mutual exchange, share market and auction market in the border area between the two is dense. But the most important issues in these field placement FACTS devices are optimized (H. Barati, *et al*., 2006; A. Kazemi, R. Sharifi, *et al*., 2006). Placement for problem solving many optimization methods FACTS devices such as linear and nonlinear programming, neural networks, fuzzy logic, steel plating and intelligent algorithms are used. Intelligent algorithms such as genetic algorithms (M. Saguan, *et al*., 2004; K. Reddy, *et al*., 2006) and PSO algorithm due to the inherent characteristics of natural and simple to understand, be understood, using knowledge of human and living, etc. them to make appropriate problem solving discussion. The fact that, IPFC the most important and most widely used FACTS devices considered goes (Z.X. Chen, *et al*., 2005; M. Saravanan, S. Mary Raja Slochanal, 2006). This article placement optimal IPFC using PSO algorithm and genetic algorithm on the system IEEE 14 bus (R. D. Zimmermann, D. Gan, 2005) Transmission congestion management for power systems restructured is used.

Algorithm Method Birds community:

Birds in the community position algorithm to record the motion of particles and their neighbors will change. Each particle is a position that we show with $\vec{x}_i(t)$ Shows that this position P_i st particle is the time t. In this algorithm each particle addition to the speed of a location is required:

$$\vec{v}_i(t) = \vec{x}_i(t) - \vec{x}_i(t-1) \quad (1)$$

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Algorithm community with a group of birds random answers to start, then answer the problem by optimization problem with space to make deals to search generations. Each particle as multidimensional with two values that x_{id} and v_{id} respectively Referrals location and speed to the situation after d_{st} of my i are particle is defined.

At each stage of the population moves every particle with two values is the best to date. The first value, the best answer so far is in terms of competence for each particle separately obtained and this value is called p_best . Another best value by the algorithm is obtained social birds; the best value so far by all particles in the population has obtained the best overall value and g_best is called. After p_best and g_best by the amount and speed of each particle according to its new location in relationship to that:

$$v_{id}(t+1) = w.v_{id}(t) + c_1.rand(p\_best_{id} - x_{id}) + c_2.rand(g\_best_d - x_{id}) \quad (2)$$

$$x_{id}(t+1) = x_{id}(t) + v_{id}(t+1) \quad (3)$$

Top w in the relationship, weight, c_1 and c_2 factors, learning, and $rand$ a random number in the range (1, 0) is. To prevent algorithm divergence, the final value of each particle velocity is limited.

$$v_{id} \in [-v_{\max}\ , v_{\min}] \quad (4)$$

w, c_1 and c_2 of the algorithm parameters are social birds. And convergence is dependent value for this parameter. Here, the procedure is usually equal to c_1 and c_2 and the number 2.05 is assumed. Convergence strongly depends on the amount of w is better dynamic and must be defined. Thus, the linear trend in the evolution of population 0.4 to 0.9 decreases. Initially this number must be large as possible by good answers to provide early and late stages Small w causes a better convergence. This reduction in the related form can be defined.

$$w = w_{\max} - \frac{w_{\max} - w_{\min}}{iter_{\max}} \times iter \quad (5)$$

This algorithm is the corresponding topology on. In this algorithm each particle movement relying on its experience and knowledge of all other particles is performed. Therefore, it is clear that the integrity of the community is many and complete communication is established between the particles.

The algorithm steps are:

1 - Basic population is formed randomly.

2 - Determine the competence of particles with their present position.

3 - Comparison of current competence and the best experiences of particles and their necessary replacement.

4 - Comparison of current competence of each particle's best previous result of all particles.

5 - Set the speed vector for each particle using the relationship 2.

6 - Move with their new positions related to particle 3.

7 - Return to step 2 and repeat the algorithm to reach convergence.

