Analysis of Turbine Round Effect with the Voltage Generated in Micro Hydroelectric Power Prototype

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Keywords: Prototype, Micro-Hydro, Turbine, Voltage

Abstract: In connection with the high demand for energy in remote and rural areas, one way to meet these needs is to make micro hydro-based electricity. Microhydro electrical energy is very suitable for use in rural areas because the area is usually found in many sources of waterfalls that can be used as a source of micro-hydropower without causing environmental damage. In this case, the author made a prototype of micro-hydro power to be able to analyze the effect of rotation of the turbine with the voltage generated, before it will be implemented. The faster the generator rotates, the greater the voltage caused by the rotor cutting the line magnet force on the stator coil so that the resulting voltage will be faster too. In testing the maximum 6V results in the 1200 RPM turbine rotation, it can be said that the results obtained are only half of the generator's work, due to the water pressure that does not affect the turbine rotational motion.

1 INTRODUCTION

New and renewable energy sources in the future will increasingly require a very important role in meeting energy needs. This is caused by the use of fossil fuels for conventional power plants, which in the long run, will deplete the source of petroleum, gas, and coal whose reserves are increasingly depleting. The National Electricity Company (PT. PLN) as an energy-producing industry also uses fuel (fuel oil) to turn large generator engines. Natural resources are non-renewable; what can be needed requires a long time (Reharmanto, 2007). Therefore, alternative energy is needed to overcome this. That can be realized with the increasingly developing technology. Therefore, there is alternative energy that can be used to replace fossil fuels, such as sunlight, geothermal, wind, air, and coal (Yogo Pratisto, 2014). Alternative energy like this, which is expected to replace the fossil fuels used so far to be converted into electrical energy, replaces the reserves of fossil fuels that we will get (Liun, 2011). The author will choose a micro-hydropower plant, and a micro-hydropower plant is a power plant that uses air power, which is one alternative energy that uses air power.

2 BASIC THEORY

2.1 Hydroelectric Power Generation

Hydroelectric power generation is a generation of electrical energy by converting the potential energy of water into mechanical energy by a turbine, which then converted into electrical energy by a generator by utilizing the height and speed of water flow (Pranata, 2014). There are several types of hydroelectric power plants, including:

a. Hydropower type waterway
b. Hydropower DAM/DAM type
c. Hydropower with regulatory pond
d. Hydropower type pumped storage

2.2 Water Turbine

Water turbines are tools for converting potential energy from water mechanical energy. The mechanical energy is then converted into electrical energy by a generator. With the advancement of fluid mechanics and hydraulics, as well as paying attention to the abundant sources of water energy available in rural areas, the plan for turbine emerges which varies with the high fall of water (head) and available water discharge (Q) (Haimerl L.A, 1960).

Sahara, A., Aly, F., Saputra, R. and Vegatama, M.
Analysis of Turbine Round Effect with the Voltage Generated in Micro Hydroelectric Power Prototype.
DOI: 10.5220/0009423501240128
In *Proceedings of the 1st International Conference on Industrial Technology (ICONIT 2019)*, pages 124-128
ISBN: 978-989-758-434-3

2.3 Generator

The generator is a device that can convert mechanical energy into mechanical energy. Mechanical power can be gained from heat, water, and steam. The electrical energy produced by a generator can be either AC (alternating electricity) or DC (direct electricity). This depends on the construction of the generator used by the power plant. The generator is closely related to faraday law. The following are the results of the legal faraday "that if a piece of the electrically conductive wire is in a changing magnetic field, then an electric force will form in the wire."

If a long metal is in an electric field, it will cause the free electron to move to the left, which will eventually cause an induced electric field that is as strong as the electric field so that the total field strength becomes 0. In this case, the potential of the two metal ends becomes equal, and the electron's flow will stop. As a result, both ends of the metal have an induction charge. For the free electron flow to continue, the induction charge must continue to be taken, so that the induced electric field does not arise on the metal. Furthermore, the source of electromotive force (emf) in the form of a battery can make the potential difference between the two ends of the price remain fixed so that the electron flow continues.

There are two types of electric generators:

a) AC generator (alternating current)

b) DC generator (direct current)

AC generators produce alternating electric current because of the current direction will be reversed at every half turn. DC generators produce direct current of electricity because the construction is equipped with a commutator, usually functions as an amplifier in the main generator induced.

2.4 Arduino

Arduino is an open-source single-board microcontroller, derived from the wiring platform, designed to facilitate electronic use in various fields (Santoso, 2015). The hardware has an Atmel AVR processor, and the software has its programming language. Arduino is a versatile microcontroller kit that is very easy to use. To make it needed a programmer chip (to embed the Arduino bootloader on the chip). Both Arduino's hardware and software are available from open sources. On the side of software, Arduino can be run on various platforms, namely Linux, Windows, or also Mac. Arduino hardware is a microcontroller based on AVR from ATMEL, which has been given a bootloader and also has standard I / O pins.

