Solution of Combined Emission Economic Load Dispatch in Thermal Power Plant by using Particle Swarm Optimization

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Abstract – *Economic Load Dispatch (ELD) proves to be a vital optimization process in electric power system for allocating generation amongst various units to compute the cost of generation , the cost of emission involving global warming gases like sulphur dioxide, nitrous oxide and carbon monoxide etc. It is here and now determination of the most ideal yield of various generators units, to meet the power framework stack, at the base conceivable cost, topic to operational requirements and transmissions. This research paper tries to show the numerical detailing of Economic load dispatch issue arrangement utilizing delicate registering method in electric era structure considering different physical and power induced system imperatives. This method increases the tendency of particles to venture into the solution space to ameliorate their convergence rates.*

***Key Words*: Economic load dispatch, Equality constraints, In-equality constraints, Over view of PSO technique, Proposed PSO algorithm**

1. INTRODUCTION

Power system stability is the tendency of a power system to develop restoring forces equal to or greater than the disturbing forces to maintain the state of equilibrium. In this paper, particle swarm optimization (PSO) which is one of the computational algorithm technique is applied successfully to solve the problem of economic load dispatch. The objective function considered here is minimization of fuel cost of generators for different bus systems used in thermal power plant. In the current electric power frameworks, there are distinctive creating units e.g. hydro, steam, and biomass and so on. Likewise, the heap request vacillates for the time of a day and achieves diverse pinnacle esteems. In this way, it is basic to settle on which producing unit to off/on and furthermore the request in which the units must be closed down remembering the cost benefit of turning on and stopping. The entire work of figure and making these evaluations is known as load dispatch. The financial load dispatch implies that the generator's yield is permitted to change inside persuaded restrains so that to take care of a specific load demand contained by least fuel cost. Thus, there is a wide trend of adopting stochastic algorithms which are able to effectively solve the economic dispatch problem. Propitious results have been reported during the past few years and several methods like genetic algorithm (GA) [3], evolutionary programming (EP) [4], Taboo search (TS) [5], simulated annealing (SA) [6], differential evolution (DE) [7] and many other methods were successfully implemented in practical ED problems significantly improving the existing results of the problem.

2. PROBELM FORMULATION

The basic ELD problem is formulated in equation (1) and (2) as follows.

$$Z_i = (a_i PG_i^2 + b_i PG_i + C_i) + K_i \sin(l_i(P_i - PG_i)) \quad (1)$$

$$J_i = (h_i PG_i^{\ 2} + g_i PG_i + q_i) \quad (2)$$

Where Z_i and J_i are cost and emission objective functions and a_i, b_i, c_i, K_i, l_i and h_i, g_i, q_i are cost and emission objective function coefficients. It involve combined objective formulation encompassing cost as well as emission objective function vide price penalty factor Pf_i is formulated as (3).

$$S_i = Z_i + Pf_i \times J_i \quad (3)$$

$$Pf_i = Z_{i\max} \Big/ J_{i\max} \quad (4)$$

The constraints involved in this work are as below.i.e.

(i)Equalityconstraint:

$$\sum_{i=1}^{n} PGi = P_D + TransmissionLoss \quad (5)$$

Where P_D = net power demand.

(ii) Inequality constraint:

$$P_i \langle PG_i \langle P_j \quad (6)$$

Where PG_i represents the output power of i^{th} generating unit, P_i and P_j are minimum and maximum output Power of i^{th} generating unit respectively

3. OVER VIEW ON PSO TECHNIQUES

This section describes the proposed Particle Swarm Optimization method. It is an optimization and search technique based on the principles of social behavior of animals. The method was developed in 1995 by James Kennedy and Russell Eberhart [2]. PSO is very good at finding good enough solutions for a large range of problems, such as constrained optimization problems, multi-objective optimization problems, etc.

It is a simple and powerful optimization tool which scatters random particles, i.e., solutions in the problem space. These particles, called swarms collect information from each array constructed by their respective positions. The particles update their positions using the velocity of particles. Position and velocity are both updated in a heuristic manner using guidance from particles' own experience and the experience of its neighbor so obtain position and velocity vectors viz. P_{best} and g_{best} i.e.($P_{1best}, P_{2best} \ldots\ldots P_{ibest}$) and ($g_{1best}, g_{2best} \ldots\ldots g_{ibest}$) respectively. The updated values of position and velocity are computed using equation (7) and (8).

