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Implementation Of Fuzzy Logic On Turbine Ventilators As Renewable Energy

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ABSTRACT Energy needs in Indonesia in particular and in the world in general continue to increase. One source of electricity supply, PLTA together with steam power plants (PLTU) and gas power plants (PLTG) indeed play an important role in the availability of electricity. Indonesia, which is an archipelagic country and one of the countries located on the equator, is a factor that Indonesia has abundant wind energy potential. The electrical energy needs of remote communities can be met. Turbine ventilator is a device that functions to circulate air which is placed on the roof of the building that functions as ventilation in residential and industrial buildings. In this study using the fuzzy method. Based on previous research, there are those who examine the use of turbine ventilators as power plants, but there are still many shortcomings that need to be improved. turbine ventilator that is used to catch the wind and drive the generator, by connecting the wind turbine using a v-belt so that the rotation produced by the generator is maximized. The design of the turbine ventilator as a power generator can be realized even though the rotation of the turbine ventilator is low. Ventilator turbines can generate electricity by installing used generators from cars. The results of the average turbine speed testing are 26, 28.32, and 23.5 so that the output from the generator is 3.62 V, 3.83 V, and 3.69 V on average.

INDEX TERMS Fuzy Logic, Turbine Ventilator, Renewable Energy

I. INTRODUCTION

Energy needs in Indonesia in particular and in the world in general continue to increase due to population growth, economic growth and the ever-increasing pattern of energy consumption itself. One source of electricity supply, PLTA together with steam power plants (PLTU) and gas power plants (PLTG) indeed play an important role in the availability of electricity. Indonesia is a country that has abundant energy resources, one of which is wind energy. Indonesia, which is an archipelagic country and one of the countries located on the equator, is a factor that Indonesia has abundant wind energy potential [1].

Turbine ventilator is a device that functions to circulate air which is placed on the roof of the building that functions as ventilation in residential and industrial buildings. As an alternative to air conditioning systems, turbine ventilators are not only used in industries but have become a ventilation feature that has been commonly used in other types of buildings such as buildings for institutional, commercial and community homes. The price of this turbine ventilator is also relatively cheap and can still be reached by the lower middle class [2].

In previous research, the design of a wind power plant with a turbine ventilator as a generator driver explained the prototype of a wind power plant using a turbine ventilator as a generator drive [3]. This power plant utilizes wind speed as its driving force. The output of the generator is processed using the MT3608 module. The MT3608 module is used to stabilize and increase the voltage installed at the input and output of the charging circuit. From several problems and related descriptions and problems in the field, in this study a research development will be carried out [4].

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In a previous study further developed by has conducted research on the use of a turbine ventilator as a medium for converting wind into motion energy, where the movement of the turbine is continued by a comparison of the pulley and v-belt to the generator. Testing how much electrical energy is generated at differences in wind speed from 3 to 5.4 m/s. In this study, there is no circuit to monitor and control so that it cannot know how much voltage is generated at what wind speed [6].

In a previous study on the design of a turbine ventilator power transfer mechanism with a wind speed of 4 m/s (Sayuti et al. 2019) explained the application of a turbine ventilator as a generator of electrical energy. Two gears are used to transmit the rotation of the main shaft of the turbine ventilator to the generator shaft. In the study the voltage and current produced were high and the drawback was that the generator used worked with high rpm while the result was low power [7]. In a previous study further developed by (Ellysa Kusuma Laksanawati et al., 2019) explaining using a turbine ventilator as a household-scale power source with a capacity of 900 Watt. Analysis of the utilization of the turbine ventilator using the experimental method. From the test results, the turbine ventilator can be used as a power source with a power of 5.57 Watt. The advantage of being very complete and detailed is that the results described are incomplete regarding how many rpm from the generator to produce 5.57 Watts [8].

