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Literature Review – Economic and Emission Dispatch Problems

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A B S T R A C T

This paper presents a comprehensive survey of the economic and emission dispatch problems by various conventional and Intelligent techniques and also reviews the existing developments in economic and emission dispatch problems considering generator capacity limits and power balance constraints. The recent literature published in the journals and articles on economic and emission dispatch are presented which throws light on the grey area for the beginners. This may be the helpful tool for the budding researchers working in the area of economic and emission dispatch problems.

Keywords: Economic dispatch, Literature review, Emission constrained economic dispatch, Evolutionary programming, Particle swarm optimization

1. Introduction

In modern power system operation and control, the economic and emission dispatch problems of thermal generating units and their issues are given greater importance. Conventionally, electric power plants are operated on the basis of lowest operating fuel cost strategies and less attention is given to the minimum emission strategies. Generating adequate electricity at a least possible cost under a number of constraints is Economic Dispatch (ED). While decreasing the pollution by suitably changing the generation allocation, the cost of generation may be increased deviating from ED. The process of generating power with the objective of minimizing the emission is called Emission Dispatch (EmD). The Combined Economic and Emission Dispatch (CEED) is a multi-objective optimization problem which minimizes both fuel cost and emission of pollutants simultaneously, while satisfying the load demand and other operational constraints. The Emission Constrained Economic Dispatch (ECED) is the one in which the emission limit is considered as an additional constraint [1]. Therefore, the combined economic power and emission dispatch is a multi – objective optimization problemwhich minimizes both generation cost and emission of generation units subject to system constraints. In order to solve theEconomic dispatch problems numerous optimization techniques have been applied. Some articles use mathematical programming for solving this problem [2].

According to the United Nations framework convention on climate change, the Kyoto Protocol is an international agreement for reducing the emission level from 37 industrialized countries. The Kyoto Protocol 1990 has the objective of reducing the emission of greenhouse gases by at least 5% below the value of the base year in the commitment period. The main pollutants emitted into the atmosphere are oxides of nitrogen, oxides of Sulphur and oxides of carbon. The Kyoto Protocol offers guidelines to countries to reduce their emission level from sectors like oil, refineries, power generating stations, steel industries, paper mills, cement industries and ceramic companies. This paper focuses on providing a clear review of the latest techniques both classical and Intelligent techniques to discuss economic and emission dispatch problems.

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2. Literature Review on Economic and Emission Dispatch Problems

Classical Optimization Techniques: The classical methods available in the literature for solving economic and emission dispatch problems are discussed as follows.

Newton-Raphson and Lagrangian Relaxation Methods: Jiann-Fuh& Shin-Der [3] presented N-R method to solve the multi- objective Power Dispatch (MPD) problem with line flow constraints. The recommended method was used to solve the bi-objective optimization problem one was minimization of fuel cost and another was minimization of emission. The Jacobian matrix was formulated by the incremental transmission loss in terms of the sensitivity factors, line flows and line resistances. The usefulness of the proposed method was tested on the IEEE- 14 and 30 bus test systems.

EI- Keib et al [4] suggested Lagrangian Relaxation (LR) method to solve environmentally constrained economic dispatch problem. The proposed algorithm has the ability to handle a large number of various types of linear and nonlinear environmental constraints. The proposed method was tested on a large size power system.

Hemamalini& Simson [5] presented Maclaurin series based Lagrangian method to solve Emission Constrained Economic Dispatch with valve-point effect. In this paper two conflicting functions (fuel cost and emission) were considered and formulated as a single objective optimization problem by the weighted sum method. The feasibility of the proposed method was validated on the IEEE -30 bus test system and ten unit test systems. The results obtained with the proposed method were compared with GA.

Quadratic Programming and Linear Programming Methods: Ziane et al [6] suggested Quadratic Programming (QP) method for solving Dynamic Economic Load Dispatch (DELD) problem with minimum emission. This problem determines the optimum power generation schedule while minimizing gas emission. To validate the effectiveness and the feasibility of the proposed approach, it was tested on 3, 6, and 10-unit test systems and the results were compared with the other methods. The comparison confirmed the superiority, fast convergence of the proposed method.

