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Economic Load Dispatch of Three Bus Thermal Generator Using Fuzzy Logic Technique

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***Abstract* - This paper gives details/information about economic load dispatch using manual method and optimized fuzzy method. Using manual method, we get lambda 'λ' one of the inputs to the fuzzy by using different demand values. The calculations of manual method and fuzzy results are both mentioned in this paper. The whole analysis is done considering transmission losses.**
***Keywords:* Economic Load Dispatch, Lamda, Fuzzy**

I. INTRODUCTION

One of the major problems faced in the present is the exhaustion of fossil fuels, fossil demand as day's passes are increasing rapidly that makes the future's development in all fields as fossil fuels plays major role in transportation, electricity and etc., in electrical systems fossil fuel plays major role in generation under electrical based sectors, as 70% of generation is from thermal generation. Thermal energy is produced from coal as source, where coal is one of the major fossil fuel available which is under scarcity. Hence economic load dispatch can be one of the methods to help in saving fossil fuel. Economic load dispatch saves fossil fuel by choosing appropriate generators for meeting demand and thereby reducing the generation fuel cost, thereby reducing fossil fuel consumption. The main aim of ELD (economic load dispatch) is to make surethat demand is to be met considering transmission losses by scheduling or selecting appropriate generators which givesminimal fuel cost.

II. ANALYTICAL METHOD

Incremental fuel cost: It is the major consideration to get optimized fuel cost value through economic load dispatch. It is represented as lambda 'λ', defined as change in fuel cost corresponding to change in generation units given by,

$$\lambda = \frac{dCi}{dPi}, \qquad i = 1,2,\ldots n \qquad (1)$$

Ci = Fuel cost equation for ith generating unit
Pi = Generating unit

III. CONSTRAINTS OF ECONOMIC LOAD DISPATCH

There are generally two constraints in power system i.e., equality and inequality constraints. Equality constraints which deal with generation meeting both load and transmission losses given by

$$\sum Pi = Pload + Ploss \qquad (2)$$

Inequality Constraints deal with voltage, current and power maintained under its limits which are not considered in this paper.

IV. SYSTEM UNDER INVESTIGATION

The data gives details about cost and loss functions including generation constraints.

Unit1:C1= 200+7.0Pg1+0.008Pg12 Rs/MW (3)
Unit2:C2= 180+6.3Pg2+0.009Pg22 Rs/MW (4)
Unit3:C3= 140+6.8Pg3+0.007Pg32 Rs/MW (5)
Loss Function:
PL= 0.000218Pg12+0.000228Pg22+0.000179Pg32 MW (6)

The above three bus system is considered and accordingly manual calculations are done to solve economic load dispatch, where the incremental fuel cost is found considering losses for different demands which are assumed values.
The formulas used to calculate manually are mentioned below:
Assuming incremental fuel cost 'λ' is assumed for first iteration as 8.0

$$Pg_i = (\lambda^{(K)} - Bi) / (2(\gamma_i + \lambda^{(K)}\beta_{ii})) \qquad (7)$$

$$\sum_{i=1}^{ng} (\partial Pi / \partial\lambda)^{(K)} = \sum_{i=1}^{ng} (Ci + \beta_{ii}B_i)/(2(C_i + \lambda^{(K)}\beta_{ii})^2) \qquad (8)$$

Pgi= Power output of different generating units
$(\lambda^{(K)})$ = incremental fuel cost
β_{ii} =loss coefficients
B_i, C_i =Fuel coefficients

Considering demands of 150MW, 180MW, 200MW and their corresponding values of Pg_i, P_L, λ, fuel cost was calculated for 3 iterations and is tabulated below.

TABLE I FUEL COST FOR 3 ITERATIONS

Pd	λ	Pg1	Pg2	Pg3	P_L	Fuel cost
150	7.678	35.09	64.13	52.47	1.699	1892
180	7.878	45.19	73.094	64.106	2.399	1825.9
200	8.013	52.20	79.29	71.89	2.952	1988

Disadvantages of Analytical Method

1. Time consuming as the number of iterations increases to get precise value.
2. Complex as to calculate the generation or the fuel cost for changing demands.

Hence using soft computing techniques, one such technique used here is fuzzy logic using matlab software.There are few disadvantages working with manual method hence going to soft computing techniques such as fuzzy technique which is used in this paper to get optimized solution considering the values got in manual calculation which is used to solve it in fuzzy which is explained in further part of the paper.

V. IMPLEMENTATION OF FUZZY LOGIC

In general fuzzy deals with uncertainties as well it does not consider Boolean values as 0 and 1 as an answer, where it gives a mathematical/ algorithm to solve the uncertainties present in the problem. Here the fuzziness is checked (the degree of uncertainty).

