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Increased Efficiency in the use of Water Pump (NS-50) as a Turbine on Pico Hydro Power Plants

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Abstract:- Water pump (NS-50) was operated as a turbine for the Pico Hydro Power Plant was an idea in finding alternative energy that is simple and easy to assemble. In this study, the water pump (NS-50) was operated as a turbine, so that the working principle was reversed, where water from a certain height will move the pump, so that the pump impeller rotates and continues to rotate the generator and will produce electrical energy. In this study, the water pump (NS-50) is operated as a turbine, the working principle of the pump is reversed, water from a certain height will move the pump impeller, so that the pump impeller rotates and the pump shaft will rotate the generator and produce electrical energy. This study emphasizes the pump which was operated as a turbine (PAT) by utilizing a height difference of 14.51 m at a flat distance of 46.21 m with a pipe installation with a slope of 17.43º. The variable used is the discharge calculated from the water level height (H) at different V-notch weirs, namely 15 cm, 12 cm and 11 cm with the impeller used having an inlet and outlet angle of 30/75. The pump was connected to a generator to generate electricity. From the research results, the best efficiency that can be achieved was 23.33%, the rotation was 1500 rpm and the power generated was 283.5 watts.

***Keywords**:- Pump as a Turbine, Pico Hydro, NS-50, Rapid Pipe Slope.*

I. INTRODUCTION

Along with population growth, the need for energy will also increase. The demand for conventional energy such as oil and gas was high and was not matched by production capacity causing a shortage which results in price increases and an energy crisis. Efforts related to energy policy are the development and improvement of energy diversity, including current and future potential energy, especially the development of the renewable energy sector.

Indonesia has a target electricity level of 90% for a current (estimated) population of over 273 million. The average standard for electricity was 450 watts per house, so around 9000 MW was needed until 2025. Hydroelectric power plants (PLTA) in Indonesia have the potential to reach 70,000 MW. Thus, predictably the shortage of 9000 MW will be met through hydroelectric power. Of the 70,000 MW potential, only about 6% has been utilized. In remote rural areas, the provision of electricity needs through hydropower can be assisted by the Pyco-Hydro Power Plant (PHPP).

Indonesia has natural conditions that are very rich in water potential that can be used as a power plant. Optimization of the use of water resources needs to be done to meet energy needs. The Picohydro system is one of the new renewable energy sources that can provide great benefits to the community in providing electrical energy at a relatively low cost and environmentally friendly.

An economical alternative to building a small-scale hydroelectric power plant is to use a pump as a turbine. technically the operation of the pump as a turbine is often called Pumps As Turbine (PAT). Several types of water pumps can be operated as water turbines, generally the pump is driven by an electric motor to raise a certain amount of water to a certain height. In the application of the pump as a turbine, the working principle of the pump is reversed, which is given the flow of water from a certain height to rotate the pump impeller. This impeller rotation will be forwarded to the generator shaft to produce electrical power.

In an effort to optimize the performance of this turbine, it will be investigated the effect of changes in the incoming flow rate. In this research, it will be tested experimentally to determine the performance of the output power produced by the turbine blades by varying the inflow discharge using variations in the water level on the V-notch weir, namely 15 cm, 12 cm and 11 cm. This research was carried out at the Laboratory of the Mechanical Engineering Department at the Merdeka University of Madiun and the application in Poncol Village, Magetan Regency.

The problem that will be discussed in this study was how the inflow discharge affects the turbine mechanical power, generator power and turbine efficiency. while the scope of this research are:

- The difference between the height of the turbine and the upper reservoir was 14.51 meters;
- The flat distance between the turbine and the upper reservoir was 46.21 m;
- The slope of the pipeline was 17.43º;
- The impeller used has an inlet and outlet angle of 30/75;
- Variation of inflow discharge with variation of water level on V-notch weir : 15 cm, 12 cm and 11 cm.

II. BASIC THEORY

On the working principle of a hydroelectric power plant, water is flowed from a certain height to a lower place, the resulting water head can be used to do work. The power plant, in this case the turbine, can transfer the mechanical components into rotational energy which is transmitted to the shaft to drive a generator to produce electricity. The choice of the appropriate turbine for each site depends on the site characteristics, available heads and exhaust ducts. Modern and expensive turbines are a bottleneck for rural communities. However, if we use pumps that are easily available and affordable, clean, green and sustainable are the solutions to the electricity needs of rural communities. The targeted generation scale for household needs is around 400 W - 5000 W.