Genetic algorithm:

A genetic algorithm GA searches technique in computer science to find the optimal solution and search problems. Genetic algorithms, evolutionary algorithms are one of the types of biological science such as inheritance, mutation, selection of sudden, natural selection and composition is inspired. Genetic algorithms on a set of solutions called the population, will work. A crowd of people, which are strings of numbers are called chromosomes, and contains information encoded parameters have to decide. Typically, 30 to 100 people including the person that in some matters, the number to about 10 individuals are also used. At the beginning of solving several random features to create the first generation are produced. During each generation, each attribute is evaluated fitness value (fitness) is measured by the fitness function. The next step is to create a second generation of community-based selection processes, production of selected characteristics on the genetic operators are: connecting chromosomes to each other and change over.

For each person, a parent pair is selected. Preferences are such that the appropriate elements to be selected, even the weakest elements also have the chance to choose from approaching the local response prevents. Connection creates two child chromosomes, which are added to the next generation. The next step is to change the new offspring. Genetic algorithms and prove a possibility that a small change. The degree of probability with the show P_m . P_m rates reflect mutations or mutations that is likely based on the number of mutant genes obtained. Based on this possibility, child chromosomes are randomly changed or find a mutation. This process led to a new generation of chromosomes is such that the previous generation is different. The whole process

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repeats for the next generation is, pairs are selected for the composition, the third generation of the population comes into existence and the process is repeated until we reach the last stage. Genetic algorithms for better convergence in the values of the parameters are set as follows.
popsize=30, maxgen=200, Pc=0.97, Pm=0.08

Parameter of genetic algorithm to converge more and better results as a table is set.

Table 1: Values of genetic parameters

Parameter	Value
Total Population	20
The number of repeat	1000
C_1	2
C_2	2
w	0.4-0.9
r_1	0-1
r_2	0-1

The proposed method problem solving:

FACTS devices include installation has two stages. First location in the network equipment should be specified and then control the device parameters for the desired goal should be optimal. Method first proposed standard system IEEE 14 bus to test on it and share the load chosen regardless of UPFC on the values and passing power lines we calculated. Then the effect of IPFC in all different places, IPFC based on the desired sensitivity Replacement and doing calculations, density lines with and without IPFC gain. Calculations performed with IPFC Replacement in many different places and with PSO algorithm and genetic algorithm continued and finally the most optimal location of IPFC installation, we manage specific density.

To determine the best relationship 6 is a multiple function and define it as we choose the objective function. Therefore, the aim of obtaining the minimum objective function and the implementation of the algorithm is to remove congestion.In this regard, V_i, $\cos t$, $loss$ and TCC, respectively, bus voltage, the production cost, total mortality is density and cost. Coefficients α, β and γ coefficients also are coordinating with the $\cos t$ so:

$\alpha = 36000,\ \beta = 900,\ \gamma = 16$

$$f = \alpha \sum_{i=2}^{i=14} \left| (1.05 - V_i) - (0.95 - V_i) \right| + \cos t + \beta.loss + \gamma.TCC \tag{6}$$

$$C_i = \sum_{i=1}^{N_g} C_{gi}.P_{gi} \tag{7}$$

$$TCC = \sum_{i-1}^{Nb} P_i^D \lambda_i - \sum_{i=1}^{Nb} P_i^G \lambda_i \tag{8}$$

Ties 7 and 8 respectively to relations of production and total cost of congestion costs are [1]. In addition to the above relations, limitations and constraints related to the bus voltage and active power productions as well as nine are defined relationship.

$$P_{gi}^{\min} \le P_{gi} \le P_{gi}^{\max}\ ,\ V_i^{\min} \le V_i \le V_i^{\max} \tag{9}$$

The constraints and limitations of the IPFC control parameters are considered as follows:

$$\begin{aligned} V_{se1}^{\min} \le V_{se1} \le V_{se1}^{\max} \quad &, \quad \delta_{se1}^{\min} \le \delta_{se1} \le \delta_{se1}^{\max} \\ V_{se2}^{\min} \le V_{se2} \le V_{se2}^{\max} \quad &, \quad \delta_{se2}^{\min} \le \delta_{se2} \le \delta_{se2}^{\max} \end{aligned} \tag{10}$$

