

A Comparative Overview of a Classical Optimization and Evolutionary Optimization Technique in View of Power System Optimization Problem

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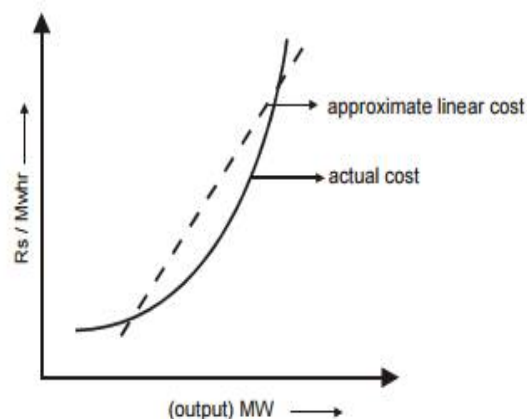
ABSTRACT: Power system optimization associates with complex and non –linear characteristics with many equality and non equality constraints. Either classical or evolutionary optimization techniques may be employed to the problems. In conventional optimization method, the function, which must have convexity and continuous variable, must be at least twice differentiable. As the input –output characteristic of generators are not always smooth; CEED is a non convex optimization problem, which is not easily solvable by traditional optimization method. In such situation, Evolutionary optimization becomes the alternative to solve optimization problem of power system with non-convex, non-differentiable and discontinuous function. But premature convergence and stagnation becomes an obstacle for direct use of evolutionary optimization method in power system. In this paper, a comparative study of a classical optimization method and an evolutionary optimization technique is tried to establish.

KEYWORDS: classical optimization method, evolutionary optimization techniques, Power system optimization, premature convergence.

I. INTRODUCTION

Electrical Power, is associated with the system like generation, transmission and distribution of electrical power in the load centers with economical high quality, reliable and cheapest power within certain limits and constraints on the generators. This can be accomplished by allocating the loads to the individual generator in a certain sequence which is termed as optimal combination of power output for all generators causing minimum fuel cost.. In short, minimizing cost requires Economic load dispatch of Electrical energy.

Following curves reveal the situation graphically Fig[1.1]& Fig[1.2]



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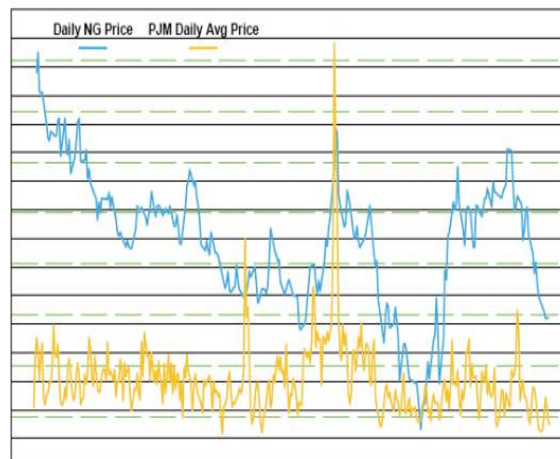


Fig.1.2

Minimum fuel cost level results Un-noticed Environmental pollution problems The energy conversion processes ,particularly thermal power plants , are creating ever increasing threat Fig [1.3] to the environment in respect of pollution , which necessitates some steps to limit the emission of pollutants in economic power dispatch. Thus a combined economic emission dispatch (CEED) becomes an important optimization problem with an aim to dispatch the electric power, taking into account both economic and environmental concerns.



Fig.[1.3]

emission from the combusted fossil fuels
(i).CO, (ii).CO₂, (iii).NO_x, (iv).SO₂
(v).Particulates (vi). Thermal emission

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Table I

Pollutant	Hard coal	Brown coal	Fuel oil	Other oil	Gas
CO ₂ , (g/GJ)	94,600	101,000	77,400	74,100	56,100
SO ₂ (g/GJ)	765	1,361	1,350	228	0.68
NO _x ,(g/GJ)	292	183	195	129	93.3
CO(g/GJ)	89.1	89.1	15.7	15.7	14.5
Non methane organic compounds (g/GJ)	4.92	7.78	3.70	3.24	1.58
Particle matter (g/GJ)	1.203	3.254	16	1.91	0.1
Fuel gas volume total (m ³ /GJ)	360	444	279	276	272

