



A COMPREHENSIVE LITERATURE SURVEY ON COMBINE ECONOMIC AND EMISSION DISPATCH

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ABSTRACT – The modern economy is totally depends on the electricity as a basic input. This is turn has led to the increase in the number of power generating stations and their capacities and the consequent increase in power transmission lines which connects the generating stations to the load centers. The generation of electricity from fossil fuel releases several contaminated elements, such as Sulphur Dioxide (SO₂), Nitrogen Oxides (NO_x) and Carbon Dioxide (CO₂) into atmosphere which pollute the environment. This leads to the formulation of combined economic and emission dispatch (CEED) problem. Recently researchers are developing different soft computing techniques to solve the combine economic and emission dispatch (CEED) problem. This paper presents a review which deals with problems of combine economic load and emission dispatch (CEED) which are solved by different techniques which mainly include Conventional Techniques, Genetic Algorithm (GA), Particle Swarm Optimization (PSO), Gravitational Search Algorithm (GSA) Artificial Bee Colony Algorithm (ABCA) and other alternative techniques.

Keywords – Optimum power flow, CEED, CO₂, GA, PSO, GSA, ABC.

1. INTRODUCTION

Today electrical power plays an exceedingly important role in all walks of life of an individual as well as the community. The development of various sectors such as transportation, industrial, agricultural, entertainment, information and communication sectors etc. depends on electrical energy. Combine Economic and Emission Dispatch (CEED) problem allocate optimal power generation among the committed units which minimizes fuel cost as well as the amount of emission while satisfying all the operational constraints of the system. The generation of electricity from fossil fuel releases several contaminated elements, such as Sulphur Dioxide (SO₂), Nitrogen Oxides (NO_x) and Carbon Dioxide (CO₂) into atmosphere which pollute the environment. Atmospheric pollution affects all firms of life and also causes global warming. Due to increasing concern over the environment and the passage of US clean air act amendments of 1990, utilities are force to modify their strategies for power generation not only at minimum cost but also at minimum emission level. Therefore it is necessary to find out an operating point , that strikes a balance between cost and emission. This is

achieved by combine economic and emission dispatch (CEED).

To solve the real time economic and emission dispatch problem. Based on convention, electrical power system are operated based on minimizing operational cost while maintaining the system constraints. The dispatch approaches should consider both economic factors and emission reduction. Though economic and emission dispatch issues have been successfully solved several existing techniques, the related dispatch program need to be rerun when the system load changes and thus is unsatisfactory for the real time dispatch [2].

Conventionally classical optimization techniques such as, Lambda-iteration, Newton Raphson method, Linear Programming, Non-linear Programming were used for economic load dispatch problem. These methods need derivative information of the objective function, give non satisfactory results and require large computational time for non-linear complex problem. Linear programming method suffers from the limitation as it require piecewise linear cost approximation. Newton based methods struggle with handling large number of inequality constraints. Recently various heuristic search techniques such as Genetic Algorithm (GA), Particle Swarm Optimization (PSO), Gravitational Search Algorithm (GSA), Artificial Bee Colony (ABC) and other alternative methods have been used to solved complex optimization problem [5].

2. CONVENTIONAL TECHNIQUES

In analyzing the optimization problem, there are many controllable parameters of interests. Further, many objective functions and constraints must be satisfied for power systems economic

operation. Existing methods for solving the economic dispatch problem solve it as a function of time using different constraints of the system. It uses mathematical techniques such as:

1. Newton Raphson (NR)
2. Lambda Iteration method
3. Linear Programming (LP)

2.1 NEWTON RAPHSON METHOD

Proposed newton raphson method getting trap into local minima, increasing computational complexity, non satisfactory results are experienced while working with Genetic Algorithm (GA) method. In this paper, various advance in the field of evolutionary method based on genetic algorithm for solving combine economic/emission dispatch problem have been discussed [5].

