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Maximizing Biogas Electrical Power Generation Using Fuzzy Logic Controller

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Abstract: The epileptic power supply in the society today has become a chronic problem in our industrial sector. This inconsistence in power supply can be outwitted by using biological gas like improving biogas electrical power output using fuzzy logic controller. This can be done in this manner, characterizing the network under study, designing a membership function that analyzes the increase of biogas electrical power, designing a fuzzy rule that sticks in the increase of biogas electrical power output, designing a Simulink model for Improving biogas electrical power output using fuzzy logic controller and comparing the percentage biogas electrical power increase with and without fuzzy controller. The result obtained shows that biogas electrical power output without using fuzzy is 8KW while when fuzzy is incorporated is 10.77KW which is 14.78% increase when fuzzy controller is incorporated than when it was not imbibed.
Keywords: Improving, biogas, electrical power, fuzzy controller.

INTRODUCTION

The increasing need for Biogas electrical energy, as well as limited fossil fuel reserves, and the increasing concerns with the population call for fast development in the area of Renewable Energy system. These changes imply a requirement for better control schemes in modern power systems. Fuzzy logic is used in solving a wide range of control problems in power system operation because of simplicity, robustness, and reliability which are essentially based on linearized mathematical models of the controlled systems.

The fuzzy control method tries to establish the controller directly based on measurements, long term experiences, and knowledge of domain experts/operators [1].

Benachaiba and his collogues have applied fuzzy logic technique within micro-grid energy system [2]. It is used to track the disturbance of the grid and improve the quality of system. Fuzzy logic technique is found to be very compatible even when used in conjunction with other complex algorithms for arriving at effective solutions. Mohamed have proposed an algorithm for optimizing the distribution system operation using a fuzzy based smart controller in a smart grid considering cost and system stability [3]. The algorithm aims at controlling the power available from different sources which focused on renewable energy sources. Adaptive chaos clonal evolutionary programming (ACCEP) has been used by for short-term active power scheduling of a stand-alone wind and solar PV system [4]. As fuzzy logic was found to be a highly appropriate tool in capturing uncertainties, fuzzy sets was used to model the uncertainties. The fuel cost and CO2 emission that will result from such systems are also analyzed. Romeo developed a control strategy with neural network (NN) and fuzzy logic expert system (FLES) for optimizing the biomass boiler cleaning for maximizing heat transfer over time [5]. The results indicate that the AI technique proposed increased the power production by approximately 3.5%. Ayoub also have used genetic algorithm, fuzzy C-means clustering and decision trees for planning bioenergy production from biomass in Japan Ayoub *et al.*, [6]. The above data mining techniques define the optimal size and location of the conversion plants and simulation models with a user interface that evaluates the supply chain from economical and technical point of view. Balaman and Selim developed a fuzzy mixed integer linear programming (MILP) model for design and management of anaerobic digestion based biomass to energy supply [7]. A real world problem was explored using the fuzzy MILP model and it was found that the model can be effectively used for bioenergy supply chain design problems. The model has been designed to handle different types of feedstock and transportation problems.

METHODOLOGY

This research paper develops a Fuzzy Logic Controller to improve Biogas electrical power output for Ade-Oyo community in Ibadan Oyo state with the aims to improving electricity access of the area using pig dung. This system was designed calculating the daily energy generated for biogas to establish the futures of the network understudy. The biogas electrical power mathematical model is formulated and simulation was performed using MATLAB/SIMULINK.

To characterize the network understudy

The following empirical and analytical data were gotten as shown below.

Number of pigs	Volume of digester(m^3)	Volume of biogas(m^3)	Generated electric energy(Kwh/d)	Generated electric power(Kw/d)
50	6	3.6	11.6	0.5
100	12	7.2	23.2	1
150	18	10.8	34.9	1.5
200	24	14.4	46.5	2
250	30	18	58.2	2.5
300	36	21.6	69.8	3
350	42	25.2	81.4	3.5
400	48	28.8	93.1	4
450	54	32.4	104.7	4.5
500	60	36	116.3	5
550	66	39.6	127.9	5.5
600	72	43.2	139.6	6
650	78	46.8	151.2	6.5
700	84	50.4	162.8	7
750	90	54	174.5	7.5
800	96	57.6	186.1	8
850	102	61.2	197.7	8.5
900	108	64.8	209.4	9
950	114	68.4	221	9.5
1000	120	72	232.4	10