The fuzzy control also works as well for complex nonlinear multi-dimensional system, system with parameter variation problem or where the sensor signals are not precise. It is basically nonlinear and adaptive in nature, giving robust performance under parameter variation and load disturbance effect. In process control applications, recent literature has explored the potentials of fuzzy control for machine drive application. It has been shown that a properly designed direct fuzzy controller can outperform conventional proportional integral derivative (PID) controllers.[9]

This paper presents an application of fuzzy logic to control the speed of a synchronous machine (SM). The fuzzy controller generates the variations of the reference current vector of the SM speed control based on the speed error and its change. Digital simulation results shows that the designed fuzzy speed controller realises a good dynamic behaviour of the motor, a perfect speed tracking with no overshoot and a good rejection of impact loads disturbance.[10]

II. MATERIALS AND METHODS

A. MATERIALS

On this system there are several materials used in its planning. In Figure 1 is a mechanical design that has been made. In the mechanical design there are several components installed, including:

1. Turbine Ventilator

Turbine ventilator is a type of exhaust fan or roof fan without the use of a driving motor where its function is to circulate fresh air outside the room and help circulate hot air in the room. The turbine ventilator uses wind energy to drive the ventilation turbine. This tool is often used on the roof of buildings that function as ventilation of residential and industrial buildings. Wind energy that blows on the turbine ventilator blades will generate a drag force and cause the turbine ventilator to rotate. Turbine ventilators are very suitable for various types of buildings such as factories, warehouses, sports buildings, kitchens, residential houses, offices, and restaurants [11]. Turbine Ventilator used for this tool with a turbine diameter specification of 16 inches.

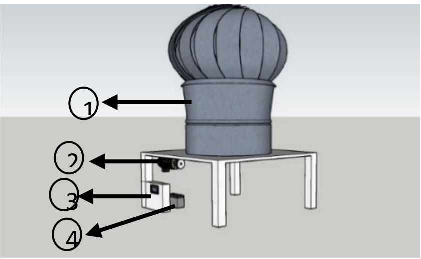

Figure 1. Tool Planning

2. DC Generator and Pulley

Direct current generators have basic components that are generally almost the same as components of other electrical machines. Broadly speaking, a direct current generator is a device for converting mechanical energy in the form of rotation into direct current electrical energy. Mechanical energy is used to rotate the coil of conducting wire in a magnetic field. According to Faraday's law, an induced emf will occur in a conducting wire which is proportional to the rate of change of flux enclosed by the conducting wire[12].

A pulley is a mechanism consisting of a wheel on an axle or rod that has a groove between two edges around it. A rope, cable, or belt is usually used in the pulley groove to transfer power. Pulleys are used to change the direction of the applied force, continue rotational motion, or move heavy loads [13]. A belt pulley system consists of two or more pulleys connected by a belt. This system allows to transfer power, torque, and speed, and can move heavy loads with different diameter variations [14].

3. Box Panel

The first electrical panel component is the electrical panel box. The usefulness of the panel box is to place all the tools used in the electricity network. Some panel boxes are equipped with protection against water (IP) and dust. Usually, the box contains protection against mechanical material strength (IK)[15].

4. Battery

The battery is a secondary element and is a source of direct electric current that can convert chemical energy into direct electrical energy which can convert chemical energy into electrical energy. Battery is an electrochemical element that can affect the reactants, so it is called a secondary element. The positive pole of the battery uses an oxidation plate and the negative pole uses a lead plate while the electrolyte solution is a sulfuric acid solution. When the battery is used, a chemical reaction occurs which causes the anode to be reduced and the cathode to oxidize. As a result, within a certain time between the anode and cathode there is no potential difference, the battery is empty and needs to be filled by flowing an electric current that is opposite to the electric current released by the battery. When the battery is charged there will be a collection of electric charges [16].

B. Methods

In fuzzy logic there are several methods that can be used to predict consumer behavior. One method that can be used to predict consumer behavior is the Tsukamoto method. This method was chosen because it is flexible, and has a tolerance for existing data. The advantages of this method are that it is faster in computing, more intuitive, accepted by many parties, more suitable for input received from humans not by machines. Each rule in the form of IF-THEN is represented by a fuzzy set with a monotonous membership function. As a result, the output of each rule is given explicitly based on the alpha predicate (α), then the final result is obtained using centralized average. [17]. Fuzzy logic is a problem-solving control system methodology that is suitable to be applied to systems, ranging from simple systems to complex or complex systems. Fuzzy logic can be applied in various fields, including disease diagnosis systems (in medicine), marketing system modeling, operations research (in economics), water quality control, prediction of earthquakes and others. Fuzzy logic is an appropriate way to map an input space into an output space. In addition, fuzzy logic can also be interpreted as an appropriate way to map an input space into an output space [18]. Fuzzy logic uses a set of rules to describe its behavior. The rules describe the expected conditions and the desired results using the IF... THEN statement. A fuzzy set A in the universe of discourse is expressed by the membership function A μ, whose value is in the interval [0,1]. Mathematically this is expressed by the equation