2.5 Voltage Sensor

The voltage sensor functions to read the voltage value of a circuit. Arduino can read the voltage value using an analog pin. If the voltage range that is read between 0-5 V, it can directly use an analog pin, whereas if the voltage range is above 5V, we must use an additional circuit voltage divider. This is due to circumstances that the Arduino pin works at max 5 V.

2.6 RPM Sensor

The RPM sensor is a sensor that serves to read how many rotating objects are rotating, such as the wheel rotation, turbine rotation of gear rotation. The common principle of this sensor is to calculate the speed of magnetic pulses or the principle of using light as in an RPM sensor that uses an optocoupler consisting of LEDs and phototransistors where the phototransistor captures the speed of light from LEDs to be converted as RPM sensors (Winanti, 2014).

3 METHODOLOGY AND ANALYSIS

In this research report, there are research flow diagrams, workflow diagrams, and tool block diagrams that are intended to make it easier for readers to understand the flow of starting data collection and also how the stages of this tool work.

3.1 Flow Chart of The Tool Design

The following is a working flow chart of the tool designed in Figure 1.

From the flow chart above can be explained the working principle of the tool as follows:

a. Fill the reservoir with water,

b. Turn on the monitor/LCD first,

c. Water will move the turbine so that the turbine will rotate, and the turbine rotation will drive the generator so that the generator produces electricity voltage.

d. The sensor will read how many voltages and turns produced by the tool. There are two possibilities:

- "Yes": The sensor volt will read how much voltage is generated from the generator, then the RPM sensor will read how many turns are produced by the turbine
- "No ": step back on the monitor/LCD while checking the problems that occur in the device.

e. The result of the voltage read by the sensor volt and the rotation generated by the turbine read by the RPM sensor will be displayed on the LCD.

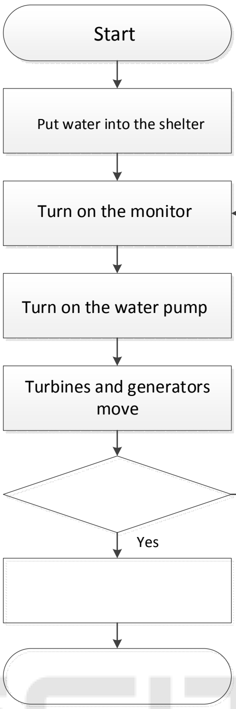

Figure 1. Flowchart of The Tool Design

3.2 Block Diagram of the Tool

The following is a block diagram of the tool created:

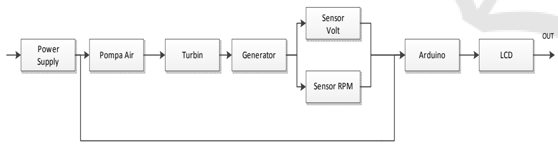

Figure 2. Block Diagram of The Tool

From the block diagram above, it can be explained the workflow component of the tool as follows:

a. When the power supply is connected, it will run the water pump, and the LCD will turn on.

b. The water pump will work so that it spills water to turn the turbine

c. When the turbine rotates, the turbine rotation will be connected to the generator using a belt so that the generator will spin too

d. The generator will spin so that it produces voltage. The voltage that comes out will be read by the voltage sensor, and the turbine rotation will be read by the RPM sensor that uses a magnetic sensor

e. The results of the two sensors will be sent to Arduino/microcontroller for later

f. The results of the data from Arduino/ microcontroller will be displayed on the LCD so that we can find out the output voltage and how many RPM the turbine rotates.

3.3 Design Hardware

The hardware design in this tool can be seen in the schematic circuit of the microcontroller. In this series, we can see how the schematic electronic circuits are arranged, as shown in Figure 3 as follows:

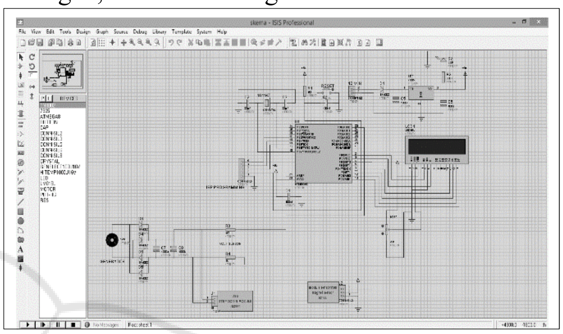

Figure 3. Schematic Tool Set

In this schematic, it can be seen that the turbine rotation is read by the RPM sensor that uses a magnetic sensor, as in Figure 3. The reading results then will be read by the microcontroller itself. Afterward, in the rotating valve of the turbine will be displayed on the LCD. The turbine rotation magnitude is calculated by how many times the magnet passes through the sensor. Then for the voltage reading itself, it is read by a voltage sensor where the voltage sensor will read what voltage is generated from the generator, for the voltage generated from the generator is an alternating voltage (AC) then rectified by a rectifier (DC). After that, the data will be brought to the microcontroller to be converted into numbers and displayed on the LCD.