To design a membership that analysis the increase of biogas electrical power

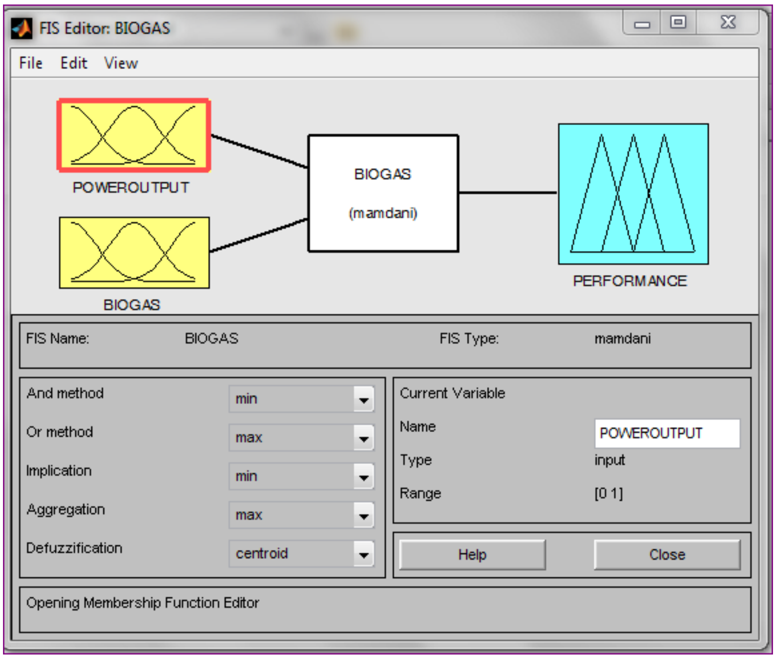

Fig-1: Designed fuzzy inference system editor

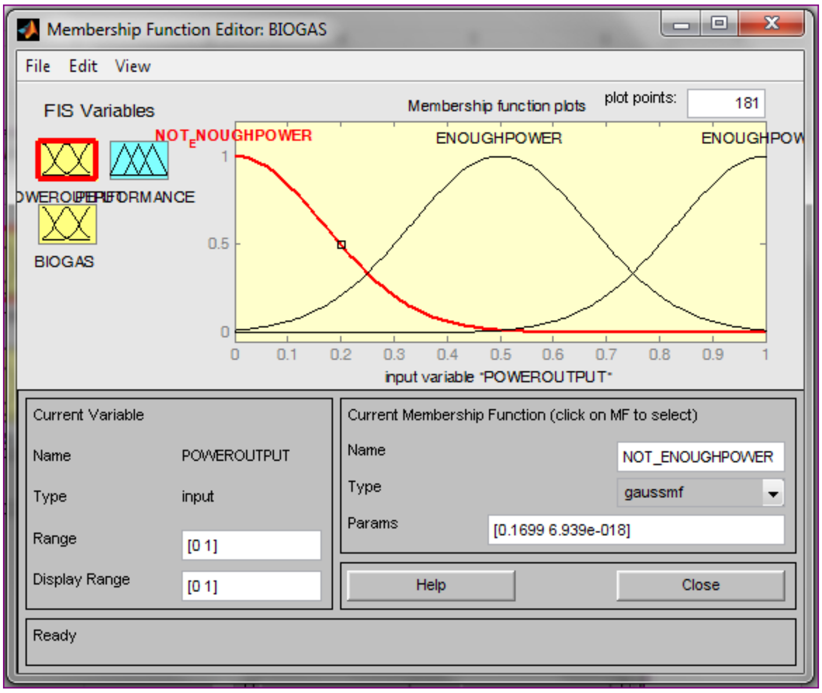

Fig-2: designed membership function that analysis the nature of output of biogas

Fig-2 shows designed membership function that analyzes the nature of biogas electrical output power. It gives a comprehensive analysis of the type of biogas output power to be produced.

