IJCRT.ORG ISSN : 2320-2882
INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)
An International Open Access, Peer-reviewed, Refereed Journal

ECONOMIC LOAD DISPATCH USING HYBRID PARTICLE SWARM OPTIMIZATION

Parul Pandey[1], Dr. K.T. Chaturvedi[2]
[1] *Department of Electrical Engineering, University Institute of Technology, RGPV Bhopal (M.P.)*
[2] *Associate Professor, Department of Electrical Engineering, University Institute of Technology, RGPV Bhopal (M.P.)*

Abstract - In recent years, generation cost and fuel emission have been essential to minimize to sustain on the planet. Fossil fuel has been enormously utilized for power generation for a long time. It is required to manage the demand of customer and efficiently utilize the fossil fuels. The economic load dispatch problem has been considered to solve the crisis of conventional energy resources. So here, a novel stochastic optimization approach to solve constrained economic load dispatch problem using hybridization of Particle swarm optimization. This review paper shows that by applying hybridPSO algorithm the power demand can be successfully met at minimum generation cost incurring minimum transmission loss.

1.Introduction

In the present scenario, the study focuses on small thermal power generating system where main concern is continuous and reliable power generation to meet the increasing demand with optimum generation schedule of the generators. With the Increase in power demand and fuel cost, the generation cost is higher which ultimately affects the user community. So the other aim of optimization of power generation and distributionis to minimize the overall generation cost and power loss in transmission lines.

The economic dispatch (ED) aims at determining the optimal scheduling of thermal generating units so as to minimize the fuel cost while satisfying several operational and power system network constraints. The generator fuel cost functionsare invariably nonlinear and also exhibit discontinuities due to prohibited operating zones (POZs). In addition, the valve point loading effect causes non convex characteristic with multiple minima in the generator fuel cost functions and thus imposes challenges of obtaining the global optima for high dimensional ED problems. Thus, ED is a highly nonlinear, complex combinatorial, non-convex, and multi constraint optimization problem with continuous decision variables. The classical mathematical methods like gradient, Lagrange relaxation methods, and so forth, except dynamic programming, are not suitable for such complex optimization problems. The modern met heuristic search techniques such as particle swarm optimization (PSO), genetic algorithms (GAs), biogeography-based optimization (BBO), differential evolution (DE), ant colony optimization (ACO), artificial bee colony (ABC), and hybrid swarm intelligent

based harmony search algorithm (HHS) have shown potential to solve such complex ED problems due to their ability to obtain global ornear global solution but are computationally demanding especially for modern power systems which are large andcomplex.

The PSO has several advantages over other met heuristic techniques in terms of simplicity, convergence speed, and robustness. It provides convergence to the global or near global optima, irrespective of the shape or discontinuities of the cost function. The potential of PSO to handle non-smooth and non-convex ELD problem was demonstrated. However, the performance of the PSO greatly depends on its parameters and it often suffers from the problems such as being trapped in local optima due to premature convergence, lack of efficient mechanism to treat the constraints, and loss of diversity and performance in optimization process. PSO is a population based optimization technique in which the movement of the particles is governed by the two stochastic acceleration coefficients, that is, cognitive and social components and the inertia component. In order to enhance the exploration and exploitation capabilities of PSO, the components affecting velocity of particles should be properly managed and controlled.

