IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)
An International Open Access, Peer-reviewed, Refereed Journal

Solution of Problem of Combined Economic/ Emission Dispatch by Genetic Algorithm

[1]Dr Ritunjoy Bhuyan, [2]Dr Sarmila patra

[1]Professor , [2]Professor
1Electrical Engineering Department

[1] The Assam Kaziranga University,Jorhat, Assam, India

Abstract— —"Genetic Algorithm "is an efficient hybrid optimization Technique which is proposed in this paper as a tool to optimize the Combined Economic /Emission Load Dispatch Problem in Electrical Power System . The key mechanism of this optimization method is that the solution found by Genetic Algorithm is coping up with non-linearity and discontinuities which are very common in optimization problems.. Being an evolutionary optimization technique, this method adopts random search method within a definite search space .The Algorithm has been experimented on three different test systems and the superiority has been revealed in comparison to some other optimization techniques.
.

Key word: optimization, Genetic Algorithm, , Load dispatch, non- Linearity
.

1.INTRODUCTION

The economic load dispatch problem deals with the determination of optimal combination of power output for all generators to minimize the total fuel cost maintaining all demands and operational constraints. But the operation at minimum fuel cost level causes environmental pollution problems. Fossil fuels like coal, gas or combinations, after being burnt, emits CO,C N ,S ,Particulates and thermal emission. One of the methods for reduction of emission is allocation of load to individual generator keeping in view minimum emission dispatch

Thus Combined economic emission dispatch is one of the most recent optimization problems of power system which can be solved by both conventional and evolutionary optimization techniques. Here an evolutionary optimization technique–Genetic algorithm optimization is applied to solve the combined economic emission dispatch problem

2.GENETIC ALGORITHM

It's a global optimization technique with probabilistic and heuristic approach to solve power system problem. It can cope up with non-linearity and discontinuities which are very common in optimization problems.

The basic concept of GA is ability to simulate processes in natural system following the great principle of Charles Darwin "SERVIVAL OF THE FITTEST". To solve a problem, the technique adopts a random search within a definite search space.

This GA optimization technique becomes a strong alternative to the classical method, overshadowing them gradually. GA can solve problems which either do not have specific method of solution or takes long time to get a solution. In contrast, GA. handles the objective function information in a search space for an optimum result.

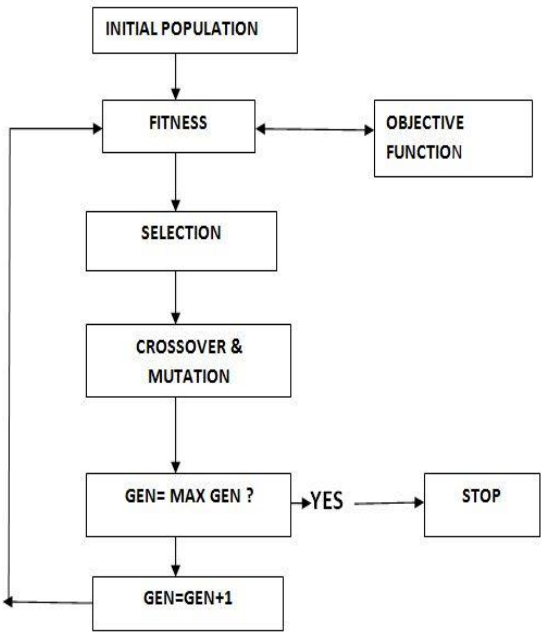
2.1 COMPONENT OF GENETIC ALGORITHIM:

Population genetics is the basic model of GA. It has five components:

1. String representation of control variable
2. An initial population string
3. An evaluation function which is used to determine the fitness of the string
4. A new population generated by cross over and mutation
5. Value of the parameters used by the technique

There is a strong analogy between GENETIC ALGORITHIM and NATURAL GENETICS. The strings are similar to chromosomes of biology. The chromosome contains genes called "alleles" For real number control variables , it is called Real coded GA and for binary, it is called binary coded GA. GA always works with a population of strings where new string takes the place of parent. In GA, the input is string and the output is the fitness of the string.