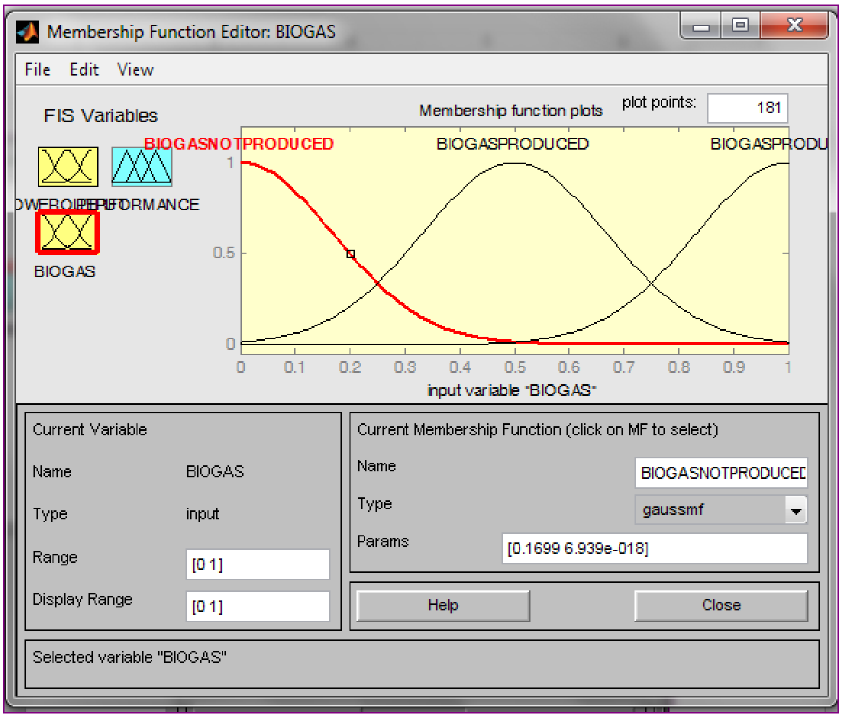

Fig-3: designed biogas membership function analysis

Fig-3 shows designed biogas membership function analysis. This gives a perfect analysis of the quantity of biogas produced for biogas electrical power output.

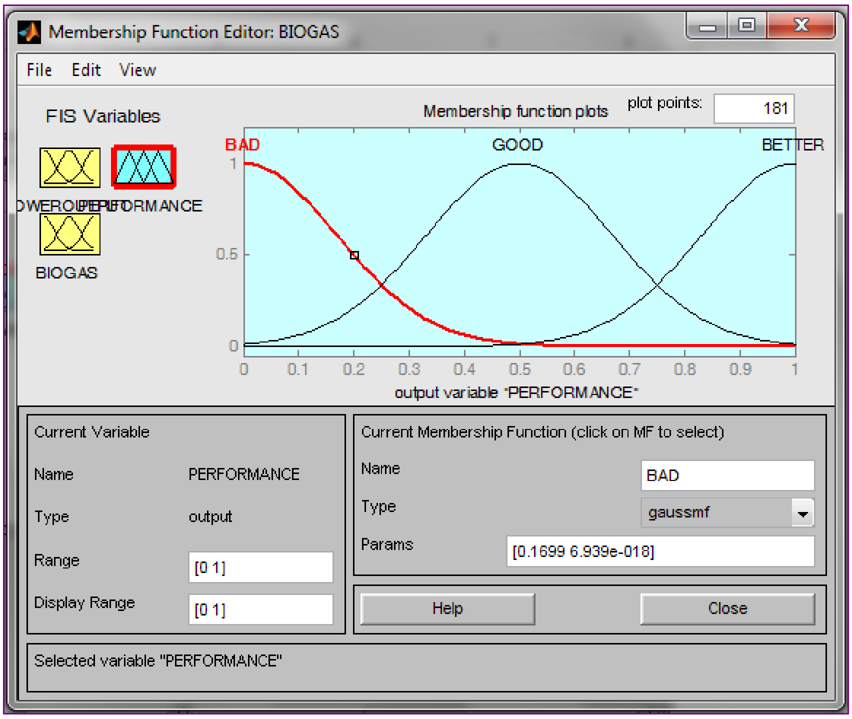

Fig-4: Designed membership function for performance analysis

Fig-4 shows designed membership function for performance analysis. It analysis the quality of biogas electrical power produced.

To design a fuzzy rule that sticks in the increase of biogas electrical power output