$$v_i^{(t+1)} = wv_i^t + c_1 rand\left(p_i^{lb} - x_i^t\right) + c_2 rand\left(p_i^{gb} - x_i^t\right) \quad (7)$$

$$x_i^{t+1} = x_i^t + v_i^{t+1} \quad (8)$$

Where C_1, C_2 are acceleration coefficients

W = Inertia weight

V_i^t = Initial velocity of i^{th} particle after t^{th} iteration

V_i^{t+1} = Updated velocity of particle at t+1 iteration

X_i^t = Initial position of i^{th} particle after t^{th} iteration

X_i^{t+1} = Updated position of particle at t+1 iteration

Here w describes inertia weight that controls the momentum of the particle by weighing the contribution of the previous velocity–basically controlling how much memory of the previous flight direction will influence the new velocity.

4. PROPOSED PSO ALGORITHM

Basically the proposed PSO algorithm deals with to generate optimum amount of real power generation With minimize emission level of green house gases like carbon dioxide, carbon monoxide, sulphur dioxide etc.

In this paper, an algorithm is developed to solve Equality constraints and Inequality constraints for ELD problem using PSO to obtain a high quality solution. The PSO algorithm is utilized mainly to determine the optimal allocation of power among the committed units, thus minimizing the total generation cost. To implement the PSO algorithm to solve the ELD problems mentioned steps should be visualized in the flowchart Fig.1.

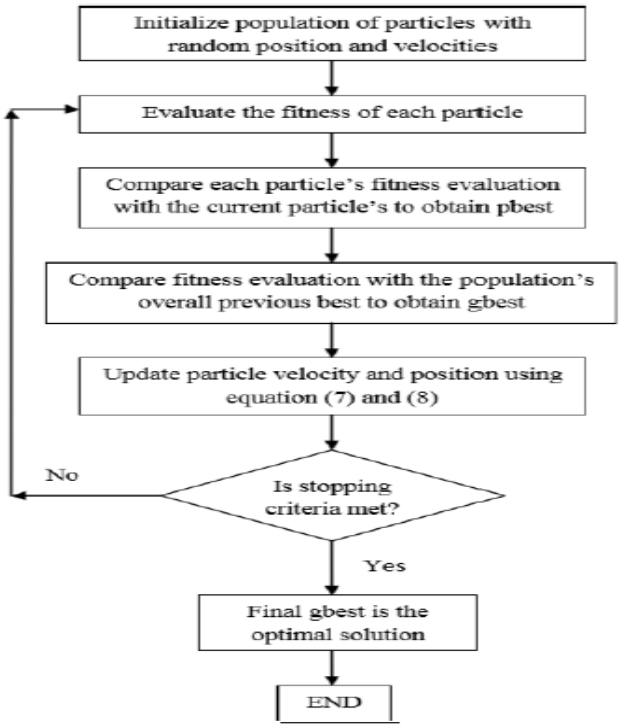

Fig -1: Flow chart of PSO algorithm

5. RESULT ANALYSIS

Table(1): Cost coefficients, emission coefficients & other coefficients for 6 power generating units

Unit	a_i	b_i	c_i	h_i	g_i	q_i	k_i	l_i
1	0.111	-40.429	755.75	0.0035	0.3244	-23.849	200	0.025
2	0.551	-41.121	-1048.82	0.0038	0.32665	-23.849	100	0.031
3	0.01160	-32.363	-1048.82	0.00672	0.54711	40.270	150	0.031
4	0.00041	36.312	450.325	0.00102	0.54632	40.2608	140	0.043

5	0.019	34.311	-1652.52	0.00500	0.5112	42.8855	140	0.043
6	0.155	37.100	1352.65	0.00502	-0.5138	50.8553	120	0.053

Various objective Functions:

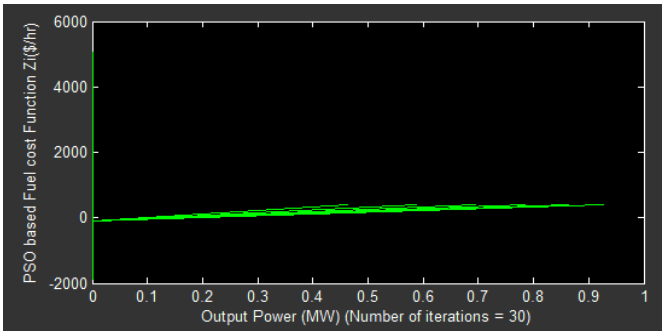

Fig -2: Convergence characteristics of PSO based cost Objective function for 6 generating units

