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EXPERIMENTAL STUDY OF VARIATION OF THE EFFECT OF THE PELTON TURBINE VALVE OPENING ON ELECTRICITY ENERGY THAT WAS PRODUCED TO TURNED ON A LAPTOP

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ABSTRACT

In this modern era all human activities are still very dependent on non-renewable energy sources. Electricity is one of the most important needs for humans, starting from lighting, communication, transportation and other needs. Energy supplies, especially fossil energy, are increasingly depleted, therefore an alternative energy source that is environmentally friendly and abundant availability is needed. One alternative energy source is water energy, especially energy derived from Piko Hydro. With variations in valve openings installed on pelton turbines of 18°, 36°, 54°, 72°, and 90° analyzed using the experimental method to determine the efficiency of the pelton turbine system used to produce electrical power from the Piko Hydro system. The results of this study indicate that the highest power is produced with a 90° faucet opening where the Power is 3.96 Watts and the system efficiency is 14.56%.

Keywords: Pelton turbine, Pico hydro, Renewable energy.

INTRODUCTION

Future energy supply is an issue which is always a concern of all nations because after human welfare in modern life is strongly associated with the number and quality of energy used. The need for energy continues to increase along with the increase in development, especially development in the industrial sector, economic growth and population growth. Various efforts continue to be made both seeking new potential or by developing the technology. Considering the source of energy used for generating electrical power comes mostly from fossil fuels like oil, gas, and coal it reduces dependence on fossil fuels resulted in the rapid depletion of energy resources. Therefore an alternative energy source is needed which can be used for environmentally friendly electric plants and abundant availability (Singh and Singal, 2017). One of the alternative energy sources is Pico Hydro.

This Pico hydro is a power plant that uses water as a blade driver on a turbine that drives a generator to produce electricity (Yahya et al., 2014, Jawahar and Michael, 2017). Pico hydro in principle is utilizing the flow rate of water which functions to drive the turbine connected to the generator. Pico hydro is the best breakthrough to be used as one of the new energy sources, one of which is an energy source to turn on a laptop. But many researchers have found obstacles in terms of initial costs in the procurement of Pico Hydro components to spread renewable energy, but for long-term utilization of Pico Hydro is very promising (Lahimer et al., 2012). E. M. Nfah and J.M. Ngundam conducted a feasibility study of hybrid pico hydro and photovoltaic energy systems intended for small villages in the Cameroon region (Nfah and Ngundam, 2009). In this study, the results of the merger of Pico-hydro energy, biogas, and batteries were compared with the results of the merger of photovoltaic energy, biogas, and batteries. There they found that the system of combining pico-hydro energy, biogas, and batteries produced lower energy costs than using a system of combining photovoltaic energy, biogas, and batteries.

Research on pico-hydro itself has been done a lot, as done by D. Powell et.al. (Powell et al., 2018) In this study, they developed a new pico hydro turbine system that has a high evision value and is capable of igniting electrochemical cells for off-grid water disinfection. The results of the study found that the selection of a compatible DC generator was very influential on the electrical power produced and increased efficiency. While research on pico hydro systems using platoon turbines has also been carried out, such as those carried out by D. Agar and M. Rasi (Agar and Rasi, 2008). Laboratory scale turbines are built using a simple and easily found apparatus in a science laboratory. The turbine is intended as a hydroelectric power plant, which is then

analyzed in the research. From the turbine system it was found that the maximum mechanical efficiency obtained reached 0.47 ± 0.02 with a flow rate of 0.17 L / s. Hydropower plants using pelton turbines and loading using lights have been investigated by Hery Irawan et al (Irawan et al., 2018). In this study, the performance of the Pelton turbine type hydroelectric power system was analyzed by varying the faucet openings and lamp loads using an inverter. The results of the study indicate that the highest electrical power is obtained at the 9 watt lamp load and at the valve opening 90° with the acquisition of electric power of 1,761 watts.

This study aims to investigate the effect of valve opening variations on the electrical power produced to determine the power and efficiency of the Pelton turbine system with laptop media as loading. With this research, it is hoped that it can be used as a reference for the utilization of wasted energy in the piping system.

RESEARCH METHODS

To find out the efficiency of the Pelton turbine system used to produce electrical power and from the electrical power is then used to turn on the laptop, the testing is done by varying the valve opening by 18°, 36°, 54°, 72°, and 90°. In this study, the measured variables include voltage, current strength, turbine rotation, pressure and discharge. In this test the water used to drive the turbine comes from a water reservoir with a height of falling water 17 m. Before the water into the turbine, given the pipeline valve used to regulate the flow of water that flows into the turbine.