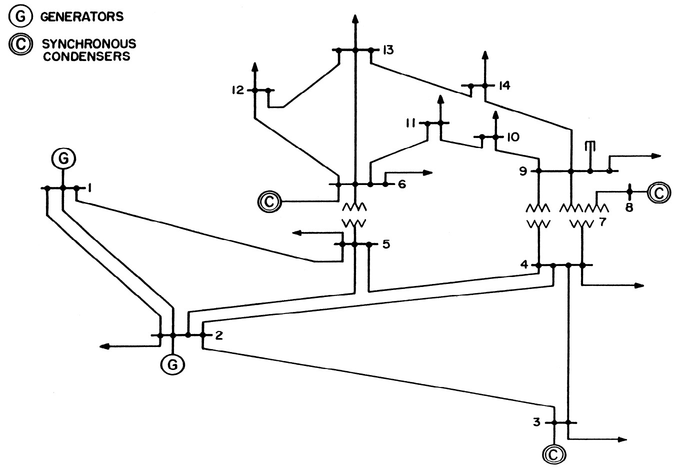

Fig. 1: Sample system used (IEEE 14 bus)

IPFC model used in the algorithm implementation:

IPFC combinations of two or more static synchronous series, which is compensated by a dc interface pair are together, the real power flow between the terminals of the SSSC are easy.

Independent control of reactive power to compensate for real power flow in each line, and set the optimal distribution of the lines is preserved. Figure 2 Schematic IPFC, based on two VSC converters and interface with a DC voltage that a capacitor can be shown (J. Zhang, A. Yokoyama, 2006). Injection model of IPFC is shown in Figure 3 can be used extensively in research and studies on the impact of the IPFC is in the system. Therefore this model to simulate the performance of the algorithm is used (N. Hingorani, and L. Gyugyi, 1999).

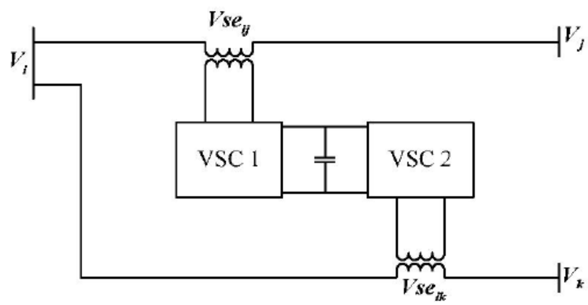

Fig. 2: Schematic IPFC with two converters

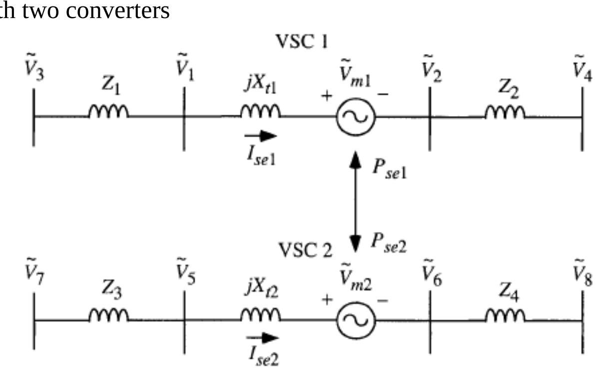

Fig. 3: Power injection model of IPFC

In the analysis of power systems is usually lines are simulations with the model π. Circuit transmission lines with IPFC are shown in Figure 4. Also in Figure 5, the injection lines embedded with IPFC is shown (Gyugi, K.K. Sen, C.D. Schauder, 1999).