The application of the PSO method to optimal Power Flow solution to Combine Economic Emission Dispatch Problem is demonstrated in this Paper. The test results for the Problem brings out the advantages of the PSO method. In the PSO method, there is only one population, in each iteration, that moves towards the global optimal point. This makes the PSO method computationally faster. The convergence abilities of the PSO method are better than the other evolutionary methods. The price penalty factor for solving the CEED problem has been demonstrated on the IEEE 30 bus test system in order to obtain the exact total operating cost. In the proposed approach the minimum solution is obtained for PSO based combine economic emission dispatch with line flow constraints for IEEE30 BUS system [10].

2.2 LAMBDA ITERATION METHOD

The results show that GA solution is found to be more optimal than the conventional lambda iteration method. But degrades its performance due to premature convergence and reduce search capacity. The solution obtained by ACSA is more accurate compared to the lambda iteration method and is more optimal compared to GA method. Thus ACSA is observed to be efficient in terms of minimizing the cost and thermal emission solution but it takes more computing time. This paper shows the merit of ACSA which gives a considerable reduction in the total operating cost and emission calculated in comparison to the cost calculated by Lambda iteration and GA method. [16].

In this paper, a new optimization of BAT algorithm has been proposed. In order to prove the effectiveness of algorithm it is applied to CEED problem with three and six generating unit. The results obtained by proposed method were compared to those obtained conventional method, RGA and SGA and Hybrid GA and ABC. The comparison shows that BAT algorithm performs better than above mentioned methods. The BAT algorithm has superior features, including quality of solution, stable convergence characteristics and good computational efficiency. Therefore, this results shows that BAT optimization is a promising technique for solving complicated problems in power system [26].

When compared with conventional method, the genetic algorithm method, the total cost obtained and the total emission is less and the premature convergence nature of GA method is avoided by introducing elitism and changing probabilities of cross over and mutation. Due to these operators, this modern method is concluded

as more efficient method with better solution with reasonable feasible computation time. This can be used further for unit commitment for known priori and also can be used for hydro scheduling This paper provides proposed method provides optimal solution with economic cost and less emission of NO_x [3].

A new strategy involving SA for solving EED problem has been developed with a view to lower the computational burden and renders it suitable for online applications. The close agreement of the performance of PA with the benchmark λ – iteration method, besides allowed to acclaim its accuracy. The fact that it has been coined with a single decision variable facilitates it with a smaller search horizon and cool down at the global optimal solution vary fast. The objective function is thus obtained by blending the emission cost function with the fuel cost function through the use of a price penalty factor [25].

This paper proposes a lambda based approach for solving the Combined Economic and Emission Dispatch (CEED) problem using Genetic Algorithm (GA) methodologies considering the power limits of the generator Algorithms have been developed for the determination of the global or near-global optimal solution for the Combined Economic and Emission Dispatch (CEED) problem. The solution algorithms have been tested for test system with three generating units. This paper provides proposed method provides optimal solution with economic cost and less emission of NO_x in to atmosphere. Hence GA is more efficient method which gives better solution [8].

2.3 LINEAR PROGRAMMING METHOD

In this paper the fuel cost and emission are combined into a single function and the load dispatch for minimum of the total objective function are obtained. SVC is installed in the IEEE 30 bus system and the stabilized voltages and reduction MVA loading of the transmission lines has been observed. PSO technique is employed as it possesses advantages of modeling flexibility, sure and fast convergence, less computational time over other heuristic methods. Further this work can be extended over to other FACTS devices [12].

This paper has formulated and implemented a hybridized PSO and ABC algorithm and has been shown to improve the optimization of the combined economic and emission dispatch problem. Though the proposed method shows efficiency than the algorithms it was compared with, its speed can be improved with the inclusion of mutation operators from other algorithms to improve its real time benefit which minimize fuel cost and emission [14].

3. GENETIC ALGORITHM

Literature shows that GA is not limited to single objective problems. Guvenc [6] proposed genetic algorithm based algorithm on similarity crossover for solving combine economic and emission dispatch (CEED) problem in power system. In this, offspring are created by using similarity measurement between mother and father chromosomes relationship. In the proposed method price penalty factor is used to convert multi-objective problem into single objective. This technique can applied on CEED problem.

