Economic Load Dispatch with fixed DC link Placement

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Abstract

Economic load dispatch (ELD) is an important operational problem of the power system, aiming to minimizing the chosen objective functions of the The recent developments in Power electronics have enabled introduction of DC links in the AC Power Systems with a view of making the operation more flexible, secure and economical The proposed algorithm (PA) is applied to the standard IEEE30bus test system and the result are presented to demonstrate its effectiveness.

Keywords

Economic Load Dispatch, Load flow, Optimal Power flow

NOMENCLATURE

a_i b_i c_i	Fuel cost coefficients
d_i e_i	Coefficients of valve point effects of the generator
ELD	Economic load dispatch
F_C	Net fuel cost
$Iter^{max}$	Maximum number of iterations for convergence check.
nd	Number of decision variables
ng	Number of generators
$p(V,\delta)$	Real power at bus as a function of voltage magnitude and voltage angle
$q(V,\delta)$	Reactive power at bus as a function of voltage magnitude and voltage angle
P_{Gi} and Q_{Gi}	Real and Reactive power generation at i -th bus respectively
P_{Di} and Q_{Di}	Real and Reactive power demand at i -th bus respectively
P_D	Total load demand
P_L	Total Transmission losses
P_{Gi}^{min} and P_{Gi}^{max}	lower and upper limits of P_{Gi}
Q_{Gi}^{min} and Q_{Gi}^{max}	lower and upper limits of Q_{Gi}
t	iteration counter

I. INTRODUCTION

Present day power systems have the problem of deciding how best to meet the varying power demand that has a daily , weekly and yearly cycle in order to maintain a high degree of economy and reliability. Among the options that are available for an engineer in choosing how to operate the system, economic load dispatch (ELD) is the most significant.ELD is a computational process whereby the total required generation is distributed among the generating units in operation also calculate total line losses subject to load and operational constraints. The objective of proposed algorithm to reduce power losses while satisfying various constraints [1].

Over the years numerous methods with various degrees of near-optimality, efficiency, ability to handle difficult constraints and heuristics, are suggested in the literature for solving the dispatch problems. These problems are traditionally solved using mathematical programming techniques such as lambda iteration method, gradient method, linear programming, dynamic programming method and so on. The additional constraints such as line flow limits cannot be included in the lambda iteration approach and the convergence of the iterations is dependent on the initial choice of lambda. In large power systems, this method has oscillatory problems that increase the computation time [1,2].

Apart from the above methods, there is another class of numerical techniques called evolutionary search algorithms such as simulated annealing, genetic algorithms, evolutionary programming, ant colony, artificial bee colony and particle swarm optimization have been applied in solving ELD [3-8].. It has been tested on the IEEE 30 bus test systems to illustrate the performance.

II. PROBLEM FORMULATION

The ELD problem is formulated as an optimization problem of minimizing the fuel cost while satisfying several equality and inequality constraints.

Minimize

$$F_C = \sum_{i=1}^{ng} a_i P_{G\,i}^{2} + b_i P_{G\,i} + c_i + \left| d_i \sin(e_i (P_{G\,i}^{\min} - P_{G\,i})) \right| \qquad (1)$$

Subject to:

Real Power balance Constraints

$$\sum_{i=1}^{ng} P_{G\,i} - (P_D + P_L) = 0 \qquad (2)$$

Real and Reactive power generation limits

$$P_{Gi}^{\min} \le P_{Gi} \le P_{Gi}^{\max} \qquad (3)$$

$$i = 1, 2, 3 \cdots ,ng$$

$$Q_{Gi}^{\min} \le Q_{Gi} \le Q_{Gi}^{\max} \quad : \qquad (4)$$

$$i = 1, 2, 3 \cdots ,ng$$

Load flow equations

$$P_{Gi} - P_{Di} - p(V, \delta) = 0 \qquad (5)$$

$$Q_{Gi} - Q_{Di} - q(V, \delta) = 0 \qquad (6)$$

A. Representation of decision variables

The decision variables in the PA are real power generation at generator buses except slack bus, these decision variables in vector form as

$$x = [\, P_{G\,2}, \cdots, P_{Gng} \,] \qquad (7)$$

B. Stopping Criterion

The process of generating new swarm can be terminated either after a fixed number of iterations or if there is no further significant improvement in the global best solution.

III. SIMULATION

Table 3.1 Results of IEEE 30 bus test system

Control Variables (p.u)	Optimization
$P_{G\,1}$	138.539
$P_{G\,2}$	57.56
$P_{G\,5}$	24.56
$P_{G\,8}$	35.0
$P_{G\,11}$	17.93
$P_{G\,13}$	16.91
Load Demand	283.4
Before Placing DC Link (Loss)	7.0990
Before Placing DC Link (Net Fuel Cost ($/h))	813.6941
With DC Link at Line1 (Loss)	6.3639
With DC Link at Line1 (Net Fuel Cost ($/h))	811.4620

The Proposed Method is tested on IEEE 30 bus test system, whose data have been taken from Ref. [10]. The fuel cost coefficients, lower and upper limits for real power generations for IEEE 30 bus test system are given in Table 6.1 of the appendix. Programs are developed in Matlab 7.5 and executed on a 2.3 GHz Pentium-IV personal computer. Newton Raphson technique [9] is used to carry out the load flow during the optimization process. The solution obtained by IEEE 30 bus test system are given along with the before Placing DC link and with DC link at line1 in Tables 3.1 respectively. While analyzing in performances, it can be observed that Fuel cost and Loss decreases.

IV. SUMMARY

ELD problem is developed and tested on IEEE30 bus test system. The algorithm uses NR load flow technique for computing the slack bus power that includes network loss.

V.ACKNOWLEDGEMENT

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VI. APPENDIX

Table 6.1 Generator Data for IEEE 30 bus test system

Bus No	a	b	c	d	e	$P_{Gi}^{\min}$	$P_{Gi}^{\max}$
1	0.00375	2.00	0	0	0	50	200
2	0.01750	1.75	0	0	0	20	80
5	0.06250	1.00	0	0	0	15	50
8	0.00834	3.25	0	0	0	10	35
11	0.02500	3.00	0	0	0	10	30
13	0.02500	3.00	0	0	0	12	40

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