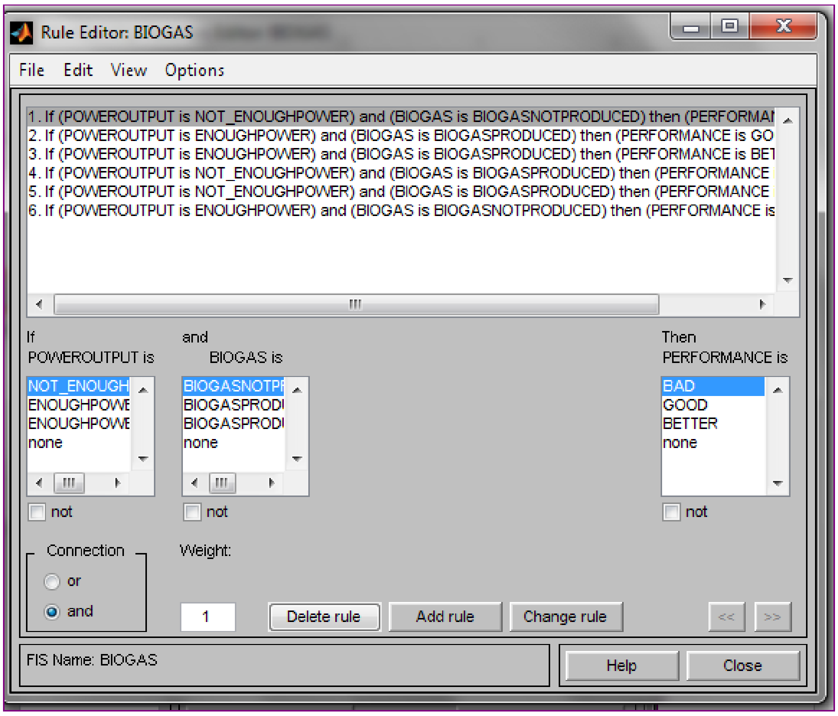

Fig-5: designed fuzzy rule that sticks in the increase of biogas electrical power output

To design a Simulink model for Improving biogas electrical power output using fuzzy logic controller.

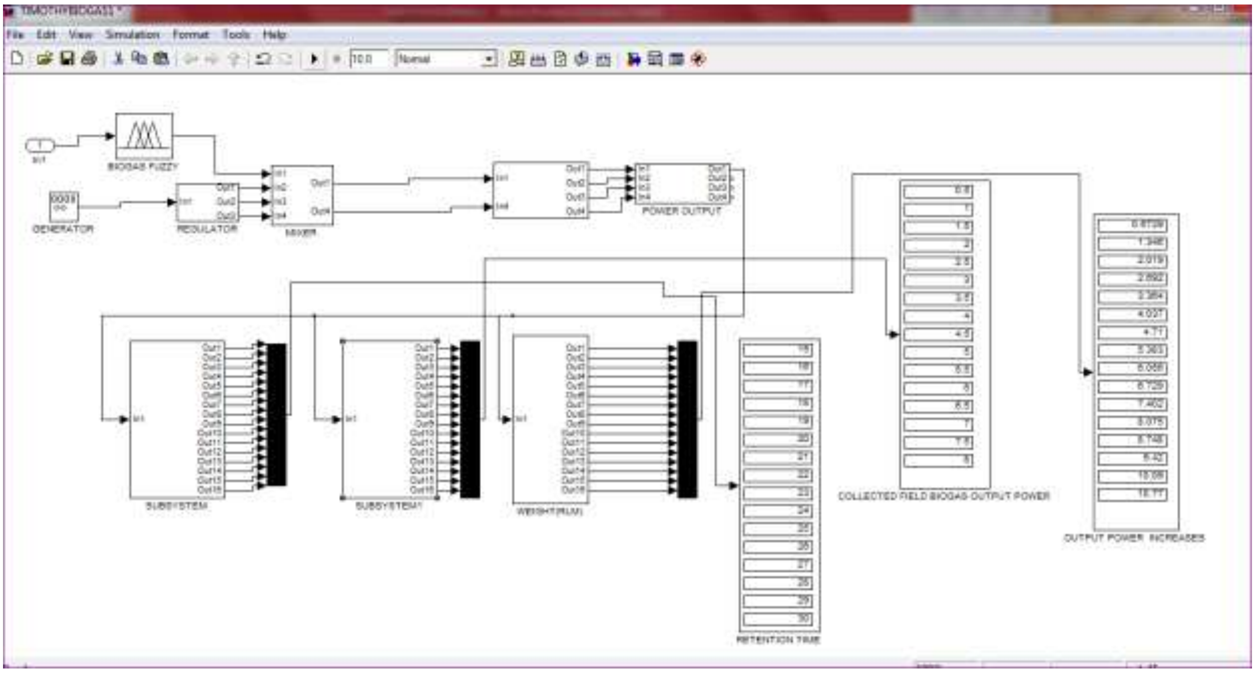

Fig-6: designed Simulink model for improving biogas electrical power output using fuzzy logic controller

RESULTS ANALYSIS

Table-2 Comparing biogas electrical power output without and with fuzzy Result Analysis

Table-2: Comparing biogas electrical power output without and with fuzzy controller

Number of pigs dung	Collected biogas electrical power without fuzzy (KW)	Biogas electrical power with fuzzy(KW)
50	0.5	0.67
100	1	1.35
150	1.5	2.00
200	2	2.70
250	2.5	3.36
300	3	4.04
350	3.5	4.71
400	4	5.38
450	4.5	6.05
500	5	6.73
550	5.5	7.40
600	6	8.07
650	6.5	8.75
700	7	9.42
750	7.5	10.09
800	8	10.77