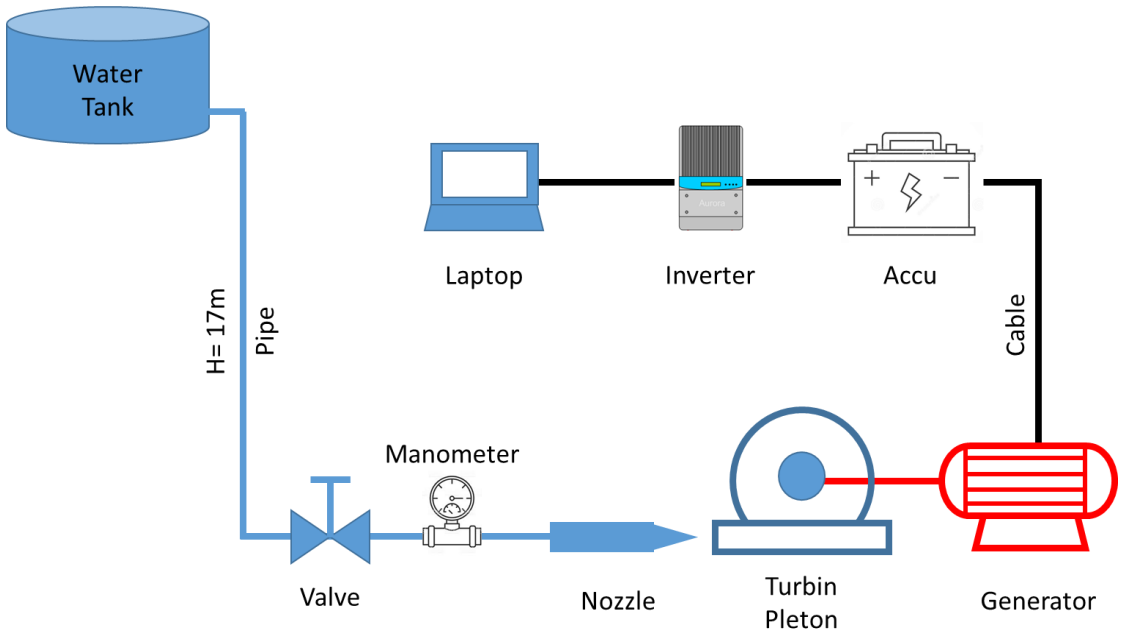

Fig 1. Sketch of the Pelton turbine system

Electrical power generated from the rotation of the pelton turbine connected to the generator is stored in the battery before being connected to the inverter. The function of this inverter is to change direct current with a voltage of 12 volts and karus 3 amperes to alternating current with a voltage of 220 volts (PLN). Furthermore, the electrical power is used to turn on a load or a device, which in this study the load used is a laptop. Where the specifications of the laptop require input energy of 100-200 V with a current of 1 Ampere (AC) and the frequency is 50-60 Hz, while the output itself is 19V and 1.75 Ampere (DC).

RESULTS AND DISCUSSION

The Effects of Valve Opening on The Discharge and Shaft Rotation

With variations in valve openings of 18°, 36°, 54°, 72°, and 90°, it can be seen the discharge and rotation of the shaft produced, as shown in figure 2. In the Figure shows that the larger the valve opening, the discharge is generated even greater. This is because when the valve opens bigger, then the capacity of the flowing water becomes even greater, so that the resulting discharge is greater, where at the smallest valve opening (18°) produces a discharge of 1.0555E-05 m3 / s while at the largest valve opening (90°) produces a discharge of 0.000163043 m3 / s.

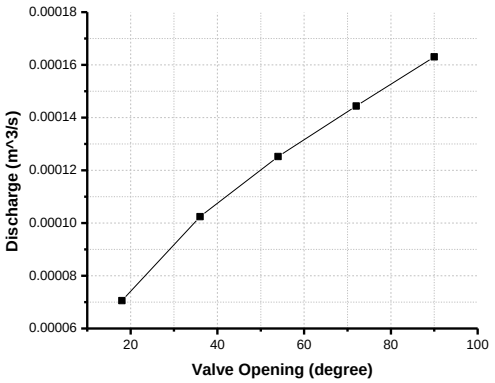

Fig 2. Effect of valve openings on discharge

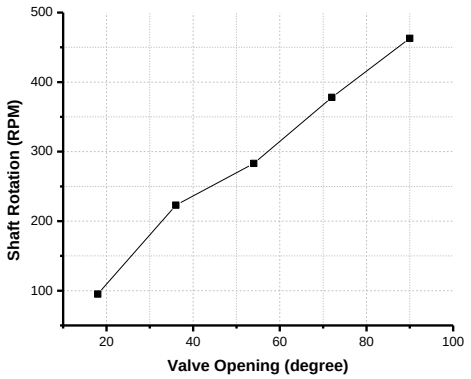

Fig 3. Effect of valve openings on shaft rotation

With the increasing amount of water discharge, then it can also affects the shaft rotation value, as shown in figure 3. In the figure shows the effect of valve openings on shaft rotation. From the figure it can be seen that the larger the valve opening, the greater the rotation of the shaft produced. This is because when the valve is opened wider, the resulting discharge will be even greater. So that it is in accordance with the continuity equation (Rao, 2018), if the discharge is large then the speed bursts of nozzle is also getting bigger, so that these bursts able to rotate the turbine shaft with a large round anyway.