2.2 . FLOW CHART OF GA:



2.3 OPERATORS:THE FOLLOWING OPERATORS ARE USED IN GA

2.3.1. Tournament selection: The selection operator improves the average quality of the population by giving individual of higher fitness a higher probability to be copied into next generation. Two individuals are selected randomly and copied the best individual into intermediate population.

2.3.2.WHOLE LINEAR CROSS OVER: This operator combines the genetic data of the existing population and generating off spring. Pair of chromosomes is recombined randomly to form two new individuals. From two parents p1 and p2 three offsprings are generated for example: 0.5p1+0.5p2, 1.5p1-0.5p2 and 0.5p1+1.5p2. Then the two bests are selected.

2.3.3.NON UNIFORM MUTATION: New genetic patterns are formed by this operator.

2.3.4.ELITIST STRATEGY: GA does not preserve the best possible solution very often. This problem may be overcome by Elitist_strategy .In the process, a new population is constructed by allowing the best organism(s) from the current generation to carry over to the next, unchanged. This **strategy** is termed as **elitist** selection. Elitist strategy ensures the fact that the quality of solution, obtained by the GA, will be improved from one generation to the next.

2.4.APPLICATION OF GA TO SOLVE CEED PROBLEM

The combined Economic Emission Dispatch is a bi-objective Problems which is converted to a single one by a cost penalty factor or hybridization factor as

f ( ) = Min ( ), ( )] (1)

Where f ( ) is the optimal cost of power generation, ( ) and ( ) are total cost and total emission, nG is the number of generators . The constraints are

= - where

is the real power generation of ith generator, and are total load and transmission loss of the system

≤ ≤ where

and are minimum and maximum real power allowed at generator I respectively

To handle the constraints, the violated constraints are squared then multiplied by a penalty coefficient and add to the fitness function.

The procedure of implementation of GA to solve CEED is described in the following steps.

Step 1: Input the total number of decision variable, population size, and cross over rate, mutation rate, cost coefficients, loss coefficients, load demand and limits of the constraints. Here the decision variables are the output of generators and are considered as population

Step 2: Generate the initial population which satisfies the limits and constraints.

Step 3: Objective function (fitness) of each individual is calculated.

Step 4: Perform cross over and mutation.

Step 5: Make the selection based on fitness.

Step 6**:** Stop the process if maximum number of iteration is reached, otherwise repeat from step 3.

i. Results and discussion:

The Genetic algorithm is applied to solve ELD, EED and CEED for three different test cases: 6 unit system,(Load 3MW) the parameters of GA are:

Population size=20;

Cross over rate=80%

Mutation rate=1%

The results of solution ELD, EED and CEED by GA for 6 unit system with load 3 MW are shown in Table 3.1, 3.2 and 3.3 respectively

Fig 3.1-3.3 shows the convergence characteristics of ELD, EED and CEED for 6 unit system by GA

Table2.1 :Economic load dispatch for 6 generators system

Generator	Economic load dispatch by GA	NSGA[15]
PG1	0.1183MW	.11680MW
PG2	0.3068 MW	0.3165MW
PG3	0.4650 MW	0.5441MW
PG4	1.1025 MW	0.9447MW
PG5	0.5463 MW	0.5498MW
PG6	0.3012 MW	0.3964MW
FUEL COST	602.47$/hr	608.245$/hr
EMISSION	0.2291Ton/hr	0.21664 Ton/hr
Loss	0.0533 MW	