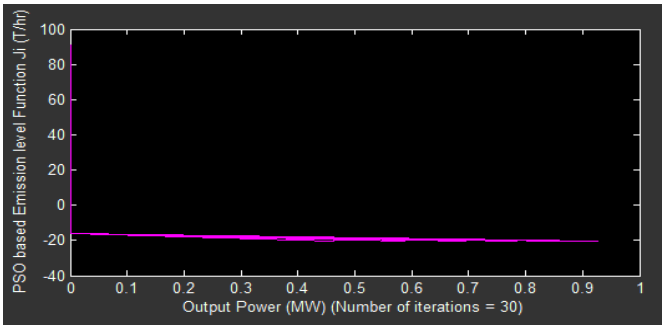

Fig -3: Convergence characteristics of PSO based Emission level function for 6 generating units

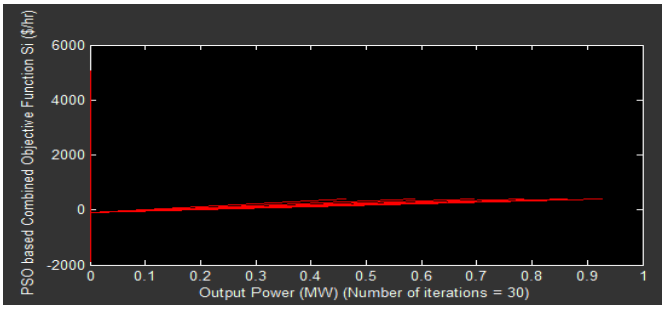

Fig -4: Convergence characteristics of PSO based Combined objective function for 6 generating units

The above various objective functions are analysed by writing programmes in MATLAB software.

4. COMPARASION OF RESULT ANALYSIS BASED ON PSO

Based on 30 numbers of iterations the PSO based cost objective function shows that the optimum amount of real power generation with minimizes fuel cost, the PSO based emission level function is slightly decreasing & the PSO based combined objective function is slightly increasing. The non-convex economic problem of power dispatch is solved using PSO strategy. These results are compared with the results available in literature for 6- generator system and it is found that results are significantly improved by the proposed algorithm.

5. CONCLUSION

Tuning of various parameters of PSO [8] is important and it is found that the values of parameters in this paper are perfect for the improvement of results. The results demonstrate that PSO out performs other methods, particularly for non-convex cases, in terms of solution quality, dynamic convergence, computational efficiency, robustness and stability. The proposed algorithm can also be applied to other power system optimization problems like dynamic economic dispatch and reactive power dispatch. The proposed method presented advanced PSO technique involving valve point loading, ramp rate constraints, constriction factor based swarm optimization [1] tool box for analysing the economic dispatch problem. The results of this analysis outperform classical methods like lambda iteration method, mixed integer linear programming method (MILP), quadratic programming method etc. and heuristic methods like particle swarm optimization, weight improved particle swarm optimization (WIPSO), dispersed particle swarm optimization (DPSO) etc. in terms of computational time for better optimal solution.

7. REFERENCES

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BIOGRAPHIES

Himanshu Shekhar Maharana completed his B. Tech degree in EEE from JITM, Paralakemundi under BPUT Rourkela, Odisha in 2010 and Completed M. Tech degree in Power System Engineering from GITA, Bhubaneswar science & Engineering under BPUT, Rourkela, Odisha in the year 2014. Prior to it he worked in industry and then worked as an Asst. Professor in the Dept. of Electrical Engineering at Einstein Academy Of Technology & Management, Bhubaneswar for 4 years. Now he is working as an Asst. Professor in the Dept. of EEE at Gandhi Institute Of Excellent Technocrats (GIET), Ghangapatna, Bhubaneswar, Khordha, Odisha. At present he is continuing full time Ph.D. under the guidance of professor Dr. Saroj Kumar Dash in BPUT, Rourkela, Odisha. He has awarded with best research paper during Ph.D work i.e. "Ramp Rate and Constriction Factor Based Dual Objective Economic Load Dispatch Using Particle Swarm Optimization", International Journal of Energy and Power Engineering, Volume: 11, No: 6, Pp.636 - 640 in ICEESAO conference, World Academy of Science, Engineering and Technology, San Francisco, USA during 7th -8th, June 2017. Also he has published so many international journals in conferences like (ICCIC 2015, SPRINGER BIT, Mesra) & (ICCTICT 2016, IEEE New Delhi & ICCIC 2016, IEEE Chennai) in the field of Computer Science & Engineering.

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