Many limitations such as large computational time, getting trap into local minima, increasing computational complexity, non satisfactory results are experienced while working with Genetic Algorithm (GA) method. In this paper, various advance in the field of evolutionary method based on genetic algorithm for solving combine economic/emission dispatch problem have been discussed. In this paper worked on real-coded GA to minimize the dispatch cost and emission while satisfying generating unit and branch power-flow limits. [5].

In this paper, a novel genetic algorithm method based on similarity crossover for solving CEED problem in power systems is proposed test results have shown that the proposed genetic algorithm can provide better solutions than particle swarm optimization, differential evolution, lambda-iteration, recursive and simplified recursive methods. Due to these properties, the proposed methods in future should be applied in complex unit commitment problems and dynamic CEED problems, in the search of better quality results. In this paper finds the optimal combination of power generation that minimizes the total fuel cost while satisfying the total demand and power system constraints. The operation cost and emission of SRM is higher than the operation cost and emission of the proposed method [6].

This paper presents the survey on the existing ED optimizing techniques for power system with its functionalities specific features and drawbacks. The existing Economic and emission Dispatch techniques present in the literature which is very much required to minimize the operating cost while maintaining system stability and consistency and provide better performance. This paper present major studies of power system ED

techniques, such as ANN, fuzzy logic, Genetic Algorithm and other optimization techniques which is available in the literature. And the solutions have been obtained for various values of weight factor w and the obtained total thermal cost and total NO_x emission values have been evaluated [2].

The results show that GA solution is found to be more optimal than the conventional lambda iteration method. But degrades its performance due to premature convergence and reduce search capacity. The solution obtained by ACSA is more accurate compared to the lambda iteration method and is more optimal compared to GA method. Thus ACSA is observed to be efficient in terms of minimizing the cost and thermal emission solution but it takes more computing time. This paper shows the merits of ACSA which gives a considerable reduction in the total operating cost and emission calculated in comparison to the cost calculated by Lambda iteration and GA method [16].

This paper proposes a lambda based approach for solving the Combined Economic and Emission Dispatch (CEED) problem using Genetic Algorithm (GA) methodologies considering the power limits of the generator Algorithms have been developed for the determination of the global or near-global optimal solution for the Combined Economic and Emission Dispatch (CEED) problem. The solution algorithms have been tested for test system with three generating units. This paper schedule generating units, comparative reduction is achieved in both total fuel cost and No_x emission [8].

When compared with conventional method, the genetic algorithm method, the total cost obtained and the total emission is less and the

premature convergence nature of GA method is avoided by introducing elitism and changing probabilities of cross over and mutation. Due to these operators, this modern method is concluded as more efficient method with better solution with reasonable feasible computation time. This can be used further for unit commitment for known priori and also can be used for hydro scheduling. This paper provides proposed method provides optimal solution with economic cost and less emission of NO_x in to atmosphere. Hence GA is more efficient method which gives better solution [3].

3. PARTICAL SWARM OPTIMIZATION

The concept of particle swarm optimization (PSO) was first given by Kennedy and Eberhart in 1995 [28]. It is based on the principle of fish schooling and bird flocking. It is a population based method in which individual is considered as particle and each particle represent the solution candidate. A swarm of individuals fly through the solution space. The position of particle is adjusted by best position encountered by the particle itself or its neighbors.

Algorithms have been developed for the determination of global or near-global optimal solution for the CEED problem. The solution algorithms have been tested for test system with three generating units. The PSO approach has demonstrated an ability to provide accurate and feasible solutions within reasonable computation time. This paper schedule generating units, comparative reduction is achieved in both total fuel cost and No_x emission [8].

Economic and emission Dispatch problems are combined and converted into single objective function. The converted objective

function is minimized based on efficient Particle Swarm Optimization (PSO). The result shown that sets of suitable dispatch with respective economic or emission objectives can be efficiently found [9].

This paper presents a review algorithm based approach, particle swarm optimization(PSO), Differential Evolution (DE),artificial Immune system(AIS), strength pareto evolutionary algorithm (SPEA) which will encourage the researches for providing better solution for CEED Optimization in power system [5].