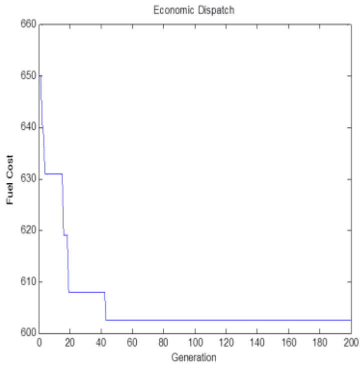


Figure 2.1: Convergence characteristic of ELD for 6 units

Generator	Emission dispatch by GA	NSGA[15]
PG1	0.418 MW	0.4113MW
PG2	0.465 MW	0.4591MW
PG3	0.543 MW	0.5117MW
PG4	0.407 MW	0.3724MW
PG5	0.531 MW	0.5810MW
PG6	0.52 MW	0.5304MW
FUEL COST	649.04$/hr	647.251$/hr
EMISSION	0.1942 Ton/hr	0.19432 Ton/hr
Loss	0.038 MW	

Table 2.2: Economic Emission dispatch for 6 generators system

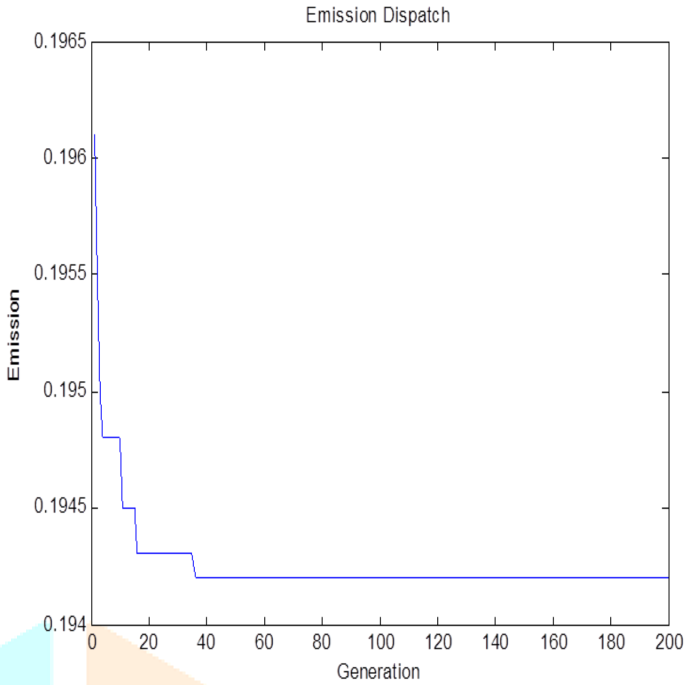


Figure 2.2 : Convergence characteristic of EED for 6 units

Table 2.3 : Combined Economic Emission dispatch for 6 generators system

Generator	**CEED by GA**	**By NSGA[15]**
PG1	0.193 MW	0.2699MW
PG2	0.34 MW	0.3885MW
PG3	0.48 MW	0.5645MW
PG4	0.71 MW	0.6570MW
PG5	0.693 MW	0.5441MW
PG6	0.449 MW	0.4398MW
FUEL COST	616.01$/hr	618.686$/hr
EMISSION	0.2044Ton/hr	0.19940Ton/hr
Loss	0.044 MW	

