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An Experiment Approach to Economic Load Dispatch Using Optimization Using Heat and Power

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Abstract— In service with the problem of determining the outputs of the generating units the Economic dispatch is concerned, keeping the fuel cost to the minimum, in order to meet the total load. At equal incremental costs all the units (excluding those who are at their limit) would be operating, it is well known that at the optimum point. At the solution point in addition to the power demand in systems having some co-generation units, additional constraints have to be satisfied. For such system the simple equal incremental cost based economic dispatch schemes cannot be used. On the type of co-generation units the additional constraints that one has to include into the economic dispatch problem is depend. The economic dispatch problem of the system having co-generation type of units is addressed by the several researchers. With combined cycle co-generation units the economic dispatch of systems having simple cycle co-generation units has been investigated in the ED problem. In scheduling of back-pressure cogeneration plants the daily operation scheduling of co-generation units having heat storage tanks has been studied, additional issues like the time of use rate, wheeling, etc., have also been included. For the combined heat and power dispatch of systems it is seen that the mathematical models having cogeneration units turn out to be different depending on the type of the units as well as the operating environment of the units.

Keywords- *Economic dispatch; co-generation; combined cycle;* cogeneration.

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I. INTRODUCTION

There is sharp rise in energy demand which results increased pollution. Due to this, issues of energy conservation and green power gained much attention in 21st century. The conversion of primary fossil fuels, such as coal and gas, to electricity is a relatively inefficient process. Even the most modern combined cycle plants can only achieve efficiencies in between 50–60%. Most of the energy that is wasted in this conversion process is released to the environment as waste heat. The principle of combined heat and power (CHP), also known as cogeneration, is to recover and make beneficial use of this heat, which raise the overall efficiency of the conversion process. The very best CHP schemes can achieve fuel conversion efficiencies of the order of 90%. The energy saving potential as well as less greenhouse gas emission due to the wise use of cleaner fossil fuels burned in CHP units, like natural gas, give them advantage from conventional power systems. Cogeneration systems have now been extensively utilized by the industry. The industries with necessities of both heat and power can supply its own demands with CHP systems. CHP systems can be constructed in urban areas and used as distributed electrical energy sources. To obtain the optimal utilization of CHP units, economic dispatch (ED) must be applied for more energy saving.

Improved ant colony search algorithm, evolutionary programming (EP), the genetic algorithm, the harmonic search algorithm, and multi-objective particle swarm optimization (PSO) have been successfully applied to solve the CHPED problem. Differential evolution (DE), a relatively new member in the family of evolutionary algorithms, was first proposed throughout 1994–1996 by Storn and Price at Berkeley as a novel approach to numerical optimization. It is a population-based method and generally considered to be a parallel stochastic direct search optimizer that is very simple yet powerful. The main advantage of DE is its capability for solving optimization problems that a require minimization process with non-linear and multi-modal objective functions. DE has been applied successfully to various fields of power system optimization. In this thesis work one of the most recent heuristic techniques In a genuine bee colony, a few assignments are performed by particular people. These particular bees attempt to augment the nectar sum put away in the hive utilizing proficient division of work and self-association. The artificial bee colony (ABC) algorithm, proposed by Karaboga in 2005 for genuine parameter streamlining is a streamlined algorithm which re-enacts the forging conduct of a bee colony. The negligible model of swarm intelligent rummage choice in a bumble bee colony which the ABC algorithm mimics comprises of three sorts of bees: employed bees, onlooker bees and scout bees. A simple and very reliable method. These are precisely the characteristics of ABC that make it attractive to solve combined heat and power economic dispatch (CHPED) problems.

II. PROPOSED WORK

In proposed work Genetic Algorithm (G.A) and Particle Swarm Optimization algorithm is used for the better optimization results. Genetic algorithm is a meta-heuristic algorithm which is based on the gene and their operation. In the genetic algorithm all the process is based on the selection, cross-over and mutation operation for the optimal results. The optimization is based on the fitness value of the genes. This algorithm supports the local optimization process which is not enough to get the effective results. To overcome this issue the hybrid approach is proposed in the present work. The Particle swarm Optimization algorithm is a meta-heuristic algorithm which is based on the behavior of swarms. This algorithm is used to solve the complex problem to get the optimal results. PSO supports the Global optimization feature and gives the solution of the problem which is globally best. In the present work, PSO and G.A work parallel for better and optimal solution because both have different feature of optimization. In