$$\mu A: U \rightarrow [0,1] \quad (2.1)$$

The fuzzy set A in the universe of discourse U is usually expressed as a set of pairs of elements u (u are members of U) and the degree of membership of these elements is as follows:

$$A = \{(u\ u\ )/u \in U\} \quad (2.2)$$

If U is discrete, then A can be expressed by:

$$A = \sum_{i=1}^{n} \mu\,(u_i/u_i) \quad (2.3)$$

The fuzzyfication stage is the mapping of the clear input to the fuzzy set. Fuzzyfication process is a process to change non-fuzzy variables (numeric variables) into fuzzy variables (linguistic variables). The input values that are still in the form of numerical variables that have been quantized before being processed by the fuzzy controller must first be converted into fuzzy variables. Through the Membership function that has been compiled, the input values become fuzzy information which is useful later for fuzzy processing as well. This process is called fuzzyfication.[19]

The inference stage is the generation of fuzzy rules. In general, fuzzy rules are expressed in the form of "IF...THEN" which is the essence of fuzzy relations. A fuzzy relation, denoted by R , is also called a fuzzy implication. There are two main ways to get the "IF.....THEN" rule:

1. Asking human operators who have been able to control the system manually, are known as "human experts".
2. By using training algorithms based on input and output data.
3. Defuzzification stage, namely the transformation of the output from a fuzzy value to a firm value.

The input of the defuzzification process is a fuzzy set obtained from the composition of fuzzy rules, while the resulting output is a number in the domain of the fuzzy set. So if given a fuzzy set within a certain range, it must be able to take a certain crisp value as output[20].

III. RESULT

The results of the testing of this tool aim to determine the output value of the generator and how many turbine rotations, and also to know how much error value is generated.

A. *Wind Speed Test*

Testing of wind speed data that has been measured for 3 days with an anemometer, in FIGURE 2 is a test activity. For Table 1 is the result of the turbine ventilator test.

FIGURE 2 Wind Speed Test

In FIGURE 2, a turbine ventilator is tested against turbine rotation before being coupled with a generator, the test results produce the following data:

TABLE 1 Wind Speed Test Results

Data Retrieval On Hours	Day - 1 (m/s)	Day - 2 (m/s)	Day - 3 (m/s)
09:00	0,9	1,1	1
11:00	0,9	1	1
13:00	1,2	1,3	1,2
15:00	1,1	1,3	1,2
Average	1	1,18	1,1

TABLE 1 displays the turbine ventilator rotation readings. From the test data, the average test was obtained, so that an average of 1, 1.18, and 1.1 was obtained

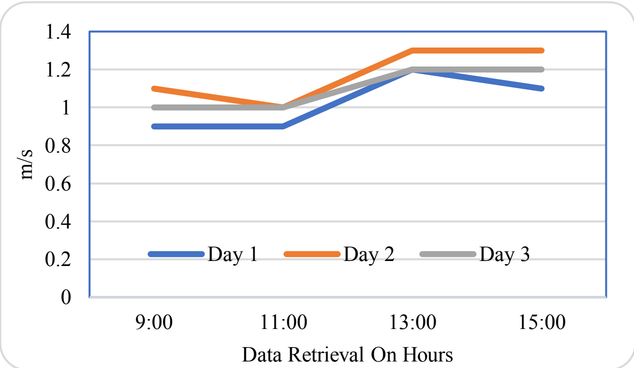

FIGURE 3 Graph of Wind Speed Test

FIGURE 3 is a graph of the results of tests carried out on the Wind Speed Test of the ventilator connected to the generator.