A water turbine is a device for converting the potential energy of water into kinetic energy and then converted into electrical energy by a generator. In designing and selecting a water turbine, it is necessary to conduct a feasibility test and analysis of the water resources that will be used for its potential energy, especially the availability of head and water discharge from the water source for the design load.

By knowing the potential head that exists in the water flow source, then the turbine type and the planned load are determined. The design load should not exceed the availability of potential energy from water sources, because it will result in not achieving maximum operational efficiency and otherwise causing economic losses.

A. Pico Hydro

A pico-scale hydroelectric power plant was a power plant that produces an electrical power output of not more than 5 kW. Pico-scale hydroelectric power plants in principle use different heights and the amount of water discharge per second that was in the flow of water from irrigation canals, rivers or waterfalls. This water flow will rotate the turbine shaft to produce mechanical energy. This energy then drives a generator and the generator produces electricity.

B. Pump as Turbine

Hydropower systems convert energy from falling water into mechanical energy by turbines. In some cases, it may be more appropriate to replace the turbine with a centrifugal water pump, and run it in reverse. One of the economical alternatives to build a small-scale hydroelectric power plant was to use a pump as a turbine.

Usually the pump was driven by an electric motor to raise a certain amount of water to a certain height. In the application of the pump as a turbine, the working principle of the pump was reversed, which was given a drop of water from a certain height to rotate the pump plunger. This impeller rotation will continue to turn on the generator so that electricity was generated.

III. RESEARCH METHODS

The test was carried out at the location of the micro hydro power plant installation in Poncol Magetan village. Equipment used includes: NS 50 pump, piping system and electric generator.

C. Test installation on pump as turbine

The installation of a hydroelectric power plant that will be used in this study could be seen in Figure 1 below:

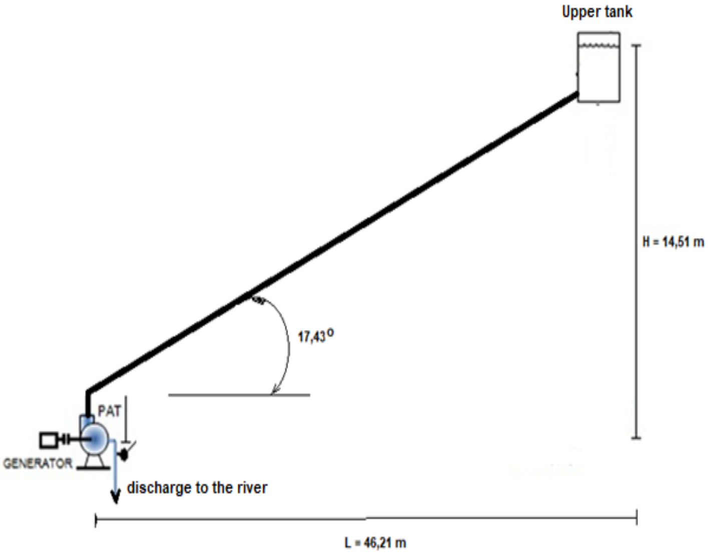

Fig 1:- Test installation on the pump as a turbine

D. Impeller

In thwas test, an impeller with an inlet and outlet angle of 30/75 (Forward) was used. Specimen specimens were made of composite materials. This was intended to obtain a material that was lightweight and resistant to pressure. The illustration of the impeller used could be seen in Figure 2 below.

Fig 2:- Impeller with variations in the angle of entry and exit angle of 30/75

IV. RESULTS

The test was carried out on the pump as a turbine with a height difference of 14.51 meters while the flow discharge variation was by adjusting the valve opening and measuring the water level on the V-notch weir at a height of: 15 cm, 12 cm and 11 cm. The test results data could be seen as in table 1. below:

Table 1. Experimental data

Number	**n_t rpm**	**n_b rpm**	**F_s kg**	**n_i rpm**	**n_v rpm**	**i Ampere**	**v Volt**
1	1500	1390	2,60	130	1440	2,1	135
2	1375	1340	2,24	174	1330	1,8	123
3	1236	1125	2	120	1215	1,5	112

Information :
- nt = shaft rotation without load (rpm)
- nb = shaft rotation without load (rpm)
- Fs = force measured on a digital scale
- ni = shaft rotation without load (rpm)
- nv = shaft rotation without load (rpm)
- i = generator current output (Amperes)
- v = generator output voltage (Volts)

From the experimental results, then data processing was carried out to obtain torque, turbine power, generator power and efficiency.