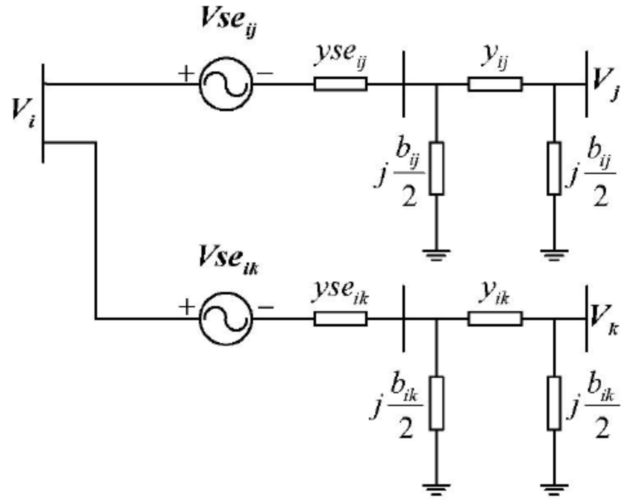

Fig. 4: Equivalent circuit transmission lines with IPFC

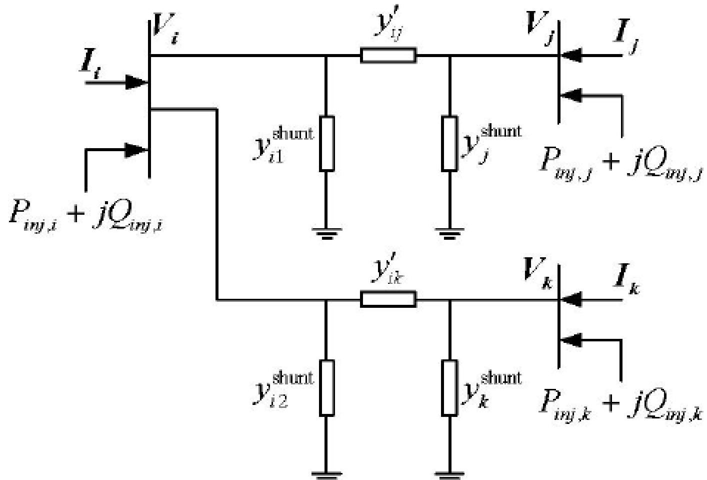

Fig. 5: The injection lines Transmission with IPFC

Relations used in the model according to Figure 3 are:

$$P_{sh} = -V_i V_{sh} \sin(\theta_i - \delta_{sh}) / X_{t1} \tag{11}$$

$$Q_{sh} = V_i (V_{sh} \cos(\theta_i - \delta_{sh}) - V_i) / X_{t1} \tag{12}$$

$$P_{to} = V_j (V_{se} \sin(\theta_j - \delta_{se}) - V_i \sin(\theta_j - \theta_i)) / X_{t2} \tag{13}$$

$$Q_{to} = -V_j (V_j - V_i \cos(\theta_j - \theta_i)) + V_{se} \cos(\theta_j - \delta_{se}) / X_{t2} \tag{14}$$

On the linear series voltage sources are connected to it, be active and reactive to reach the second bus, from 15 to 18 are achieved through relationships (X. Wei, 2004).

$$P_{to1} = V_2 (V_{m1} \sin(\theta_2 - \alpha_1) - V_1 \sin(\theta_2 - \theta_1)) / X_{t1} \tag{15}$$

$$Q_{to1} = -V_2 (V_2 - V_1 \cos(\theta_2 - \theta_1) + V_{m1} \cos(\theta_2 - \alpha_1)) / X_{t1} \tag{16}$$

$$P_{to2} = V_6 (V_{m2} \sin(\theta_6 - \alpha_2) - V_5 \sin(\theta_6 - \theta_5)) / X_{t2} \tag{17}$$

$$Q_{to2} = -V_6 (V_6 - V_5 \cos(\theta_6 - \theta_5) + V_{m2} \cos(\theta_6 - \alpha_6)) / X_{t2} \tag{18}$$

Any population structure in the implementation of the PSO algorithm is shown in Figure 6. Based on the length of a population that is 7 Location IPFC placement represent and also show parameters IPFC.

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bus_i	bus_{j1}	bus_{j2}	V_{se1}	V_{se2}	δ_{se1}	δ_{se2}

Fig. 6: Structure of each population

LMP in the calculation to this point is that the buses that the generator is installed if the cost is $P^{\min}\langle P\langle P^{\max}$ generators operating in the proposed set of LMP but when $P \geq P^{\max}$ or $P \leq P^{\min}$ is LMP is determined by the system.