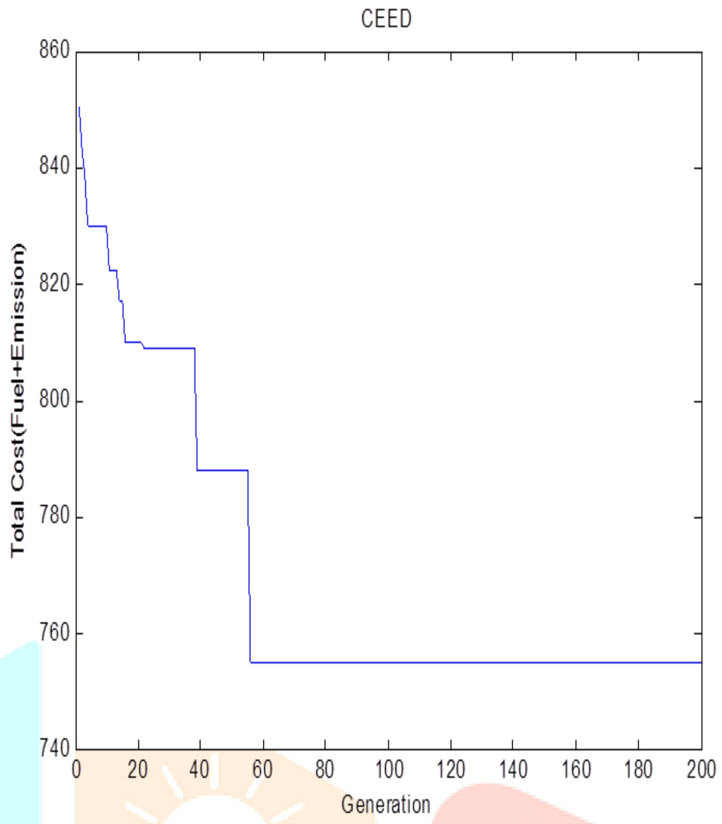


Figure 2.3 : Convergence characteristic of CEED for 6 units

The results of solution ELD, EED and CEED by GA for 10 unit system(load 2000MW) are shown in Table 3.4, 3.5 and 3.6 respectively Fig 3.4-3.6 shows the convergence characteristics of ELD, EED and CEED for 10 unit system by GA.

Table 2.4 : Economic load dispatch for 10 generators system

Generator	**ELD by GA**	**RCCRO[51]**
PG1	55 MW	55 MW
PG2	80 MW	79.9999 MW
PG3	106.93 MW	106.9220 MW
PG4	100.57 MW	100.5426 MW
PG5	81.49 MW	81.5216 MW
PG6	83.01 MW	83.0528 MW
PG7	300 MW	299.9999 MW
PG8	340 MW	339.9999 MW
PG9	470 MW	469.9999 MW
PG10	470 MW	469.9999 MW