It solves the problem by the help of membership functions, member functions is nothing but having number of sets which deals with binary certain precise solutions and imprecise solutions to get a universe of sets which can give a overall value of solution for a certain problem.

The fuzzy controller here is a two input three output system. The controlling is done by manmade rules entered in the fuzzy interface system. The input quantities are lambda and demand where as the output quantities are the generating units which are Pg1, Pg2, and Pg3.

The membership functions are represented by VVL,VL, L, M, H, VH, VVH stands for Very Very Low, Very Low, Low, Medium, High, Very High, Very Very High. Hence the rules will be depicted as ‘if Pd is Low and λ then Pg1 is L4, L5, L6, L7. Triangular membership functions are used. For defuzzification, Centroid method has been used.

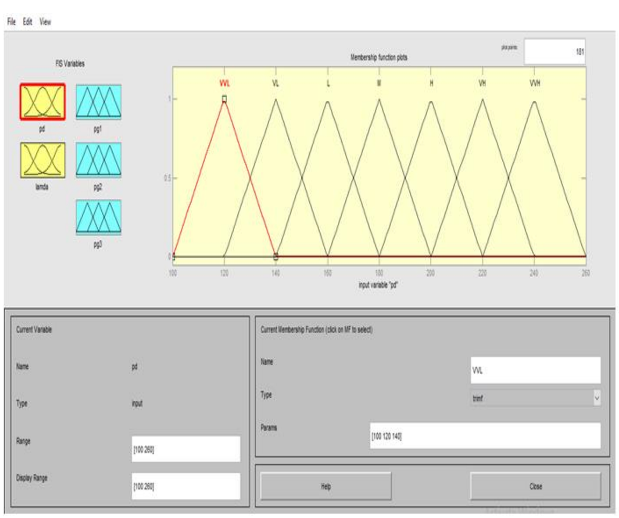

Fig.1 Membership function of Pd

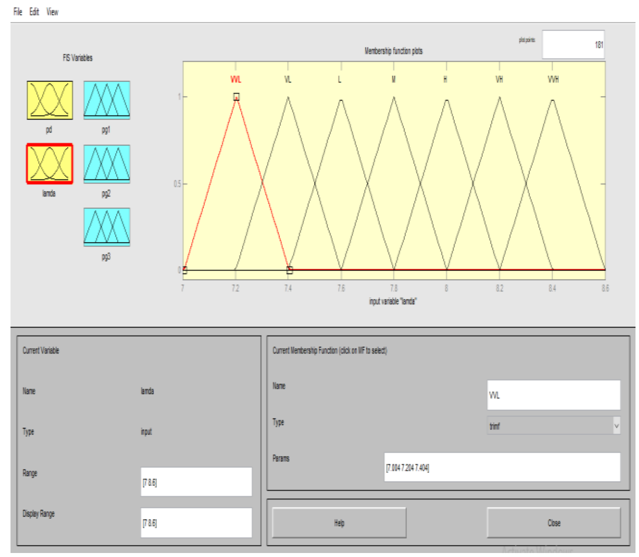

Fig. 2 Membership function of lambda

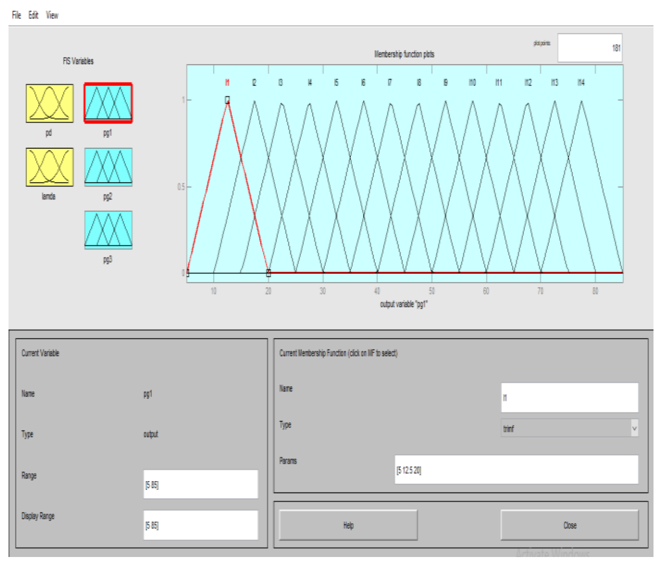

Fig. 3 Membrship function of Pg1

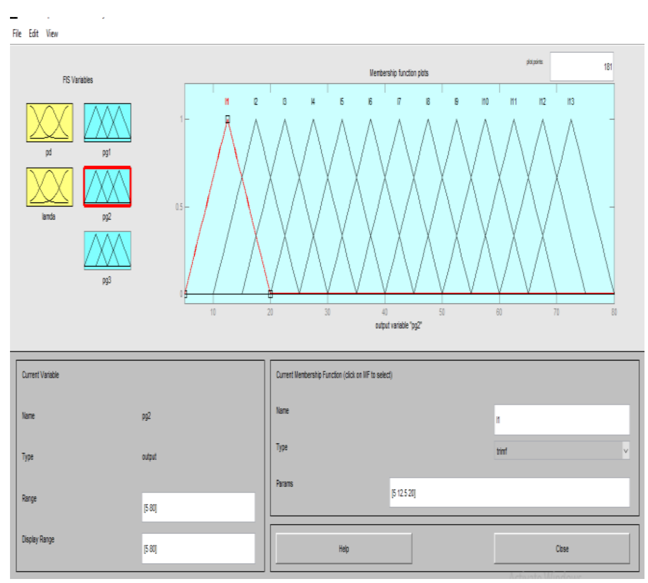

Fig. 4 Membership function of Pg2

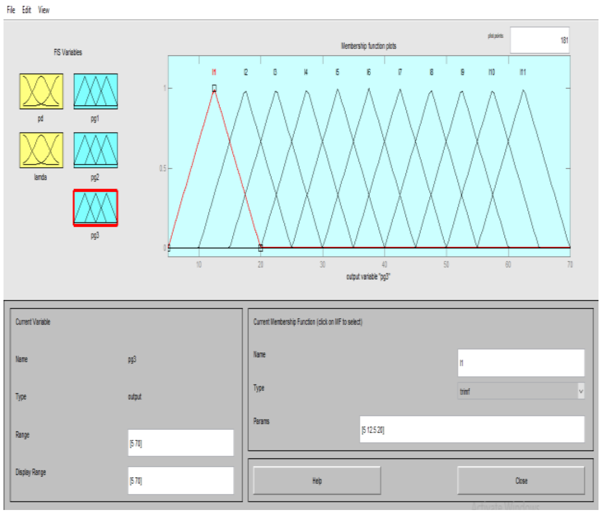

Fig. 5 Membership function of Pg3

TABLE II RULE TABLE FOR FUZZY INTERFACE

Pd (demand)	λ(lambda)	Pgi(generation)