The application of the PSO method to optimal power flow solution to combine economic emission dispatch problem is demonstrated in this Paper. The test results for the Problem brings out the advantages of the PSO method. In the PSO method, there is only one population, in each iteration, that moves towards the global optimal point. This makes the PSO method computationally faster. The convergence abilities of the PSO method are better than the other evolutionary method. In the proposed approach the minimum solution is obtained for PSO based combine economic emission dispatch with line flow constraints for IEEE30 bus system [10].

This paper introduces a Particle Swarm Optimization algorithm to solve the economic power dispatch of power system with pollution control. The fuel cost and emission are combined in a single function with a difference weighting factor. The main advantage of PSO over other modern heuristics is modeling flexibility, sure and fast convergence, less computational time than other heuristic methods. PSO requires only a few parameters to be tuned, which makes it attractive from an implementation viewpoint. The feasibility of the proposed algorithm is demonstrated on an IEEE 30-bus system. The result including the

generation cost, the emission level and power losses are compared for economic dispatch and emission dispatch using Particle Swarm Optimization (PSO) [11].

In this paper the fuel cost and emission are combined into a single function and the load dispatch for minimum of the total objective function are obtained. SVC is installed in the IEEE 30 bus system and the stabilized voltages and reduction MVA loading of the transmission lines has been observed. PSO technique is employed as it possesses advantages of modeling flexibility, sure and fast convergence, less computational time over other heuristic methods. Further this work can be extended over to other FACTS devices [12].

This paper introduces a new approach based on Particle Swarm Optimization (PSO) optimization to study the power system economic dispatch with Emission, which is formulated as a constrained optimization problem. The proposed method has been applied to one test case. When compared with Evolution with a Genetic Algorithm (GA), the analysis results have demonstrated that PSO outperforms the other methods in terms of a better optimal solution and significant reduction of computing times. Overall, the PSO algorithms have been shown to be very helpful in studying optimization problems in power systems. In this paper mentioned multi-objective optimization problem can be converted to a single objective optimization problem by introducing a price penalty factor that strikes balance between cost and emission [13].

Combined and converted into a single objective function. The converted objective function is minimized the based on efficient Particle Swarm Optimization (PSO). The results

showed that sets of suitable dispatch with respect to economic or emission objectives can be efficiently found. This paper deals with issue of solving the economic dispatch problem includes the minimize carbon dioxide emission, and also achieve the minimum fuel cost [2].

This paper has formulated and implemented a hybridized PSO and ABC algorithm and has been shown to improve the optimization of the combined economic and emission dispatch problem. Though the proposed method shows efficiency than the algorithms it was compared with, its speed can be improved with the inclusion of mutation operators from other algorithms to improve its real time benefit. This paper considering the overall results the ABC-PSO yields a better combine economic and emission dispatch than both GA and PSO [14].

In this paper some intelligence techniques have compared with each other Combine Economic and Emission Dispatch problem has become an active area of research in the field of power system. It has been observed that the CEED problem can be solved by optimization algorithm like PSO, ACO, CS which reduces total emission and there total cost [15].

3. GRAVITATIONAL SEARCH ALGORITHM

In this paper, a GSA optimization algorithm has been proposed and successfully applied to solve the CEED problem. Simulation results show that the GSA approach provides effective and robust high-

quality solution. Moreover, the results obtained using GSA are either better or comparable to those obtained using other techniques reported in the literature. The convergence characteristics of GSA for the fuel cost, NO_x emission and combined fuel cost and NO_x emission minimization respectively [17].

GSA is one of the recent heuristic algorithms improved for solving optimization problems. In this paper, GSA is successfully applied to solve a combined economic and emission dispatch problem. The CEED problems formulated as a bi-objective optimization problem. The proposed approach is tested on four different test systems. Firstly, GSA is tested on six generators and eleven-generators, with a quadratic cost function for combined economic emission load dispatch problems. Secondly, the proposed algorithm is applied to ten generators and forty generators, with a non smooth cost function for CEED problems. The simulation result demonstrate the effectiveness and robustness of the proposed approach in solving the CEED problem under various test systems. Moreover, the results of the proposed GSA technique have been compared to those techniques published in the literature. It is seen from the comparison that the proposed method confirms the effective high-quality solution for CEED problems. This paper shows in GSA the cost and emission is less than other optimization techniques [18].