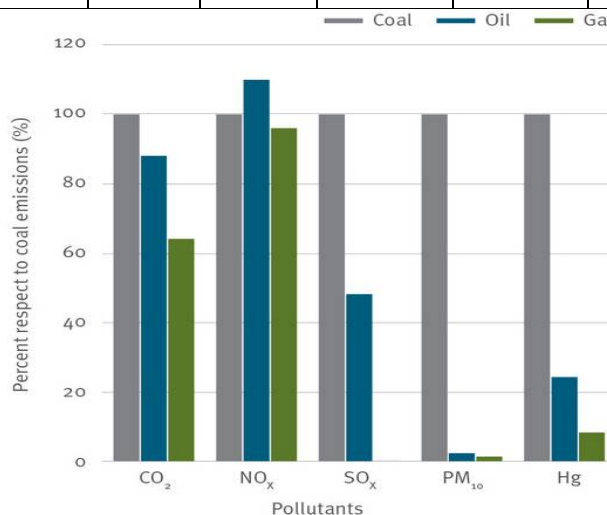


Fig.[1.4]

The harmful Emissions from the Thermal Power Plants can be reduced by Fig.[1.5]

- by using low emission potential fuels like low sulphur diesel etc
- by installing post combustion cleaning equipments
- by allocation of load to individual generator keeping in view minimum emission dispatch

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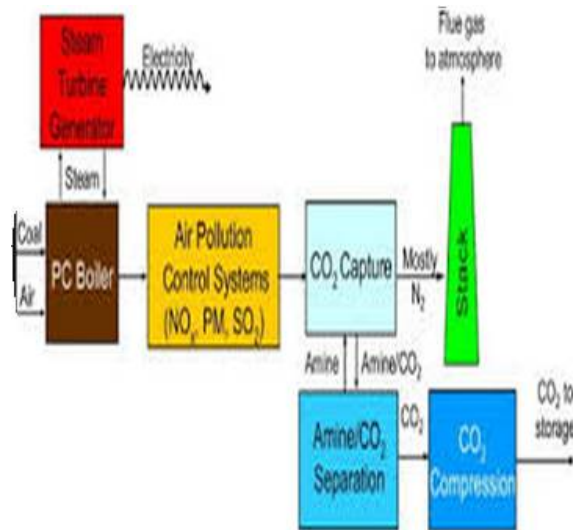


Fig.[1.5]

- Out of all the three measures, Effective low emission method demands minimum additional costs with the easiness of implementation process. The method involves in allocation of load to individual generator for minimum emission. As result for low cost as well as low emission of Toxic gas from a power generating system, a new approach comes into picture which is termed as “ECONOMIC EMISSION DISPATCH OF LOAD”, which turns out to be an ideal optimization Problem. The problem can be solved either by Classical Optimization Technique or by Modern optimization techniques.
- Traditional optimization method are
 - 1).Linear programming ,
 - 2).Evolutionary Programming,
 - 3).Newton’s method,
 - 4).Interior point method.

Modern optimization techniques includes-

(a).Genetic algorithm Fig [1.6](survival of genetically fittest), Smallest processing time out of these four modern technique of optimization.

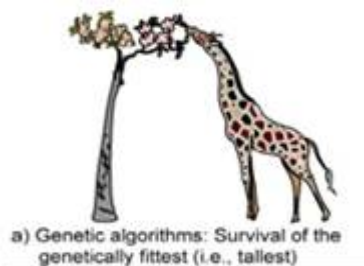


Fig.[1.6]

(b).Particle swarm Fig.[1.7] optimization(flock migration), meme tic algorithm(survival of genetically fittest& most experienced) , processing time is less than SFL.Fig.[1.7]

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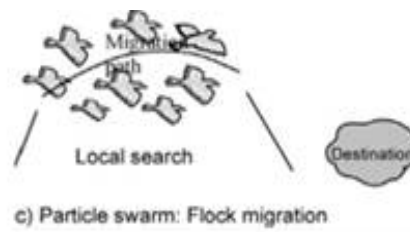


Fig.[1.7]

(c). **Ant-colony optimization** (shortest path to food particle), Fig.[1.8]

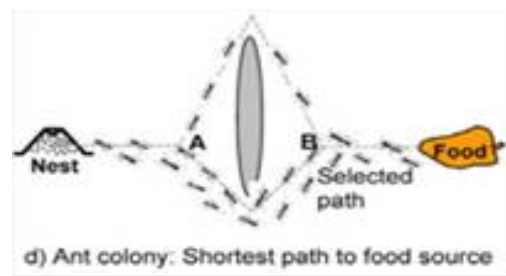


Fig.[1.8]

(d). **Shuffled frog leaping**(group search for food) –highest processing time to reach optimum Fig.[1.9]



Fig.[1.9]

Genetic Algorithm is a global optimization technique which is capable of handling non-linear and discontinuous problems. The technique is based on Charles Darwin's "SERVIVAL OF THE FITTEST"

For problems with no specific method of solution the method of course takes long time for a solution.