B. Turbine Rotation Test

Testing on the turbine ventilator in a coupel with a generator, this test is carried out outdoors, in Figure 4 is a test activity. For TABLE 2 is the result of the turbine ventilator test

FIGURE 4 Outdoor Turbine Speed Test

In FIGURE 4, a turbine ventilator is tested against turbine rotation before being coupled with a generator, the test results produce the following data:

Table 2 Turbine Rotation Test Results

Data Retrieval On Hours	Day 1 (rpm)	Day 2 (rpm)	Day 3 (rpm)
09:00	22,4	24,8	21,9
11:00	25,2	26,4	22,0
13:00	27,5	29,7	24,8
15:00	28,9	32,4	25,3
Average	26	28,32	23,5

Table 2 displays the turbine ventilator rotation readings. From the test data, the average test is obtained, so that an average of 26, 28,32, and 23.5 . is obtained

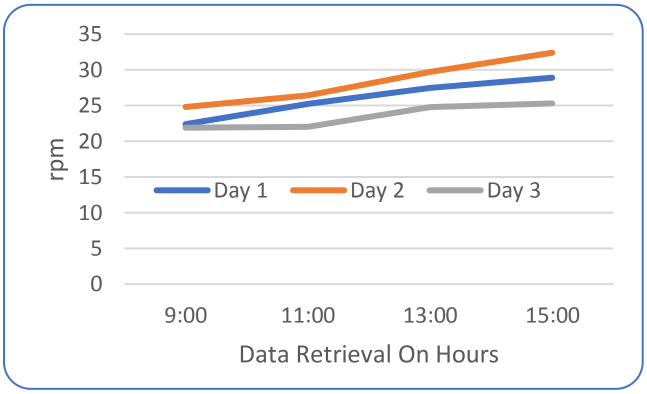

FIGURE 5 TURBINE ROTATION TEST GRAPH

In FIGURE 5 is a graph of the results of tests carried out on the rotation of the ventilator connected to the generator. The results of the test on the turbine ventilator are the results of the generator voltage output, this test is carried out outdoors, TABLE 3 is the result of the Generator Output test.

Table 3. Generator Output Test Results

Data Retrieval On Hours	Day 1 (V)	Day 2 (V)	Day 3 (V)
09:00	3,32	3,78	3,56
11:00	3,42	3,61	3,62
13:00	3,9	3,87	3,75
15:00	3,83	4,05	3,83
Rata- Rata	3,62	3,83	3,69

TABLE 3 displays the Generator Output readings. From the test data obtained the average test, so that the average obtained is 3.62, 3.83, and 3.69. FIGURE 6 shows the generator voltage test output. FIGURE 6 is a graph of the tests carried out on the generator output.

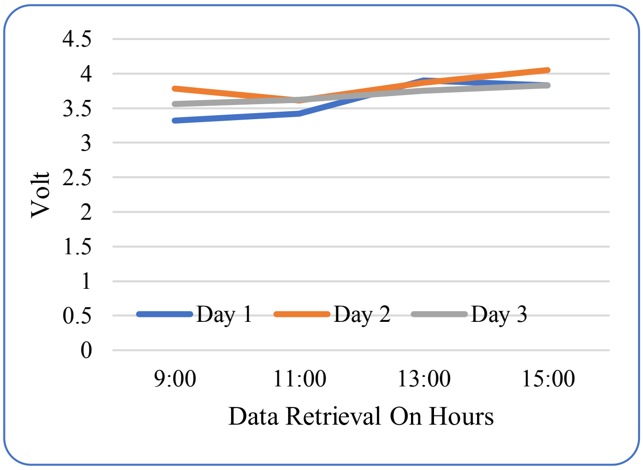

FIGURE 6. Generator output

IV. DISCUSION

The design of the turbine ventilator as a power generator can be realized even though the rotation of the turbine ventilator is low. Ventilator turbines can generate electricity by installing used generators from cars. The results of the average turbine speed testing are 26, 28.32, and 23.5 so that the output from the generator is 3.62 V, 3.83 V, and 3.69 V on average.

V. CONCLUSION

The output voltage produced by the generator coupled with the turbine ventilator which was tested on the rooftop of the 2nd floor house produces an average voltage of 3.53 Volts, the speed produced by the turbine after being coupled with the generator produces an average rpm of 24.14 with the following conditions: The average wind speed measured by an anemometer is 1.06 m/s and the test location is on the rooftop of a 2nd floor house whose surroundings are not blocked by anything. The generator used is too large and the rpm is too high so it cannot reach the reference voltage of 12 volts, so it can be replaced with a smaller and lower rpme.

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