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the below given section we explain the Genetic Algorithm (G.A) and Particle Swarm optimization (PSO) with algorithm and their flow chart. The flow chart of explains the step by step working and algorithm represents the technical implementation of the algorithms.

a. Genetic Algorithm

Step 1: Population← initialize Population
Step 2: Evaluate the population.
Step 3: ← get best solution from population. Step 4: while (! Stop condition())
Parents ← select parents(Population,)Child
For(
(
End
Evaluate the Population of Children
Population
End
Return ( )

b. Particle Swarm Optimization (PSO)

Optimizing the particle swarm may seem complicated, but it's really a very simple algorithm. On a number of iterations, a group of variables has its adjusted values closer to the member whose value is closest to the target at a given time. Imagine a flock of birds circling an area where they can smell a hidden food source. Whoever is closest to the food pips the loudest and the other birds sway in his direction. If one of the other birds gets closer to the target than the first one, he chirps harder and the others turn to him. This tightening pattern continues until one of the birds arrives on the food. It's a simple algorithm that is easy to implement.

The algorithm keeps track of three global variables:

1. Target value or condition
2. Best Global Value (gBest) indicating which particle data is currently closest to the target
3. Stop value indicating when the algorithm should stop if the target is not found

Each particle is composed of:
1. Data representing a possible solution
2. A velocity value indicating how much data can be changed
3. A better personal value (pBest) indicating the closest the particle's data has ever reached the target.

ALGORITHM OF PSO

Step 1: In PSO model for each particle i in S do
Step 2:for each dimension d in D do
Step 3://initialize each particle’s position and velocity
Step 4:xi,d = min) Step 5:= /3,/3) Step 6: end for
Step 7: //initialize particle’s best position and velocity
(k+1) = (k) + (k)) + (G- (k)) New velocity
(k+1) = (k) + (k+1) Where
i- particle index
k- discrete time index
vi –velocity of ith particle xi – position of ith particle
pi- best position found by ith particle(personal best)
G- best position found by swarm (global best, best of personal bests)
G (1,2)i- random number on the interval[0,1]applied to the ith particle
Step 8: =
Step 9: // update global best position
Step10: if) < Step 11:
Step12: end if
Step13: end for

C. Proposed Methodology

Flow Chart of PSO

(a) Initialize the chromosomes.
(b) Cross over between chromosomes.
(c) Apply Roulette Selection.
(d) Check Optimization. If optimize then go to convergence Check otherwise loop is running untilObjective form is not obtained.
Step 6: Check the convergence. If converge then check the cost features otherwise again initialize the particles and Repeat the step 5.
Step 7: If cost is less than Δ C then stop

PROPOSED ALGORITHM

PSO_G.A
Step 1: Initialize the load/ power. Step 2: Allocate the generators.
Step 3: Calculate the Initialize cost.
Step 4: In PSO model for each particle i in S do
Step 5: for each dimension d in D do
Step 6://initialize each particle’s position and velocity
Step 7: xi,d = min) Step 8:= /3, /3) Step 9: end for
Step 10: //initialize particle’s best position and velocity
(k+1) = (k) + (k)) + (G- (k)) New velocity
(k+1) = (k) + (k+1) Where
i- particle index
k- discrete time index
vi –velocity of ith particle xi – position of ith particle pi- best position found by ith particle(personal best)
G- best position found by swarm (global best, best of personal bests) G (1,2)i- random number on the interval[0,1]applied to the ith particle Step 11: =
Step 12: // update global best position
Step 13: if) < Step 14:
Step 15: if the output is optimize then check the converge otherwise follow Genetic algorithm for optimize results.
Step 16: Population← initialize Population
Step 17: Evaluate the population.
Step 18: ← get best solution from population.
Step 20: while (! Stop condition()) Parents ← select parents(Population,) Child
For(
(End
Evaluate the Population of Children
Population
End Return ( )
Step 21: Check the convergence.
If results are converged then optimize features are the output.
Step 22: Check the cost and stop.

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III. RESULTS AND DISCUSSION

a. COMPARISON RESULT

This section proposed result and comparison with different algorithm result. This result is calculated on the heat generators and power generators on Genetic Algorithm, PSO, and Genetic with PSO.