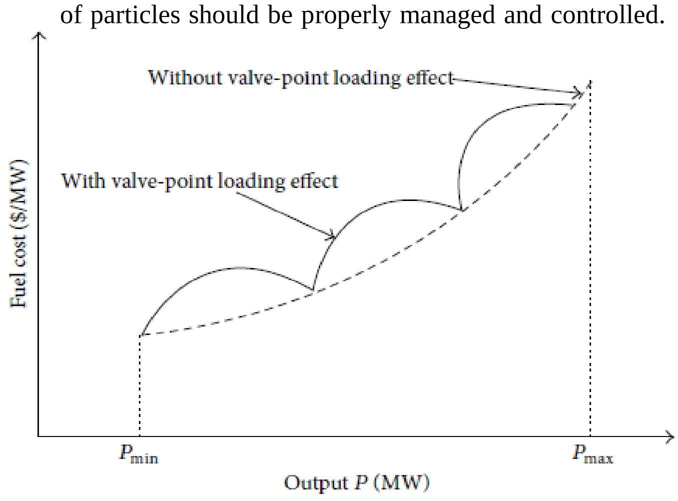


FIGURE 1: Fuel cost function with and without valve-point loading effect.

2. PROBLEM FORMULATION

The generator cost function is usually considered as quadratic,when valve-point loading effects are neglected. The large turbine generators usually have a number of fuel admission valves which are operated in sequence to meet out increased generation. The opening of a valve the throttling losses rapidly and thus the incremental heat rate rises suddenly. This valve-point loading effect introduces ripples in the heat-rate curves which introduces non-convexity in the generator fuel cost function as shown in Figure 1. The effect of valve-point loading effects can be modeled as sinusoidal function in the cost function. Therefore, the increases Advances in Electrical Engineering 3 objective function for the non-convex ED problem may be stated as

$$\text{Minimize}\, F(P_{Gi}) = \sum_{i=1}^{N_G} \left(a_i + b_i P_{Gi} + c_i P_{Gi}^2\right) + \left|e_i \sin\left(f_i \left(P_{Gi\min} - P_{Gi}\right)\right)\right|$$

$$\sum_{i=1}^{N_G} P_i = PD + \sum_{i=1}^{N_G}\sum_{j=1}^{N_G} P_{Gi} B_{ij} P_{Gj} + \sum_{i=1}^{N_G} P_{Gi} B_{i0} + B_{00},$$

where a_i, b_i, and c_i are the cost coefficients of the ith generator,e_i and f_i are the valve-point effect coefficients,P_{Gi} is the real power output of the ith generator, and N_G is the number of generating units in the system.

Subject to the following constraints:

(1) *Power Balance Constraint*

The total power generation of all generators must be equal to the sum of total power demand plus the network power loss. The network power loss can be evaluated using B-coefficient loss formula. Therefore,the generator power balance equation may be stated as follows:

where B_{ij} is the transmission loss coefficient i =1, 2, . . . , $N_G$and j = 1, 2, . . . , N_G, B_{i0} is the ith element of the loss coefficient vector. B_{00} is the loss coefficient constant.

(2) *Generator Constraint*.

For stable operation, power output of each generator is restricted within its minimum and maximum limits. Thegenerator power limits are expressed as follows:

(3) *Prohibited Operating Zones*.

Prohibited operating zones lead to discontinuities in the input output relation of generators. Prohibited zones divide the operating region between minimum and maximum generation limits into disjoint convex sub regions. The generation limits for the ith unit with j number of prohibited zones can be expressed as follows:

$$P_{Gi}^{\min} \le P_{Gi} \le P_{Gi}^{\max}.$$

where superscripts L and U stand for the lower and upper limit of prohibited operating zones of generators. $NGPZ$ and $NPZi$ denote the total number of generators with prohibited zonesand the total number of prohibited zones for the ith generator, respectively.

