Utilization of the Kelekar River Flow as Micro-Hydro Power Plant

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ABSTRACT

The number of rivers scattered throughout Indonesia can certainly be used as an alternative energy source, one of which is micro-hydro power plants, it is a power plant that uses water resources on a small scale as a turbine drive to produce electrical energy, where the generation of this energy is influenced by water discharge and the height of the water fall. One of the rivers that has a fairly large water discharge is the Kelekar River which is located in the Ogan Ilir Regency area. To calculate the amount of energy generated from the Kelekar River, a prototype micro hydro power plant is designed, then the energy generated from the simulation of the tool will be used as the basis for designing a micro hydro power plant based on actual conditions. From the analysis of water discharge and water fall height based on the condition of the Kelekar river, the design of the tools is obtained as follows: (i) the dimensions of the fast pipe are 0.8 m, (ii) the thickness of the fast pipe is at least 4 mm, (iii) the effective energy height is 3.476 m, (iv) the dimensions of the runner are 0.65 mx 1.50 m, and (v) the power generated is 11.508 kW.

Keywords: *Flow, River, Micro Hydro Power Plant*

1. INTRODUCTION

Indonesia is an archipelagic country surrounded by waters, this is certainly very beneficial for Indonesia if the abundant water can be used as alternative energy in producing electrical energy. The existence of electrical energy is needed for every human being to carry out activities ranging from activities at home and outside the home. Considering the importance of electrical energy in supporting daily life, the supply of fossil energy will certainly run out over time if its use is not controlled. Various studies have been carried out to obtain alternative energy to replace fossil energy, including the use of water energy, solar energy, wind energy, and so on, namely by making various innovative tools that can be used to produce electrical energy from unlimited available alternatives energy sources in this earth.

Utilization of rivers as micro hydro power plants by utilizing rivers as an energy source has been widely carried out in the territory of Indonesia, considering the number of river is scattered throughout the waters in Indonesia, including in East Java, West Sumatra, Aceh, South Sumatra, and other areas in Indonesia [3][4][5]. The increasing use of river flows as alternative energy in producing electrical energy can certainly help the government in realizing sustainable development so the future generations can still enjoy what is felt by the current generation [6].

A micro-hydro power plant is a small-scale power plant installation using water resources in the form of water flow as the driving force to generate electricity, which is influenced by the height (head) and water discharge [1][2]. This micro hydro power plant has the potential to be developed in Indonesia considering the large number of rivers and waterfalls. This utilization can also be done in order to save energy from Nuclear Power Plants [2][4][5]. In addition, because it uses natural resources it will produce electricity in an environmentally friendly manner.

Micro Hydro Power Plant is a power plant that utilizes power from flow or waterfalls, reservoirs or dams or irrigation canals whose construction is multipurpose with a capacity in the range of 5 – 100 kW. Its capacity is not larger than Hydroelectric Power

Plant so that it can be used as alternative energy. However, still use resources that already exist in nature, namely water [3].

The advantage of this power plant is that it can utilize natural resources in the form of water which is abundant in nature into alternative energy through a continuous water cycle. This micro hydro power plant is also an environmentally friendly power plant, where in its utilization there is no waste or gas emissions produced. The resulting efficiency is also high, namely 75% to 80%. Environmentally friendly means that there is no air pollution or noise that disturbs the community. When compared to using materials from fossils, the operational and maintenance costs provided are also cheaper.

From previous research that has been carried out on the design of a prototype micro hydro power plant based on the flow of the Kelekar river [1][2][3], this research is continued by analyzing the existing energy that can be applied to the Kelekar River, so that the flow of the Kelekar River can be utilized as Micro Hydro Power Plant.

2. METHODOLOGY

The location of the study was carried out on the Kelekar River in the Ogan Ilir regency, South Sumatra. The selection of the location with the consideration that this river has a fairly heavy flow of water and has a reservoir that can be used to hold water. If the river water discharge decreases, then the water in the reservoir can be utilized so that the micro hydro power plant can still continue to work.

The condition of the Kelekar river shown in Figure 1.

Figure 1. Location of the Kelekar River in Indralaya District

The stages in this research consist of:

1) Calculating the energy generated from the prototype of a micro hydro power plant that has been carried out in previous studies. The tools used in the prototype design are: glass tub, turbine, pump, tank, digital flowmeter, digital tachometer, digital multimeter, AC generator, PVC pipe, elbow, tee, ball valve, LED lamp.
2) Designing a prototype based on the existing conditions of the river, including the design of the rapid pipe, the transmission speed, the turbine used, the dimensions of the runner, and analyzing the power generated. The design based on the magnitude of the river flow and the height of the water fall in the Kelekar River. The design of a micro hydro power plant includes an analysis of rainfall, rapid pipe design, transmission speed, turbine design, runner dimensions, and the amount of power generated.