Now considering the above relations, distribution of samples on the system and results based on the power lines crossing between then obtained by considering the density values using the PSO algorithm and genetic algorithm, placement optimal IPFC and optimized for playback on obtaining the best location of IPFC in terms of density delete lines continued.

Results and discussions on the system studied:

Method presented in three cases has been reviewed:

In the first case: the system without IPFC and the line density isn't limited.

Second case: In this mode density limit for 80MW lines there. Using genetic algorithms and positioning IPFC, problem is solved.

Third case: In this mode density limit for 80MW lines there. Using PSO algorithms and positioning IPFC, problem is solved.

Cost function coefficients and proposed sale of energy is shown in Table 2. Value of each generator power production is given in Table 3 is noted as being expensive because of any purchase of generator 6 has been done. in Table 4 and the IPFC and linear parameters which must be exposed is shown, LMP values in Table 5 for all buses is given, in Table 6 of the algorithm implemented general information shown is.

In Figure 7 the convergence rate between the two algorithms has been compared. This comparison shows that the convergence rate PSO algorithm is higher than the genetic algorithm. Also Figure 7 shows the value of the objective function in the PSO algorithm is less than the genetic algorithm.

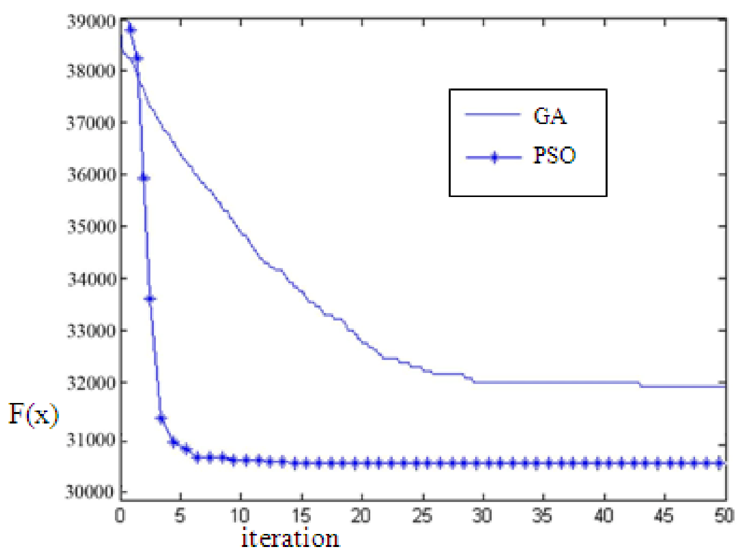

Fig. 7: Comparison of convergence rate between PSO algorithm and SWSO algorithm

Table 2: Cost function coefficients and proposed energy sales

Bus No.	α	β	γ	Bid ($/MWh)	P_{max}	P_{min}
1	0	20	0.04743	36	332	0
2	0	20	0.2391	36	140	0
3	0	35.4	0.037	38	100	0
6	0	40	0.02	60	100	0
8	0	35	0.03	40	100	0

Table 3: The rate of production power generators

Bus No.	The active powers generators in case 1	The active powers generators in case 2	The active powers generators in case 3
1	194.33	193.75	190.64
2	36.72	36.60	36.70
3	28.74	29.60	29.42
6	0	0	0
8	8.5	8.5	8.45

Table 4: parameters UPFC

algorithm	GA	PSO
IPFC installed	Line 2-4 & 2-1	Line 2-4 & 2-1
V_{se1}	0.39	0.23
V_{se2}	0.19	0.14
δ_{se1}	86	35
δ_{se}	77	76

Table 5: values of Location marginal price (LMP)

Bus No.	LMP in case 1	LMP in case 2	LMP in case 3
1	35	35	35
2	36	36	36
3	38	38	38
4	40.190	40.102	37.15
5	39.661	39.156	38.023
6	39.734	38.75	36.40
7	40.172	39.77	37.14
8	40	40	40
9	40.166	38.566	37.291
10	40.318	39.298	37.198
11	40.155	38.720	38.02
12	40.379	38.625	38.11
13	40.575	39.021	37.212
14	40.198	39.229	38.012