FUEL COST	111500$/hr	111497.6319$/hr
EMISSION	4571.2 Ton/hr	4571.9552 Ton/hr
Loss	87.03 MW	87.0387 MW

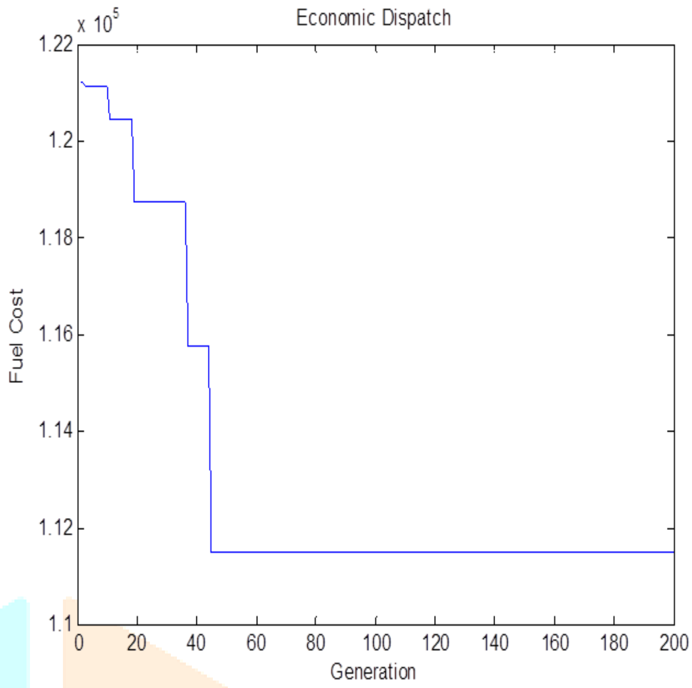


Figure 2.4: Convergence characteristic of ELD for 10 units

Table 2.5: Economic Emission dispatch for 10 generators system

Generator	**Emission dispatch by GA**	**RCCRO[51]**
PG1	55 MW	55.0000MW
PG2	80 MW	80.0000MW
PG3	81.96 MW	81.1342MW
PG4	78.82 MW	81.3637MW
PG5	160 MW	160.0000MW
PG6	240 MW	240.0000MW
PG7	300 MW	294.4851MW
PG8	292.78 MW	297.2701MW
PG9	401.84 MW	396.7657MW
PG10	391.21 MW	395.5763MW
FUEL COST	116420$/hr	116412.4441$/hr
EMISSION	3932.3Ton/hr	3932.2433 Ton/hr
Loss	87.03 MW	81.5952 MW