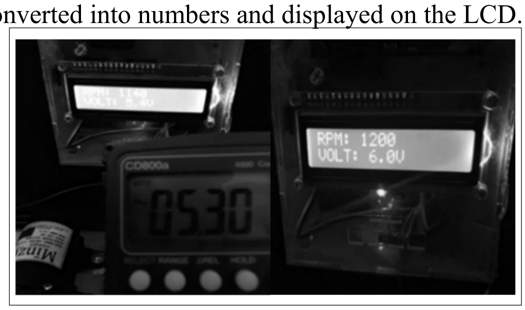

Figure 5. Results of Testing Tools

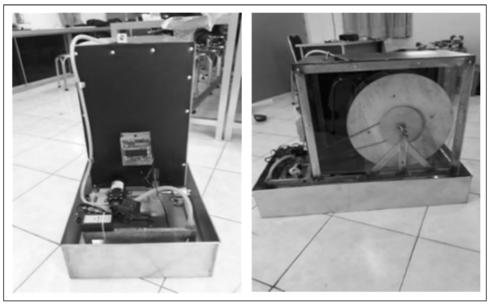

Figure 6. The Prototype of Micro Hydro Power Plant Tools

3.4 Software Program

The software used in this tool uses the CVAVR program language to read the RPM rotation magnitude and the amount of voltage generated on the generator of this tool. The RPM sensor will detect the input signal, which is then processed by the microcontroller to be converted into RPM.

The amount of RPM is determined by the number of times the magnet passes through the sensor module which is given a counter-information every 1 second, then multiplied by 60, so that the RPM is displayed on the LCD.

The voltage readings produced by the generator are obtained from the output voltage generator to the microcontroller, which is then processed using programming. So that it can be known how much voltage is generated and displayed on the LCD.

3.5 The Results of Testing The Tool as Follows

As for the test results of micro hydropower plants obtained after testing by looking at the numbers on the LCD or with a multimeter as in Figure 6, we obtained data such as Table 1.

Table 1. Data on The Results of Tool Testing

Putaran Turbin (RPM)	Output Voltage (V)
0	0
120	1.4
300	1.6
600	2.5
720	3.2
840	3.7
900	4.0
960	4.4
1020	4.9
1080	5
1140	5.4
1200	6

The turbine that was driven by rotating water then moved the generator connected to the connecting belt. According to the laws of physics, linear velocity (v) of turbines and generators are measured using the same units (m/s). Therefore, the calculation will be the same. However, for radian velocity measured in RPM units, they will have different results depends on the radius of the turbine and the generator pulley. In testing the maximum 6V results in the 1200 RPM turbine rotation, it can be said that the results obtained are only half of the generator's work, due to the water pressure that does not affect the turbine rotational motion.

4 CONCLUSIONS

The conclusion from the test results is that the greater the speed of the turbine radians, the greater the speed of the generator radians because the radius of the turbine is greater than the radius of the pulley generator, the faster the generator rotates, the greater the generator produced by the rotor. So the voltage produced will be faster too. Turbine rotation is the key to this hydroelectric or micro hydropower plant so that this tool can be used optimally, and other things needed are sources to drive the turbine, such as airflow factor, air velocity, and also air pressure to increase the rotation of the turbine itself, and also the turbine support shaft. Therefore, the calculation will be the same. However, for radians speed measured in units of RPM, they will have different results depending on the radius of the turbine and pulley generator. In answering the maximum 6V results in a 1200 RPM turbine rotation, it can be accepted that the results obtained are only from the work of the generator because air pressure does not affect the rotation of the turbine. Future development can be carried out by micro-hydro applications using the Crossflow Turbine Operation method: High airflow rates falling from 3m - 50m or average water flow discharges 25-1500 liters/sec, or the Pb Propeller Turbim Discharge method: Has a waterfall height of 1m - 6m or discharge average water flow from 100 to 700 liters/sec, which can produce electrical energy from KW.

ACKNOWLEDGMENTS

I want to give thanks to the Almighty God because with his permission this tool can be completed, and I say thank you as much as possible to our parents who have provided support, and prayers for all of us, and for all those who cannot mention their names one by one we thank you for all of your support. Thanks also to the campus community who provided support, laboratory facilities for the manufacture of this tool.

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