II. COMPONENT OF GENETIC ALOGORITHM

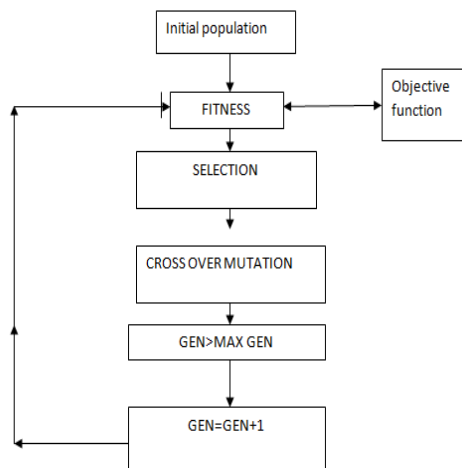
- (1). String representation of control variable
- (2). An initial population string
- (3). An evaluation function, that plays the role of the environment, rating the fitness of the string
- (4). By cross over mutation or reproduction, a new population is generated
- (5). Value of the parameters that the technique is using

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Flowchart



III. PROBLEM FORMULATION

The combined economic emission Dispatch is a bi-objective Problem which is converted to a single one by a cost penalty factor or hybridization factor as

$$f(P_{Gi}) = \text{Min} \sum_{i=1}^{nG} [F_i(P_{Gi}), E_i(P_{Gi})] \quad [3.1]$$

Where $f(P_{Gi})$ is the optimal cost of power generation, $F_i(P_{Gi})$ and $E_i(P_{Gi})$ are total cost and total emission, nG is the number of generators. The constraints are

$$\sum_{i=1}^{nG} P_{Gi} = P_D - P_L \quad [3.2]$$

Where P_{Gi}^{\min} and P_{Gi}^{\max} are minimum and maximum real power allowed at generator i respectively.

IV. EXAMPLE OF SIMULATION RESULTS

- IEEE-30 bus system
- 6 numbers of generators
- 41 transmission lines
- 280 MW load

For- fuel cost coefficient, emission coefficient. (taken from Balamurugan and Subramonium 2008)

Table II

Generation No	a_i	b_i	c_i	α_i	β_i	γ_i
1	0.00375	2.00	0	0.0126	-1.1000	22.93
2	0.01750	1.75	0	0.0200	-0.1000	25.313
3	0.06250	1.00	0	0.0270	-0.0100	25.505
4	0.00834	3.25	0	0.0291	-0.0050	24.900
5	0.0250	3.00	0	0.0290	-0.0040	24.700
6	0.02500	3.00	0	0.0272	-0.0050	25.300

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$$H_i = [1.792, 1.734, 2.230, 2.053, 2.220, 2.338]$$

Power loss = 14MW

GENERATOR OPERATING LIMIT is set as

G1 BUS with Min Power 50 MW & Max 200MW

G2 BUS with Min Power 20 MW & Max *)MW

G3 BUS with Min Power 15MW & Max 50MW

G4 BUS with Min Power 10 MW & Max 35MW

G5 BUS with Min Power 10MW & Max 30MW

G6 BUS with Min power 12 MW & Max 40 MW

RESULT are as(in MW)

G1 –from GA-138.2 & from EP-118.7

G2 -from GA-53.7 & from EP -62.2

G3-from GA 24.6 & from EP-34.4

G4-from GA 28.5 from EP-24.2

G5 from GA 22.9 & from EP- 21.6

G6 from GA 23.3 from EP-28.07

Table III.

Results of individual generator

	Best Fuel Cost	Best Emission Cost
PG1	170.85	115.52
PG2	44.604	50.19
PG3	18.87	30.167
PG4	25.67	31.45
PG5	10.42	25.13
PG6	15.32	35.12
FUEL COST	808.676	874.302
EMISSION	400.446	355.115

V. INTERPRETATION

Outcome of the approaches (Combined and individually)

1. SAVING Rupees/hr of fuel cost
2. Kg/hr minimization of toxic gases amount

VI. CONCLUSION

Genetic Algorithm Comes out to produce Satisfactory results as Faster technique and as Effective technique Than Traditional optimization technique

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