4. ARTIFICIAL BEE COLONY

In this paper, a new approach is proposed to solve combined economic emission dispatch (CEED) problem in power systems using modified artificial bee colony (MABC) algorithm

considering the power limits. to solve the combined economic emission dispatch problem considering linear equality and inequality constraints and also considering transmission losses. Economic and emission dispatch is a multi-objective problem. But the present approach makes use of only one objective function and depending upon the problem such as economic, emission or combined economic and emission dispatch, only the coefficients of the objective function has to be changed. The feasibility of the proposed method for solving CEED problems is demonstrated using IEEE 30-bus test system with six generating units. The comparison of the results with other methods reported in the literature shows the superiority of the proposed method and its potential for solving CEED problems in a power system. From the results obtained, it can be concluded that the MABC algorithm is a promising technique for solving complex optimization problems in power system operation. This paper shows minimum fuel cost and emission for CEED problem with all load demand respectively [19].

In this paper, a new optimization of artificial bee colony (ABC) algorithm has been proposed. In order to prove the effectiveness of algorithm it is applied to CEED problem with three and six generating unit. The results obtained by proposed method were compared to those obtained conventional method, RGA and SGA and Hybrid GA. The comparison shows that ABC algorithm performs better than above mentioned methods. The ABC algorithm has superior features, including quality of solution, stable convergence characteristics and good computational efficiency. Therefore, this paper shows results that ABC optimization is a promising technique for solving complicated problems in terms of minimum fuel cost, emission level and total operating cost [20].

This paper presents performances of a harvest season artificial bee colony (HSABC) algorithm for obtaining the best solution of a combined economic and emission dispatch (CEED). an application of HSABC for solving CEED problem using IEEE-30 bus system. Through the results obtained, it is concluded that HSABC used a CDP strategy is able to produce better performances, both placement strategies demonstrated in smooth convergence speeds, HSABC used CDP is faster than one of UDP, better results are also performed by the lowest value of MR and higher number of total food sources gives better this method demonstrates minimum cost and emission level in CEED problem [21].

In this paper, a flexible and efficient variant-based bee colony named dance bee colony with dynamic step size adjustment has been successfully adapted and applied for solving multi-objective economic emission dispatch considering valve point effect and total transmission losses. The robustness of the proposed approach has been tested and validated on two standard test system, IEEE 30 bus considering power losses and to the large test system with 40 units considering valve point effect. It is observed that the proposed variant is capable to enhancing the solution of the combined economic emission dispatch considering practical generator constraints. This paper results shows in 3 cases gives minimization fuel cost, minimization emission, minimization of cost and emission [22].

This paper presents a comparison of ABC's generations for solving a CEED problem using IEEE-62 bus as a sample system. The simulations considered equality and inequality

constrains as the operational limitations. The results show that all of ABC's generation have different characteristics and performances. The convergence speeds are smooth to select the solutions. Each method of ABC's generation has ability to reduce the time consumption expressed in the obtained iteration for searching a minimum cost of CEED problem. From six type of ABC, the superior algorithm is HSABC. This algorithm has produced better results for the CEED problems. In general this paper shows the minimum total cost and emission of sample system [23].

The importance of the proposed paper is coming from two main contributions. The first contribution is the proposed algorithm itself. The proposed algorithm is an adaptive and uses few parameters to be tuned. Furthermore, experimental results showed the proposed algorithms efficiency and robustness for both small and large-size problem instances. The second contribution of this paper is about parameter configuration methodology. Each metaheuristic algorithm such as the proposed algorithms has a predefined set of parameters which have to be initialized before an execution. This paper shows fuel cost rate and NO_x emission rate are calculated after each function call (each modification in food source locations) [24].

CONCLUSION

In this paper various popular techniques of combine economic and emission dispatch (CEED) covering both conventional and intelligent methodologies have been present. For each of the conventional and intelligent methodology, the contribution by researchers has been covered in review paper. This helps the reader to quickly get to know the significant contributions and salient

features of the contribution made by researchers as per the references mentioned. This paper includes discussion on conventional methods and the intelligence methods based on genetic algorithm, particle swarm optimization, gravitational search algorithm, artificial bee colony algorithm.

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