VL	VL	L4,L5,L6,L7 (Pg1)
VL	L	L4,L5,L6,L7 (Pg1)
VL	M	L4,L5,L6,L7 (Pg1)
L	VL	L4,L5,L6,L7 (Pg1)
L	L	L4,L5,L6,L7 (Pg1)
L	M	L4,L5,L6,L7 (Pg1)
VL	VL	L10,L11,L12 (Pg2)
VL	L	L10,L11,L12 (Pg2)
VL	M	L10,L11,L12 (Pg2)
L	VL	L10,L11,L12 (Pg2)
L	L	L10,L11,L12 (Pg2)
L	M	L10,L11,L12 (Pg2)
VL	VL	L9,L10 (Pg3)
VL	L	L9,L10 (Pg3)
VL	M	L9,L10 (Pg3)
L	VL	L9,L10 (Pg3)
L	L	L9,L10 (Pg3)
L	M	L9,L10 (Pg3)

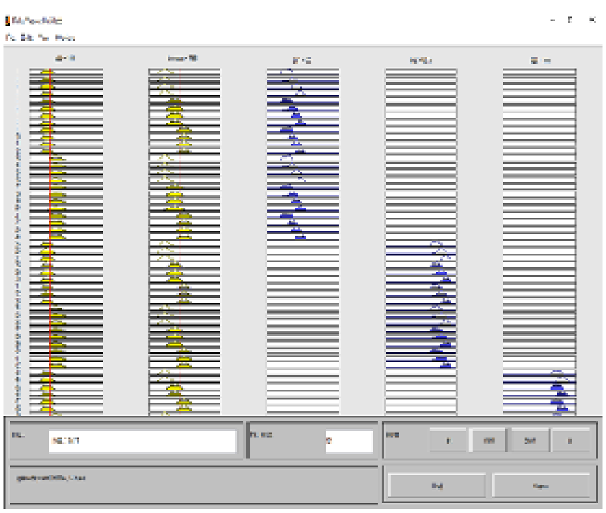

Fig. 6 Simulation Output Results

VI. APPLICATIONS

The proposed system can be implemented various distribution sectors irrespective of change in demand.

A. Advantages

1. This project will help to deal with the problem of time to solve ELD.
2. It is less complex and understandable once practiced.
3. The vales of generation obtained by this method can gives us less fuel cost compared to analytical method.
4. As soft computing technique, data is preserved and loss of data is taken care of.
5. The data preserved can be used for studying change in future demand.

VII. CONCLUSION

The proposed method shows the fuel cost thus obtained using fuzzy is better compared to analytical method by reducing time and complexity. Thereby saving fossil fuels as well as making it economic, as shown in the above figure fuzzy based solution is better and economic compared to manual method.

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