EI Keib& Ding [7] solved the economic dispatch problem in view of the Clean Air Act Amendment (CAAA) of 1990. In this approach, there are two strategies to solve the problem subject to environmental constraints-one is linear programming using the gradient projection method to guarantee the feasibility of solution and another one is based on a provision in the act that is designed to facilitate compliance.

Evolutionary Computing Methods: The Evolutionary computing techniques available in the literature for solving economic and emission dispatch problems are addressed as follows:

Evolutionary Programming: Venkatesh, et al [8] applied Evolutionary Programming (EP) techniques to solve the Economic Load Dispatch (ELD) and Economic Emission Dispatch (EED) problems to get hold of the optimal fuel cost and optimal emission of generating units respectively. The Combined Economic Emission Dispatch (CEED) problem is obtained by considering both the fuel cost and emission objectives. The bi-objective CCED problem is converted into a single objective function using a function price penalty factor approach. The CEED problem on using EP was tested on the IEEE -14, 30 and 118 bus systems with and without line flow constraints. The solution obtained was practically encouraging and useful in the economic emission environment.

Particle Swarm Optimization: Abido[9] described the CEED problem using the novel multi-objective PSO method subjected to generation limits and power balance constraints. The proposed approach extends the single objective PSO by proposing the new definitions of the local and global best individuals with multi objective optimization problems

Selvakumar et al [10] suggested a PSO to solve the multi- objective Combined Economic Emission Dispatch (CEED) problem. In this problem, there are two contradictory objectives (emission and economic cost) which are combined by using price penalty factor which blends the emission cost with normal fuel cost.

Umayal& Kamaraj [11] proposed the PSO method to solve the multi objective CEED problem. The paper was formulated by the multi-objective problem considering the various competitive objective fuel cost, NO_x, SO_x, CO_2 and variation of generation mismatch. All objectives were weighed as per significance and added to form the final objective function.

Anurag et al [12] presented the PSO method to solve Combined Economic Emission Dispatch (CEED) problem of thermal units, while satisfying the constraints such as generator capacity limits, power balance and line flow limits. The objective was to minimize the total fuel cost of generation and environmental pollution caused by fossil based thermal generating units. The bi-objective problem was converted into a single objective problem by introducing the price penalty factor to maintain an acceptable system performance in terms of limits on generator real power outputs and transmission losses with minimum emission dispatch. The proposed approach was evaluated on an IEEE 30-bus test system with six generators. The results obtained with the proposed approach were compared with the results of genetic algorithm and other techniques.

Nagendra Singh & Yogendra Kumar [13]suggested a new PSO called Moderate Random search PSO (MRPSO) for the solution of economic load dispatch as well as environmental emissions of the thermal power plant considering power balance and generation limit constraints. The new approach

was used to solve bi-objective function. One was minimization of fuel cost and the other was environmental emission minimization. MRPSO enhances the capability of particles to explore in the search spaces more efficiently and increases their convergence rates. The proposed approach was tested for the IEEE-30 bus test system and the results obtained by MRPSO algorithm show their efficiency.

Genetic Algorithm: Rajkumar et al [14] presented a multi - objective optimization algorithms, in particular None dominated Sorting Genetic Algorithms-II (NSGA-II) and Modified NSGA-II (MNSGA-II) for solving the CEED problem with a valve - point loading. In this proposed approach, the reference pareto-front was generated by means of multiple runs of real coded genetic algorithm (RCGA) with a weighted sum of objectives. To authenticate the proposed approach, the IEEE- 57 and IEEE- 118 bus test systems were taken and the performance was compared with respect to various statistical performance measures such as convergence metric, diversity metric and an inverted generational distance metric.