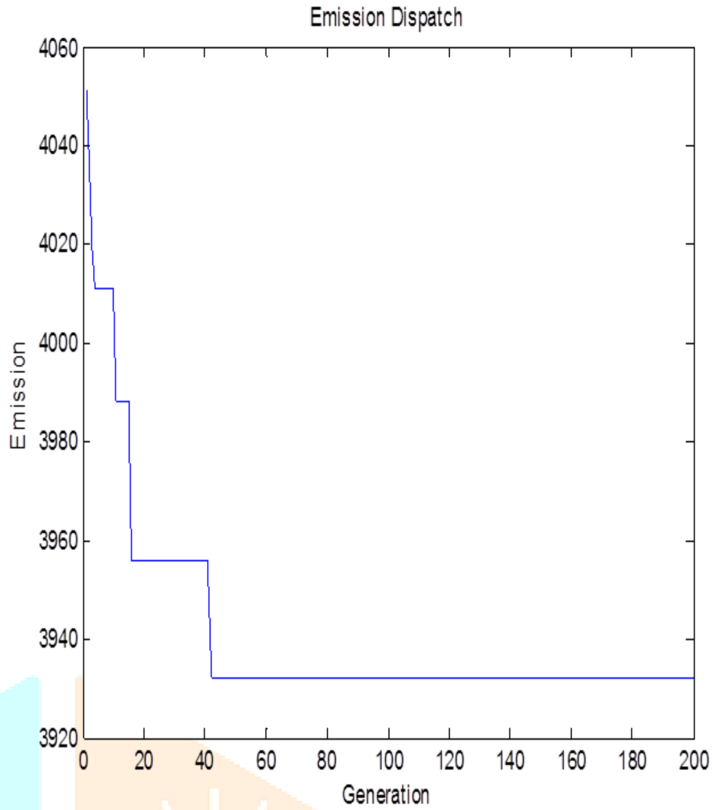


Figure 2.5 : Convergence characteristic of EED for 10 units

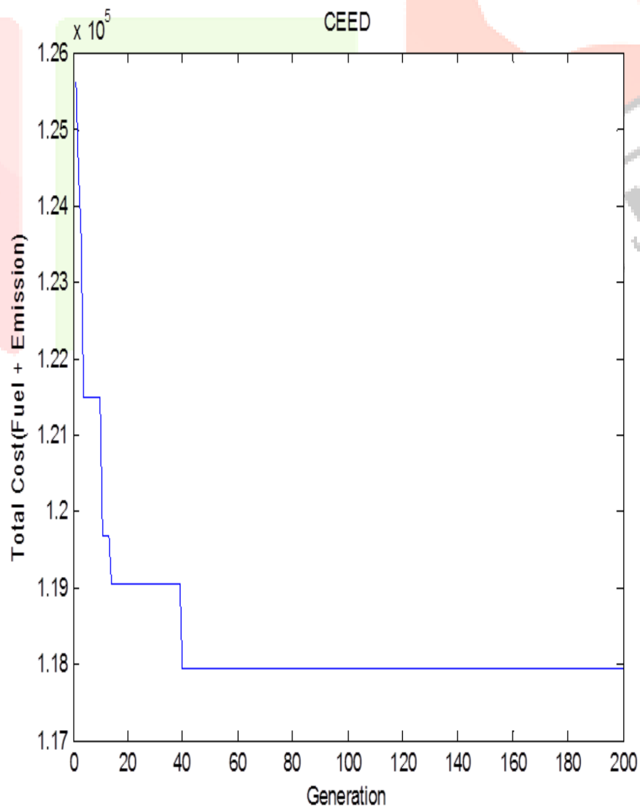


Figure 2.6: Convergence characteristic of CEED for 10 units

Table 2.6 : Combined Economic Emission dispatch for 10 generators system

Generator	CEED by GA	By RCCRO[51]
PG1	55 MW	55 MW
PG2	80 MW	80 MW
PG3	81.14 MW	85.6453 MW
PG4	81.22 MW	84.1250 MW
PG5	138.34 MW	136.5034 MW
PG6	167.5 MW	155.5801 MW
PG7	296.83 MW	300 MW
PG8	311.58 MW	316.6746 MW
PG9	420.34 MW	434.1252 MW
PG10	449.16 MW	436.5724 MW
FUEL COST	113420$/hr	113355.7475$/hr
EMISSION	4120.1Ton/hr	4121.0684 Ton/hr
Loss	88.23 MW	

Table 2.7: Economic Load dispatch for 13 generators system

Generator	ELD by GA	RCCRO[51]
PG1	628.31MW	628.3185MW
PG2	149.6 MW	222.7491MW
PG3	222.74 MW	149.5997MW
PG4	109.87 MW	109.8666MW
PG5	109.87 MW	60.0000MW
PG6	109.87 MW	109.8666MW
PG7	109.87 MW	109.8666MW
PG8	60 MW	109.8666MW
PG9	109.87 MW	109.8666MW
PG10	40 MW	40.0000MW
PG11	40 MW	40.0000MW
PG12	55 MW	55.0000MW
PG13	55 MW	55.0000MW
FUEL COST	17960.345$/hr	17963.8292$/hr
EMISSION	461.48Ton/hr	461.4806Ton/hr