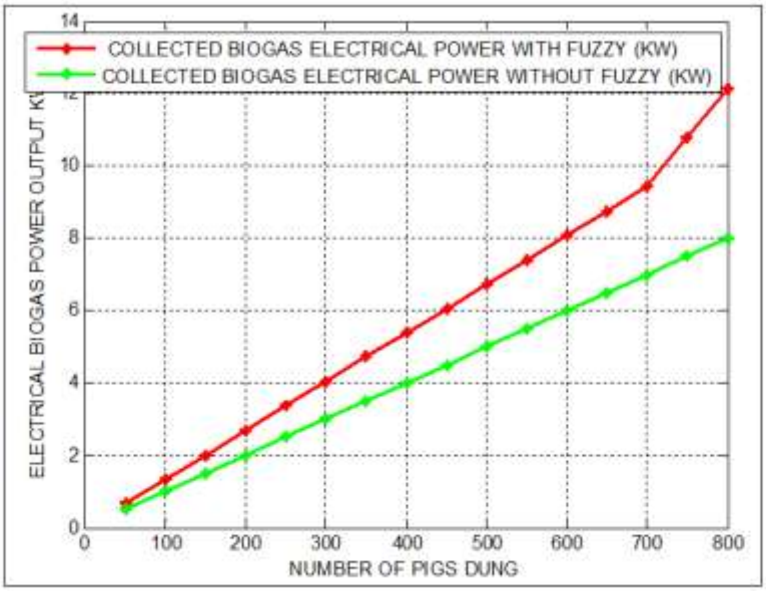

Fig-7: Comparing biogas electrical power output without and with fuzzy controller

Fig-7 shows comparing biogas electrical power output without and with fuzzy controller.

DISCUSSION OF RESULTS

The simulation result is presented in Fig 7. This shows that the biogas electrical power output when fuzzy controller is incorporated than when it is not incorporated**.** Its shows the relationship between the Number of Pig Dung, Biogas electrical Power output without fuzzy and Biogas electrical power output with fuzzy. The Biogas electrical Power output without fuzzy after processing the dung of 50, 150, 200, 250, 300, 350, 400, 450, 500, 550, 600, 650, 700, 750 and 800 fattening pigs are 0.5KW/d, 1KW/d, 1.5KW/d, 2KW/d, 2.5KW/d, 3KW/d, 3.5KW/d, 4KW/d, 4.5KW/d, 5 KW/d, 5.5 KW/d, 6 KW/d, 6.5 KW/d, 7 KW/d, 7.5 KW/d, and 8 KW/d respectively while the Biogas electrical power output with fuzzy are 0.67KW/d, 1.35KW/d, 2.00KW/d, 2.70KW/d, 3.36KW/d, 4.04KW/d, 4.71KW/d, 5.38KW/d, 6.05KW/d, 6.73KW/d, 7.40KW/d, 8.07KW/d, 8.75KW/d, 9.42KW/d, 10.09KW/d and 10.771KW/d respectively.

Fig-1 shows designed fuzzy inference system editor. It has two inputs of power output and biogas and an output of performance which helps to increase the biogas electrical power output.

Fig-3 shows designed biogas membership function analysis. This gives a perfect analysis of the quantity of biogas produced for biogas electrical power output.

Fig-4 shows designed membership function for performance analysis. It analysis the quality of biogas electrical power produced.

Fig-5 shows designed fuzzy rule that sticks in the increase of biogas electrical power output that gives a detailed rule that increases the biogas electrical power output.

Fig-6 Shows designed Simulink model for improving biogas electrical power output using fuzzy logic controller. The result shows that there is an increase in biogas electrical power output when fuzzy controller is incorporated in the system model. The detail analysis is shown in table 2 and Fig-7.

Fig-7 shows that there is an increase in biogas electrical power output when fuzzy controller is incorporated than when it is not incorporated.

The results indicate that there is an increase in the Power output when the fuzzy controller is incorporated than when is not used. The result obtained shows that biogas electrical power output without using fuzzy is 8KW while when fuzzy is incorporated is 10.77KW which is 14.78% increase when fuzzy controller is incorporated than when it was not used.

CONCLUSION

The epileptic power supply in our society and country at large can be surmounted by Improving biogas electrical power output using fuzzy logic controller. This is achieved in this manner, characterizing the network understudy, designing a membership function that analyzes the increase of biogas electrical power, designing a fuzzy rule that sticks in the increase of biogas electrical power output, designing a Simulink model for Improving biogas electrical power output using fuzzy logic controller and comparing the percentage biogas electrical power increase with and without fuzzy controller.

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