Neural Network: Benhamida&Belhanchem [15] solved the Dynamic Constrained Economic/Emission Dispatch (DEED) problem using Flexible Hopfield Neural Network (FHNN) method considering the system load demand, spinning reserve capacity, ramp rate limits and prohibited operating zones constraints. The viability of the FHNN method was applied to three power system networks and the results were compared with other methods in terms of solution quality and computation efficiency.

Cuckoo Search Algorithm: Nguyen Thi Phuong Thao & Nguyen Trung Thang [16]employed a Cuckoo Search Algorithm (CSA) to solve Environmental Economic Load Dispatch (EELD) with the quadratic fuel cost function. The effectiveness of the proposed algorithm was validated on 3- and 6-unit test systems with different loads. The obtained results, including fuel cost, emission and computation time from the CSA were compared to other methods reported in this paper. The comparison results indicated the proposed CSA as a very competent method for solving EELD problems.

Opposition Based Differential Evolution Algorithm: Thenmalar et al [17] adopted Opposition based Differential Evolutionary Algorithm (ODEA) for solving Dynamic Economic Emission Load Dispatch (DEELD) with emission constraints and valve point effects. The recommended algorithm has unique features such as self - tuning of its control parameters, self-acceleration and migration for searching. The effectiveness of the algorithm was validated through four standard test cases and the results obtained are compared with previous studies.

Hybrid Methods: The hybrid methods addressed in the literature for solving economic and emission dispatch problems are as follows:

GA based Fuzzy Logic: Dhillon & Jain [18] presented GA based fuzzy logic for the multi-objective generation and emission dispatch probleminvolving different combinations of fuel cost,oxides of nitrogen, Sulphur and carbon whichwere solved usinga Non-dominated SortingGenetic Algorithm (NSGA-II).The approach uses a crowding distance technique to add diversity to the converging solutions . The final result is a single best compromise solution of all the required objectives such as reduction of fuel cost and emission. The algorithm was tested on a system of 6 generating units.

3. Conclusion

This paper presents a preliminary survey of various methodologies used to solve economic and emission dispatch problems in power system. Inthis study, various approacheshave been discussed in the area of Economic and emission dispatchproblems for finding better solution. The pros and cons of the already existing literature in the economic and emission dispatch are listed out for the young researchers in the area of power system planning.

REFERENCES

Sudhakaran, M, Sivakumar, G, Vengatachalapathy, P &Latchumi, K, 'Particle Swarm Optimization for Economic and Emission Dispatch Problems,' Journal of the Institution of Engineers (India), vol. 88, no. 2, pp. 39-45,2007.

Narges Daryani,and Kazem'ZareMultiobjective power and emission dispatch using modified group search optimization method "Ain Shams Engineering Journal, vol 8 pp 319-328, 2018

R.Govindarajan, Dr.S.Meikandasivam, Dr.D.Vijayakumar, "Energy Management Techniques in Smart Grid", International Journal of Applied Engineering Research, Volume 10, Number 15, pp.35720- 35724, 2015.

Jiann-Fuh Chen & Shin-Der Chen, 'Multi objective Power dispatch with line flow constraints using the fast Newton-Raphson method', IEEE Transactions on Energy Conversion, vol. 12, no. 1, pp. 86-93,1997.

EI- Keib, AA, Ma, H & Hart, JL, 'Environmentally constrained economic dispatch using the Lagrangian relaxation method', IEEE Transactions on Power Systems, vol. 9, no. 4, pp. 1723-1729, 1994.

R.Govindarajan, S.Meikandasivam, D.Vijayakumar, "Energy monitoring system using Zigbee and Arduino", International Journal of Engineering & Technology, Vol. 7, No. 4, pp. 608-611, 2018.

Hemamalini, S & Simon, SP 'Emission Constrained Economic dispatch with valve-point effect using Maclaurin series - based Lagrangian method', International Journal of Power and Energy Conversion, vol. 3, no 1-2, pp.15-22, 2012.