Approaches	Heat Generator 1	Heat Generator 2	Heat Generator 3
Genetic Algorithm	14.758	331.56	0.0321
PSO	125.48	69.0432	0.205
Genetic with PSO	0.0169	778.27	0.0253

Table 1: Generator comparison values

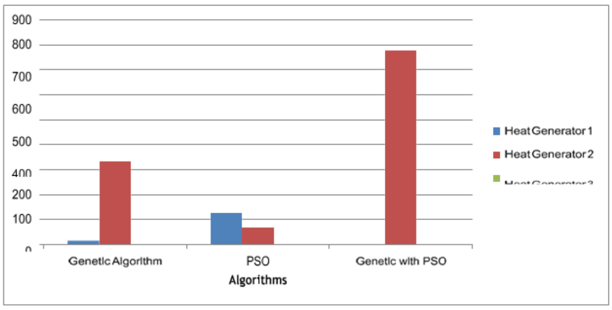

Figure 1: Heat Generators on different algorithms

In figure 1 depicts the heat generator values on the different algorithm approaches. The x- axis represents the algorithms and y-axis represents the values of the generator. The Genetic with PSO gives the effective heat generator values.

Approaches	Power Generator 1	Power Generator 2	Power Generator 3
Genetic Algorithm	49.11	79.7093	75.332
PSO	49.118	79.7093	75.332
Genetic with PSO	49.11	79.7093	75.332

Table 2: Different Algorithm Approaches

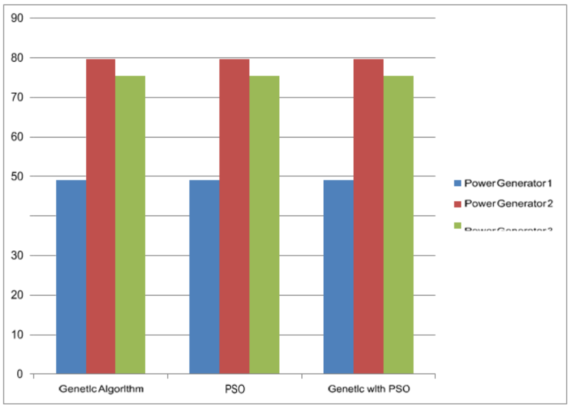

Figure 2: Power Generators on different algorithm

In figure 2 depicts the power generator values on the different algorithm approaches. The x- axis represents the algorithms and y-axis represents the values of the generator. The Genetic with PSO gives the effective power generator values.

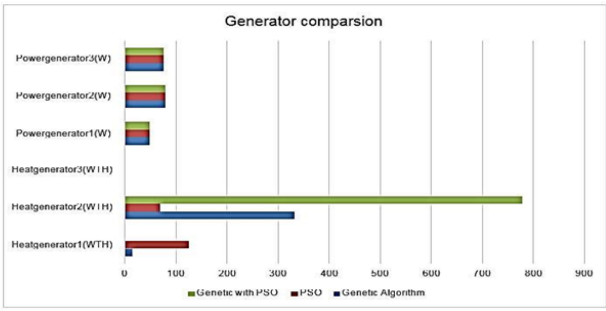

Figure 3: Generators Comparison

The figure 3 shows the comparison of the heat and power generators on the different algorithms. Here x-axis shows the values and y-axis shows the heat generators and power generators.

Approaches	Heat_Cost(Rs)	Power_cost(Rs)	Total cost(Rs)
Genetic Algorithm	725.09	1002.59	1727.68
PSO	625.03	472.74	1097.77
Genetic with PSO	515.2	320.13	835.33

Table 3: Results on different parameters

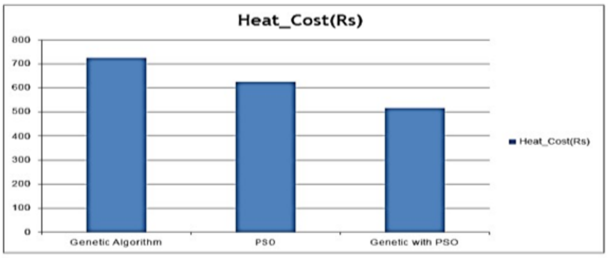

Figure 4: Heat_Cost on Different Algorithms

The figure 4 depicts the cost of heat in the different algorithms. In this graph x-axis represents the algorithmic approach and y-axis shows the value of cost