E. Effect of inflow discharge on turbine power and generator power

From the data processing the experimental results obtained data as shown in the following table.

Table 2. Effect of flow rate on turbine and generator power

Debit	**Generator power (kW)**	**Turbine power (kW)**
Debit 1	0,2835	1,22
Debit 2	0,2214	1,21
Debit 3	0,168	1,14

If plotted on the graph, we will get the relationship between flow rate and turbine power and generator power.

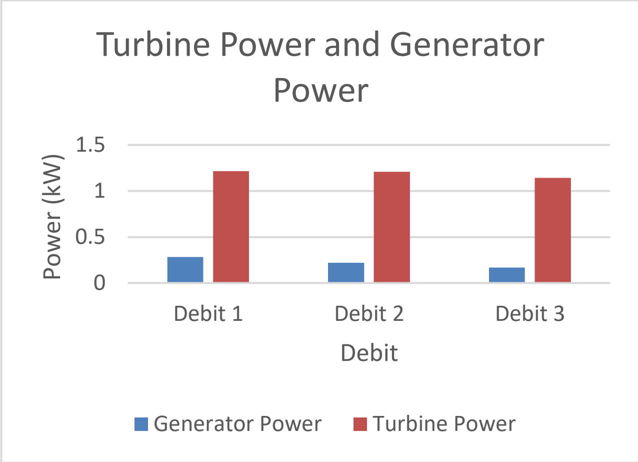

Fig 1. Relationship of flow rate to turbine power and generator power

F. Effect of inflow discharge on efficiency

From the processing of the experimental results obtained data as shown in the following table.

Table 3. The effect of variations in flow rate on efficiency

Debit	Efisiensi (%)
Debit 1	23,33238916
Debit 2	18,33139303
Debit 3	14,71124793

If it was plotted on the graph, it will be obtained the relationship between flow rate and efficiency.

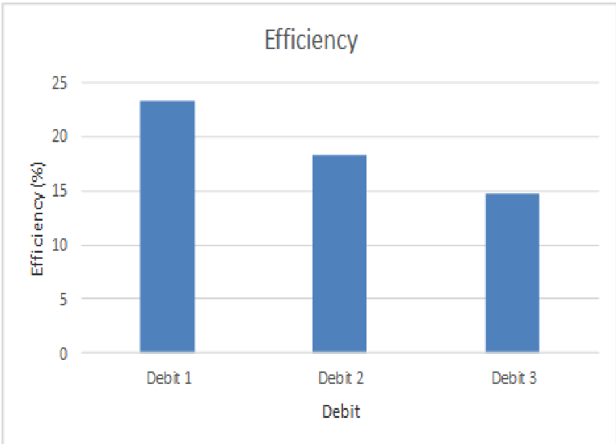

Fig 2:- the relationship between flow rate and efficiency

From the graph in Figure 1. it was known that the smaller the flow rate, the lower the turbine power and the generator power of the turbine system. This was because the smaller the flow rate, the water pressure on the blades will decrease so that the thrust on the blades decreases. Furthermore, the rotation of the turbine shaft will decrease, so that the turbine power also decreases.

While the generator power with the smaller the flow rate of the turbine shaft rotation decreases, so that the rotation of the generator shaft which was connected to the turbine shaft also decreases, so that the current and voltage produced by the generator also decreases. As a result, the electrical power generated by the generator also decreases. This was because the voltage generated was due to electromotive force, so that if the rotation was greater, the output voltage produced also increases.

If the flow rate was small, the speed of the water flow will increase, but the pressure will decrease. With a decrease in pressure, the thrust of the blades decreases so that the turbine shaft power decreases and in the end the efficiency also decreases.

V. CONCLUSION

From the results of testing and discussion, the following conclusions could be drawn:

- The effect of flow rate on turbine power and generator power was directly proportional, as the flow rate decreases, the turbine power and generator power decrease.
- The effect of flow rate on was directly proportional to the decreasing flow rate, the turbine power and generator power were decreasing, with maximum efficiency 23.33% and minimum 14.71%.

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- Head of Poncol Village, Poncol District, Magetan Regency.
- Chairman of LPPM Merdeka University Madiun

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