Ziane, I ,Benhamida, F, Graa, A, Salhi, Y &Sonag, S 'Dynamic Load Dispatch with minimum Emission using Quadratic Programming', 8th International Conference on Electrical Engineering, 2014.

EI- Keib, AA, Ma, H & Hart, JL 'Environmentally constrained economic dispatch using the Lagrangian relaxation method', IEEE Transactions on Power Systems, vol. 9, no. 4, pp. 1723-1729, 1994.

R.Govindarajan, S.Meikandasivam and D.Vijayakumar "Performance Analysis of Smart Energy Monitoring Systems in Real-time," Engineering, Technology & Applied Science Research, vol. 10, no. 3, pp. 5808–5813, Jun. 2020.

Venkatesh, P, Gnanadass, R &Padhy Narayana Prasad, 'Comparisons and Application of Evolutionary Programming techniques to Combined Economic

Emission Dispatch with Line flow Constraints', IEEE Transactions on Power Systems, vol.18, no.2, pp. 688-697.2003.

Abido, MA, 'Multiobjective particle swarm optimization for environmental/economic dispatch', Proceedings of the 8th International Power Engineering Conference, pp. 1385 -1390.2007

Selva Kumar, I, Dhanush Kodi, K & Jaya Kumar, J, R, Kuar Charlie Paul, C'Particle swarm optimization solution to emission and economic dispatch problem', Conference on Convergent Technologies for the Asia Pacific Region, IEEE TENCON-2003, Oct 15-17 Bangalore, India, pp. 435-439, 2003.

Umayal, SP & Kamaraj, N, 'Stochastic multi objective short term hydrothermal scheduling using particle swarm optimization', Proceedings of the IEEE Indicon 2005 Conference, pp.497-501,2005.

R.Govindarajan, Dr.S.Meikandasivam, Dr.D.Vijayakumar, "Cloud Computing Based Smart Energy Monitoring System", International Journal of Scientific and Technology Research, Volume 08, Issue 10, pp. 886-890, October 2019

Anurag Gupta, Swarnkar, KK & Wadhwani, K , 'Combined Economic Emission Dispatch Problem using Particle Swarm Optimization', International Journal of Computer Applications, vol.49, no.6, pp.1-6, 2012.

Nagendra Singh & Yogendra Kumar, 'Multiobjective Economic Load Dispatch Problem Solved by New PSO', Advances in Electrical Engineering, Hindwai Publishing Corporation, vol.2015, pp1-6, 2015.

Rajkumar, M, Mahadevan, K, Kannan, S & Baskar, S, 'Combined Economic and Emission Dispatch with valve-point loading of thermal Generation using Modified NSGA-II', Journal of Electrical Engg Technology, vol.8, no.3, pp. 490-498, 2013.

Benhamida, F &Belhanchem, R, 'Dynamic Constrained Economic/Emission Dispatch Scheduling using Neural Network', Power Engineering and Electrical Engineering, vol.11, no. 1, pp.1- 9,2013.

R.Govindarajan, S.Meikandasivam, D.Vijayakumar, "Low cost Arduino based smart energy monitoring system using internet of things", Journal of Engineering and Applied Sciences, Vol. 14, No. 1, pp. 170- 177, 2019.

Nguyen Thi Phuong Thao & Nguyen Trung Thang, 'Environmental Economic Load Dispatch with Quadratic Fuel Cost Function using Cuckoo Search Algorithm', International journal of u-and e-Service, science and Technology, vol. 7, no.2, pp.199-210, 2014.

Thenmalar, K Ramesh, S &Thiruvenkadam, S 'Opposition Based Differential Evolution Algorithm for Dynamic Economic Emission Load Dispatch (EELD) with Emission Constraints and Valve Points Effects', Journal of Electrical Engg and Technology, vol. 10, no. 4, pp. 1508-1517 ,2015.

Dhillon, J & Jain, SK, 'Multi-objective generation and emission dispatch using NSGA-11', IACSIT, International Journal of Engineering and Technology, vol. 3, no. 5, pp. 460-466, 2011.

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