The Effects of Valve Opening on the Electrical Power

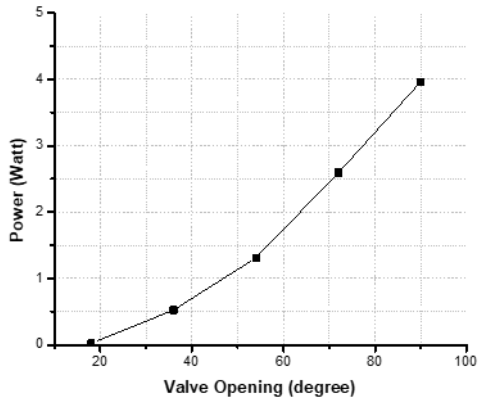

Fig 4. Effect of valve openings on electrical power

Electric power obtained from this system is strongly influence by the rotation of the pelton turbine shaft that drives the generator. As shown in figure 4, which in the figure shows the effect of faucet openings on electric power. In the figure shows that when the smallest valve opening (18°) produces a small electrical power of 0.0208 watts, but at the largest valve opening (90°) produces an electric power of 3.96 watts. From the foregoing, it can be said that the valve opening is greater then the electrical power produced is also getting bigger. This is because when the valve is opened the bigger it means the speed of the burst of water that hits the turbine blade is also the greater the consequence the turbine shaft rotation is getting bigger because of that the power produced by the electricity generator is also getting bigger.

The Effects of Valve Opening on Efficiency System

With the increase in electric power which is in line with the increasing valve opening, it has a significant effect on system efficiency. This is indicated by the equation:

$$\eta t = \frac{P}{Ph} 100\%$$

Where ηt is the system efficiency (%), P is the electric power (watts), and Ph is the hydraulic power (watts). Whereas hydraulic power (Ph) can be searched using equations:

$$Ph = \rho \, . \, g \, . Q \, . H$$

Where ρ is the density of fluid (kg / m^3), g is the gravitational acceleration (m / s^2), H is the head / height of falling water (m), and Q is the discharge (m^3 / s).

From the equations above, the value of system efficiency can be known. The results of these calculations are presented in graphical form as shown in Figure 5, where there is a figure showing the effect of valve openings on system efficiency. In the graph shows that when the valve is opened the wider the efficiency of the resulting system is also greater. That is because the electrical power that comes out is getting bigger while the large friction between the water and the pipe remains so that the efficiency increases, which is the greatest efficiency can be achieved at the valve opening 90° with an efficiency of 14.56%.

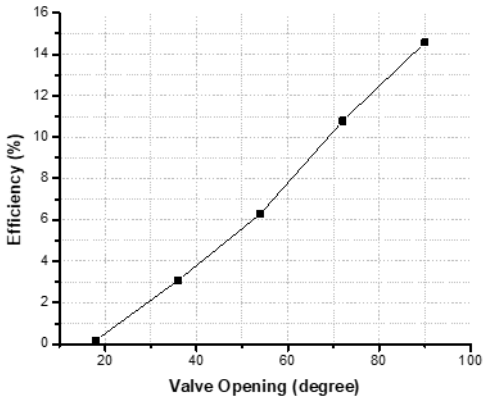

Fig 5. Effect of valve openings on sistem efficiency

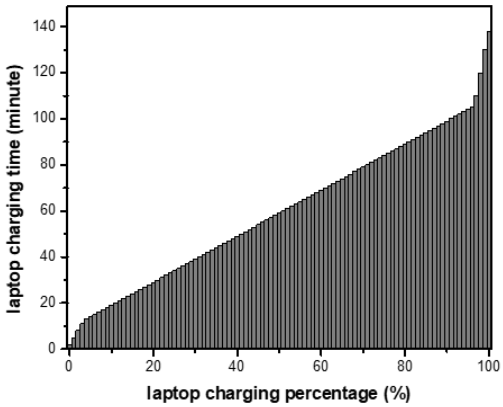

Fig 6. Duration of Laptop charging time from 0% to 100%

Duration of Laptop Charging Time

With the system used in this study, which with large valve openings produces a large amount of power. So, in the application to charge a laptop, the biggest valve openings are use

d. Power from the system is then stored in batteries and then connected to an inverter before being used directly. The duration of charging a laptop to reach 100% from the initial condition of 0% takes about 138 minutes or 2 hours 18 minutes as shown in figure 6, which in the picture shows the duration of charging laptop batteries from 0% to 100%. The duration of battery charging is similar to the duration of charging if using electricity from the National Electric Company, so it can be said that the system used in this study is feasible to be applied.

CONCLUSSIONS

From the results of the experimental study of variations in pelton turbine valve openings on the electrical energy produced to turn on laptop device, it can be conclude that:

1. Valve openings are proven to affect the electrical power produced. In this study the 90° valve opening has the highest power of 3.96 Watts.
2. The greatest system efficiency occurs when the valve opening is 90° which is equal to 14.56%.

With these results it is expected to be used as a reference for the application of other media such as street lighting or public facilities.

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