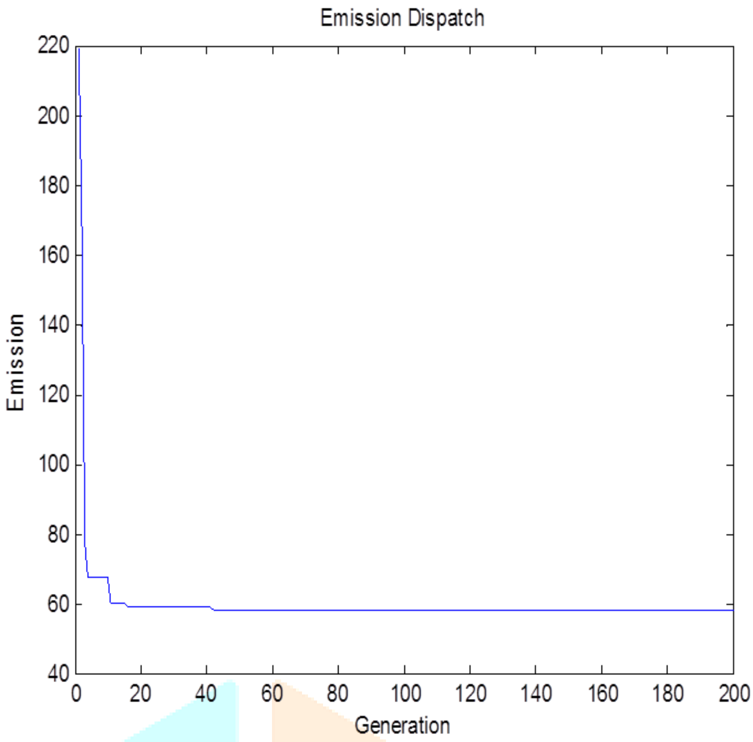


Figure 2.7: Convergence characteristic of ELD for 13 units

Table 2.8: Economic Emission dispatch for 13 generators system

Generator	**EED by GA**	**By RCCRO[51]**
PG1	80.77 MW	80.6407MW
PG2	166.31 MW	166.3287MW
PG3	166.88 MW	166.3287MW
PG4	154.77 MW	154.7332MW
PG5	155.42 MW	154.7332MW
PG6	154.87 MW	154.7332MW
PG7	154.72 MW	154.7332MW
PG8	154.52 MW	154.7332MW
PG9	154.76 MW	154.7332MW
PG10	119.43 MW	119.9637MW
PG11	119.29 MW	119.9637MW
PG12	109.20 MW	109.1877MW
PG13	109.12 MW	109.1877MW
FUEL COST	19098.76$/hr	19145.5678$/hr
EMISSION	58.24Ton/hr	58.2407 Ton/hr

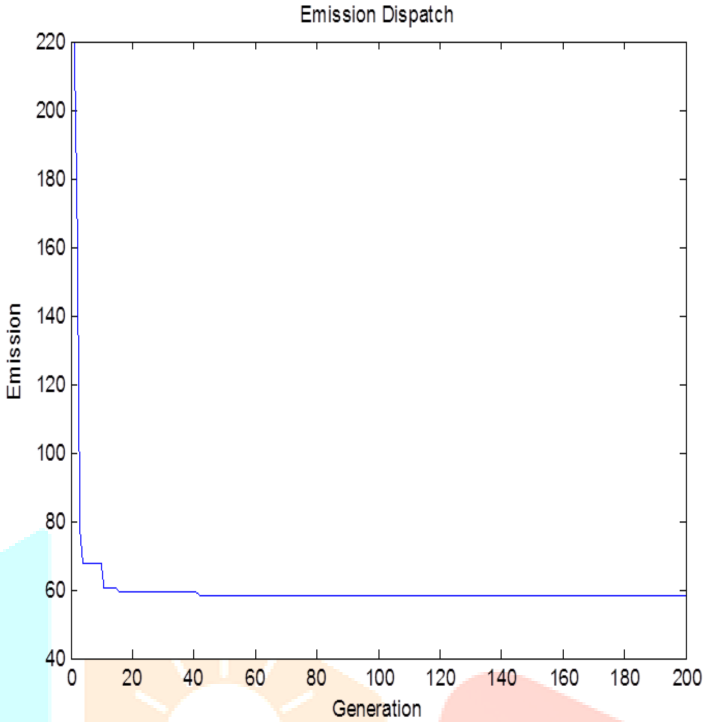


Figure 2.8: Convergence characteristic of EED for 13units

Table 2.9: Combined Economic Emission dispatch for 13 generators system

Generator	CEED	RCCRO[51]
PG1	179.5MW	179.0253MW
PG2	299 MW	224.1314MW
PG3	297.6 MW	298.4373MW
PG4	159.733 MW	159.7266MW
PG5	159.733 MW	159.7336MW
PG6	159.733 MW	159.7398MW
PG7	159.733 MW	159.7008MW
PG8	60 MW	159.6323MW
PG9	60 MW	109.8658MW
PG10	40 MW	40.0065MW
PG11	114.76 MW	40.0001MW
PG12	55 MW	55.0002MW
PG13	55 MW	55.0003MW
FUEL COST	18081.48$/hr	18038.83667$/hr
EMISSION	95.31Ton/hr	85.6546Ton/hr