3. HYBRID PSO-ACO APROACH

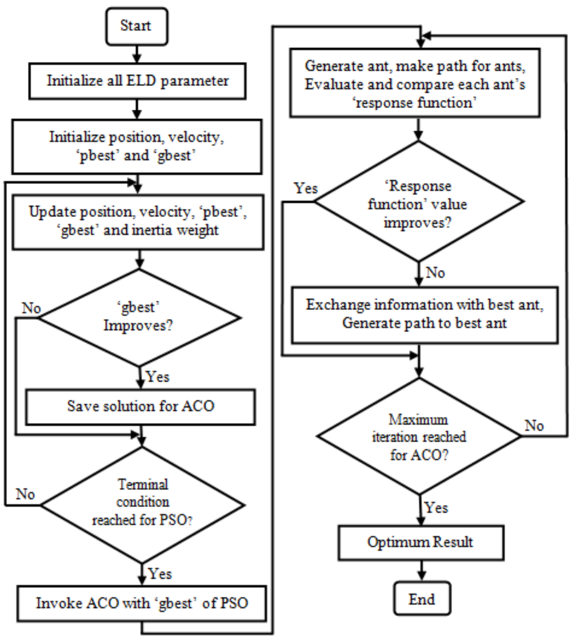
$$P_{Gi}^{\min} \le P_{Gi} \le P_{Gi,1}^{L},$$

$$P_{Gi,j-1}^{U} \le P_{Gi} \le P_{Gi,j}^{L},$$

$$P_{Gi,N_{PZi}}^{U} \le P_{Gi} \le P_{Gi}^{\max};$$

$$i \in \{1,2,\ldots,N_{GPZ}\},\ j \in \{2,3,\ldots,N_{PZi}\}$$

PSO is a population-based heuristic search algorithm thatemulates the movement of swarm in finding best solution of an optimization problem. In PSO, the particles make parallelsearches for optima in the search space by updating their velocity and position dynamically. In every iteration, the PSOkeeps track of two updated values – one is the '*pbest*' or the best value (fitness) achieved so far by a given particle while the other is the '*gbest*' i.e. the best value attained so far by the population. ACO is another swarm based method for finding optimum solution by following the strategy of movement of an ant colony towards the source of food through the shortest path. Though each ant finds a new solution, better solutions are yielded by exchanging information with other ants through the '*pheromone'* trail. Thus, analogous to an ant, the ACO algorithm constructively builds or improves a solution to an optimization problem by moving through nodes (or states) of a neighborhood graph. Though PSO is good for ELDproblems for its flexibility, robustness and fast convergence, itsometimes give unsatisfactory result due to large accumulation of particles at '*gbest*' position. ACO, on the other hand, known for its good downhill behaviour near the global optimal region, imparts better balance between local and global search when combined with PSO in the hybridPSO-ACO algorithm.