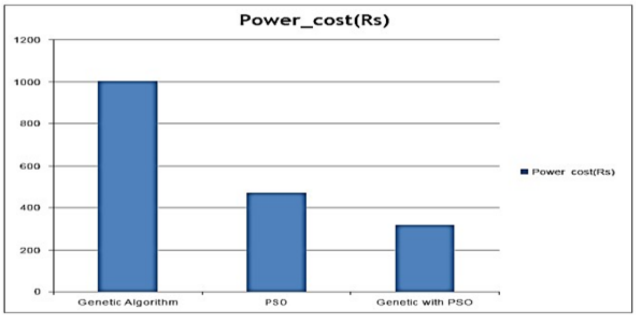

Figure 5: Power Cost on different algorithms

In figure 5 x-axis shows the approach used in the work and their comparison and y-axis represents the cost of the algorithms.

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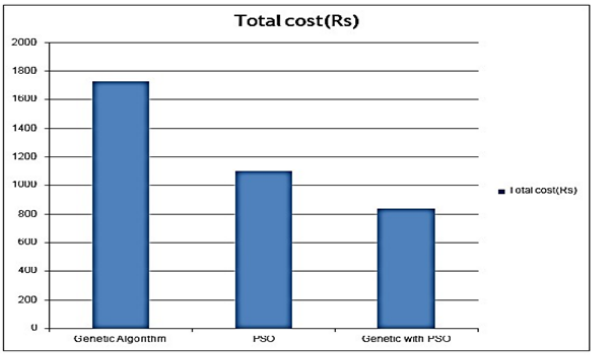

Figure 6: Total Cost on different algorithms

The figure 6 represents the total cost of the algorithms which is represented by genetic algorithm, PSO and Genetic with PSO. The proposed hybrid approach Genetic with PSO represents the reduction in cost.

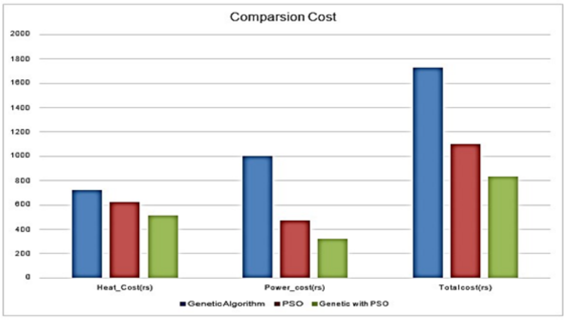

Figure 7: Cost Comparison on different algorithms

In figure 7 it depict the values of three algorithms that are Particle Swarm Optimization, G.A and Genetic Algorithm with Particle swarm optimization. The Blue bar represents the cost of Genetic algorithm, Red bar represents the Particle Swarm Optimization (PSO) and Green represents the proposed approach Genetic with PSO. The graph clearly describe the total cost is maximum on Genetic Algorithm and minimum on Genetic with PSO it is due to parallel working of both algorithm.

IV. CONCLUSION

In this study, two methods (lambda iteration method and ABC) are implemented to examine the superiority between them. Lambda iteration method is conventional method but ABC is population based search algorithm. ABC displayed high quality solution along with convergence characteristics. The plotted graphs for both three unit system and six unit systems showed the property of convergence characteristic of ABC. The reliability of ABC is also superior. The faster convergence in ABC approach is due to the employment of inertia weight factor which is set to be at 0.9 to 0.4(In fact, it decreases linearly in one run). As far as the fuel cost is concerned, it is small for three unit system but it is reasonably good for six unit system PSO method was employed to solve the ELD problem for two cases one three unit system and another six unit system. The PSO algorithm showed superior features including high quality solution, stable convergence characteristics. The solution was close to that of the conventional method but tends to give better solution in case of higher order systems. The comparison of results for the test cases of three unit and six unit system clearly shows that the proposed method is indeed capable of obtaining higher quality solution efficiently for higher degree ELD problems. The convergence characteristic of the proposed algorithm for the three unit system and six unit system is plotted. The convergence tends to be improving as the system complexity increases. Thus solution for higher order systems can be obtained in much less time duration than the conventional method.

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