Table 6: General Information results from algorithm implementation

General Information	Case 1	Case 2	Case 3
Total loss (MW)	9.255	8.452	6.198
Total generation (MW)	268.255	268.45	265.21
Total charge congestion ($/h)	527	359.86	329
Total cost of active power ($/h)	8081.1	8029.6	7694.39
Numeric value objective function	32120	31825	30947
Power flow in line 1-2 (MW)	129.524	79.39	78.441

According to Table 6, the density in the 2-1 line in both algorithms is the amount of less than 80 MW, which relieve congestion on the line shows. Power transmission in others lines is normal. Total cost congestion charge mode 2, 359 Dollars per hour now and in the case of 3, 329 Dollars per hour is achieved. The total cost of production in Mode 2 is set at 8029 $/h but this amount in case 3, the 7694 $/h is obtained. So the PSO algorithm shows good performance and increase social welfare. The Numeric value objective function, in case 2 of 31825 to 30947 in the third mode is reduced. In accordance with Table 5, the LMP of case 3, compared to modes 1 and 2 is reduced and the same building. It also shows that increases in social welfare. The best location IPFC in both algorithms lines 2-4 and 2-1 has been set.

Conclusion:

Results for the three cases studied show that the PSO algorithm to solve the genetic algorithm and increased density has better social welfare. The results also indicate that the convergence speed of PSO algorithm is higher than the genetic algorithm.

As a result, the congestion management method using FACTS devices, despite being expensive, these elements, given that the optimal use of these elements in terms of what type of equipment used and what the best location in terms of installation, eventually reduced cost to the consumer is. So it seems that the use of IPFC and the PSO algorithm for fast convergence to more congestion management costs and reduce production cost and density compared to other similar methods including genetic algorithm is more priority.

Refrences

Barati, H., M. Ehsan, M. Fotuhi-Firuzabad, 2006. "Location of Unified Power Flow Controller and its Parameters setting for Congestion Management in Pool Market Model using Genetic Algorithm", Power Electronics, Drives and Energy Systems, International Conference on, 1-7: 12-15.

Chen, Z.X., L.Z. Zhang, J. Shu, 2005. "Congestion Management Based on Particle Swarm Optimization", Power Engineering Conference, The 7th International, 2: 1019-1023.

Gyugi, K.K,.C.D. Sen, Schauder, 1999. “The Interline Power Flow Controller concept: a new approach to power flow management in transmission system”, IEEE Trans. on Power Delivery, 4(3): 1115-1123.

Hingorani, N. and L. Gyugyi, 1999. "Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems", Wiley-IEEE.

Kazemi, A., R. Sharifi, 2006. "Optimal Location of Thyristor Controlled Phase Shifter in Restructured Power Systems by Congestion Management", Industrial Technology, 2006. ICIT 2006. IEEE International Conference on, 294-298: 15-17.

Reddy, K., S. Reddy, N. Prasad Padhy, R.N. Patel, 2006. "Congestion Management in Deregulated Power System using FACTS Devices", Power India Conference, IEEE, 8: 10-12.

Saguan, M., S. Plumel, P. Dessante, J. M. Glachant, P. Bastard, 2004. "Genetic Algorithm Associated to Game Theory in Congestion Management", 8th International Conference on Probabilistic Methods Applied to Power Systems, Iowa State University, Ames, Iowa, 12-16.

Saravanan, M., S. Mary Raja Slochanal, 2006. “Application of particle swarm optimization technique for optimal location of FACTS devices considering cost of installation and system loadability”, Elsevier B.V., 77: 276-283.

Wei, X., 2004. “Voltage-Sourced converter based FACTS controllers, modeling, dispatch computation, and control”, A Thesis Submitted to Graduate, Faculty of Rensselaer Polytechnic Institute in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy, pp: 8-13.

Zhang, J., A. Yokoyama, 2006. “Optimal Power Flow Control for Congestion Management by Interline Power Flow Controller (IPFC)”, IEEE International Conference on Power System Technology, pp: 1-6.

Zimmermann, R.D., D. Gan, 2005. “Matpower a LAB power system simulation package”, User’s Manual, Version 3.0.