4.REFERENCES

1. Particle Swarm Optimization By Aleksandar Lazinica
2. Multi-Objective Optimization using Evolutionary Algorithms By Kalyanmoy Deb
3. Del Valle, Y., Venayagamoorthy, G. K., Mohagheghi, S., Hernandez, J. C., and Harley, R. G., "Particle swarm optimization: Basic concepts, variants and applications in power systems," IEEE Trans. Evolut. Computat., Vol. 12, No. 2, pp. 171–195, April 2008.
4. Ravi Kumar Pandi, V., and Panigrahi, B. K., "An improved adaptive particle swarm optimization approach for multi–modal function optimization," Intl. J. Inform. Optimizat. Sci., Vol. 29,No. 2, pp. 359–375, March 2008.
5. Mandal K.K., Mandal S., Bhattacharya B., Chakraborty N., "Nonconvex emission constrained economic dispatch using a new selfadaptive particle swarm optimization technique", Applied Soft Computing, vol. 28, pp. 188-195, 2015.
6. K. T. Chaturvedi,M. Pandit, and L. Srivastava, "Self-organizing hierarchical particle swarm optimization for nonconvex economic dispatch," *IEEE Transactions on Power Systems*, vol. 23, no. 3, pp. 1079–1087, 2008.
7. K. T. Chaturvedi,M. Pandit, and L. Srivastava, "Particle swarm optimization with time varying acceleration coefficients for non- convex economic power dispatch," *International Journal of Electrical Power and Energy Systems*, vol. 31, no. 6, pp. 249 257,2009.
8. MATLAB, "MATLAB programming language," available at: www.mathworks.com
9. Aniruddha Bhattacharya, *Member*, *IEEE*, and Pranab Kumar Chattopadhyay, ―Biogeography-Based Optimization for Different Economic Load Dispatch Problems‖, Ieee Transactions On Power Systems, Vol. 25, No. 2, May 2010.
10. N. Sinha, R. Chakrabarti and P. K. Chattopadhyay. Evolutionary Programming Techniques for Economic Load Dispatch, IEEE Trans. Evolutionary Computation, 2003, 7(1): 83-94.
11. J. B. Park, K. S. Lee, J. R. Shin and K. Y. Lee. A Particle Swarm Optimization for Economic Dispatch with Non-Smooth Cost Functions, IEEE Trans. Power Systems, 2005, 20(1): 34-42.
12. C. L. Chiang. Improved Genetic Algorithm for Power Economic Dispatch of Units with Valve-Point Effects and Multiple Fuels, IEEE Trans.Power Systems, 2005, 20(4): 1690-1699.
13. W. M. Lin, F. S. Cheng and M. T. Tsay. An Improved Tabu Search for Economic Dispatch with Multiple Minima, IEEE Trans. Power Systems, 2002, 17(1): 108-112.
14. Arul R., Velusami G. Ravi S. "A new algorithm for combined dynamic economic emission dispatch with security constraints", Energy, vol. 79, pp. 496-511, 2015.
15. Nwulu N. I., Xia X., "Multi-objective dynamic economic emission dispatch of electric power generation integrated with game theory based demand response programs", Energy Conversion and Management, vol. 89, pp. 963-974, 2015.
16. Li M.S., Wu Q.H., Ji T.Y., Rao H., "Stochastic multi-objectiveoptimization for economic-emission dispatch with uncertain wind power and distributed loads",Electric Power Systems Research, vol.116, pp. 367-373, 2014.
17. Aghaei J., Niknam T., Azizipanah-Abarghooee R., Arroyo J. M.,"Scenario-based dynamic economic emission dispatch considering load and wind power uncertainties", International Journal of Electrical Power & Energy Systems, vol. 47, pp. 351- 367, 2013.
18. Krishnamurthy S.; Tzoneva R. , "Investigation on the impact of the penalty factors over solution of the dispatch optimization problem", 2013 IEEE International Conference on Industrial Technology (ICIT),pp. 851-860, 2013.
19. R. Roy and S. P. Ghoshal, "A novel crazy swarm optimized economic load dispatch for various types of cost functions," *International Journal of Electrical Power & Energy Systems*, vol.30, no. 4, pp. 242–253, 2008
20. P. Subbaraj, R. Rengaraj, and S. Salivahanan, "Enhancement of Self-adaptive real-coded genetic algorithm using Taguchi method for Economic dispatch problem," *Applied Soft Computing Journal*, vol. 11, no. 1, pp. 83–92, 2011.
21. S. Pothiya, I. Ngamroo, and W. Kongprawechnon, "Ant colony optimisation for economic dispatch problem with non-smooth cost functions," *International Journal of Electrical Power and Energy Systems*, vol. 32, no. 5, pp. 478–487, 2010.
22. S. Sivasubramani and K. S. Swarup, "Hybrid SOA–SQP algorithm for dynamic economic dispatch with valve-point effects," Energy, vol.35,no. 12, pp. 5031–5036, Dec. 2010
23. M.Vanitha and K.Thanushkodi , "Solving Non-Convex EconomicLoad Dispatch Problem by Efficient Hybrid Simulated Annealing Algorithm",IEEE International Conference on Advanced Communication Control and Computing Technologies (ICACCCT) 2012.
24. Jatinder N.D. Gupta, Randall S. Sexton, "Comparing backpropagation with a genetic algorithm for neural network training",Elsevier, Omega 27 (1999), pp 679-684.
25. Saeide Sheikhpour, Mahdieh Sabouri, and Seyed-Hamid Zahir, " A hybrid Gravitational Search Algorithm–Genetic Algorithm for neural network training,21 st Irananian Conference of Electrical Engineering.