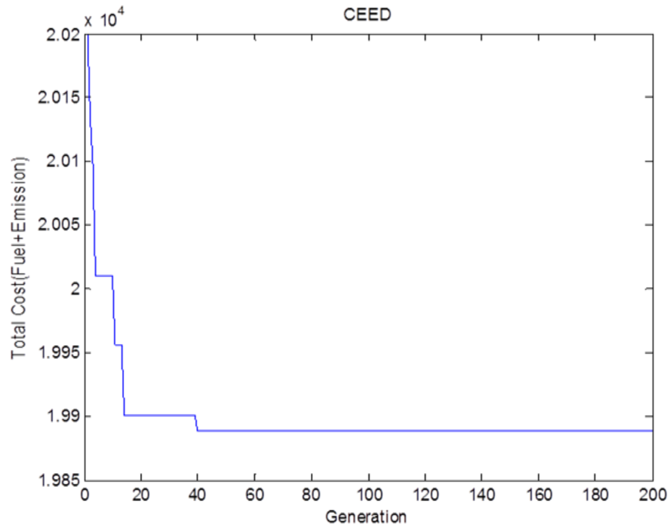


Figure 2.9:Convergence characteristic of CEED for 13units

3.Conclusion:

GENETIC ALGORITHIM is tried with 6 nos of generators (case 1), 10 generators (case2), and 13 generators (case 3). It has been found from the Table 2.3,2.6 & 2.9 that the fuel cost and emission evaluated by GA for CEED are 616. 01 and 0.2044 respectively for 6 units, 133420 & 4120.1 for 10 units and 18081.40 & 95.31 for 13 units The convergence characteristics fig 2.1 to fig 2.9also depict comparative information of the number of iterations required to converge in different cases

Table 3.1-Summery

		FUEL COST in $/hr	**EMISSION in Ton/h**	
6UNITS		**GA**	**GA**	**No of iteration**
	ECONOMIC LOAD DISPATCH	602.47	0.2291	43
	ECONOMIC EMISSION DISPATCH	648.04	0.1942	36
	COMBINED ECONOMIC /EMISSION DISPATCH	616.01	0.2044	56
10 UNITS	ELD	111500	4571.2	41
	E E D	116420	3932.3	40
	CEED	113420	4120.1	39
13 UNITS	ELD	17960.345	461.4.8	45
	E E D	19098.76	58.24	42
	CEED	18081.48	95.31	40

References

[1] K Senthi, ME ”Combined Economics Emission Sispatch using Evolutionary Programming Technic”IJCA Special Issue on “Evolutionary Computation for optimization Technique”ECOT2010.

[2] Waiel F Abd El-Wahed, A A MOSA,M A Elsisy, “Solving Economic Emission Load Dispach Problem by Using Hybrid ACO-MSM approach”-The On Line Journal on Power and Energy Engneering-vol-1, N0-1

[3] S MuthuVijayaPndian”An efficient Particle Swam Optimization Technic”

[4] Prof DrHabibRavipurdiVenkataRao”TLBO” Algorithm, Springer International,2016,DOI-10.1007/978-3-319-22732-0

[5] [16] Shi Y, Eberhart R. A modified particle swarm optimizer. Proceedings

[6] D E Goldberg ,Genetic Algorithm,AdditionWasley Reading Mass,USA,1989

[7] Kennedy J, Eberhart R. Particle swarm optimization. Proceedings of the IEEE international conference on neural networks Perth,
Australia), 1942–1948. Piscataway, NJ: IEEE Service Center; 1995

[7] Dorigo M,Maniezzo V,ColorniA.Ant system: optimization by a colony of
[8] cooperating agents. IEEE Trans SystMan Cybern 1996;26(1):29–41.
Eusuff MM, Lansey KE. Optimization of water distribution network design using the shuffled frog leaping algorithm

[9] Water Resour Plan Manage 2003;129(3):210–25.
[10] Goldberg DE. Genetic algorithms in search, optimization and machine learning. Reading, MA: Addison-Wesley Publishing Co; 1989.
[11] Caudill M. Evolutionary neural networks. AI Expert 1991;March:28–33.
[12] Dawkins R. The selfish gene. Oxford: Oxford University Press; 1976.
[13] Merz P, Freisleben B. A genetic local search approach to the quadratic assignment problem. In: Ba¨ck CT, editor. Proceedings of the 7th international conference on genetic algorithms. San Diego, CA:Morgan Kaufmann; 1997. p. 465–72
[14] Moscato P, Norman MG. A memetic approach for the traveling salesman