3. RESULT AND DISCUSSION

3.1. Energy Produced by Micro Hydro Power Plant Prototype

The prototype trial can be seen in Figure 2. The test was carried out in 2 variations at 100% valve opening and 50% valve opening.

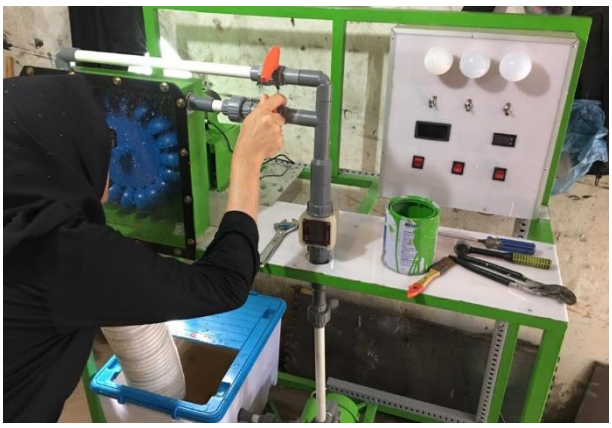

Figure 2. Operation of Prototype of Micro Hydro Power Generation Equipment

The energy that produced from the prototype from the two variations can be seen in Table 1 and 2.

Table 1. Results of Testing Prototypes for Micro Hydro Power Plants 100% Valve Opening

No.	Description	Result
1	Generated water discharge (Q)	0.000145 m^3/sec
2	Generated transmit speed (V)	23.078 m/sec
3	Generated power (Pt)	4.944 Watt

Table 2. Results of Testing Prototypes for Micro Hydro Power Plants 50% Valve Opening

No.	Description	Result
1	Generated water discharge (Q)	0.000136 m^3/sec
2	Generated transmit speed (V)	20.635 m/sec
3	Generated power (Pt)	4.637 Watt

If the turbine efficiency η_t = 0.75, then the power generated by the turbine is:

On valves 100%

$$P_t = \eta_t P = 0.75 \cdot 4.944 \text{ watt}$$
$$= 3.708 \text{ watt}$$

On valves 50%

$$P_t = \eta_t P = 0.75\ 4.637 \text{ watt}$$
$$= 3.478 \text{ watt}$$

Based on the analysis that has been done, it is found that variations in valve opening produce different discharges and power, where the discharge (Q) produced at 100% valve opening is 0.000145 m3/s and the resulting energy (Pt) is 4.944 watts. While the discharge (Q) produced at 50% valve opening is 0.000136 m3/s and the energy (Pt) generated is 4.637 watts. The results of this trial indicate that the amount of discharge will affect the amount of energy produced. In addition, the rotation of the generator is also influenced by the flow of water where the greater the discharge, the greater the rotation of the generator and vice versa, the smaller the discharge, the smaller the rotation of the generator.

3.2. Micro hydro power plant design based on the existing condition of the river

The design of a micro hydro power plant is based on the magnitude of the river flow rate and the height of the fall, then the required rapid pipe dimensions can be designed, the minimum thickness of the rapid pipe, the maximum specific speed of the runner, the allowable speed limit of the specific runner, the effective hydraulic energy height of the turbine drive, the dimensions runner, and the amount of power generated. The results of the overall calculation shown in Table 3.

Table 3. Results of Micro Hydro Power Plant Design Analysis

No.	Description	Result
1	Discharge at Maximum Rain Intensity (Q_{Rmax})	211.109 m^3/sec
2	Discharge at Minimum Rain Intensity (Q_{Rmin})	15.732 m^3/sec
3	Rapid pipe dimensions	0.80 m
4	Rapid pipe cross-sectional area	0.503 m^2
5	Minimum Thickness of Rapid Pipe	4 mm
6	Maximum specific runner speed	Nsmax ≤ 932.34
7	Turbine Type	Propeller Turbine
8	High effective energy	3.48 m
9	Turbine Tailrace Dimension	0.65 m x 1.5 m
10	Generated power	11.508 kW

From the results of the next design, it is designed to place a micro hydro power plant on the Kelekar River. An overview of the turbine placement plan can be seen in Figure 3 and 4, while the equipment placement scheme shown in Figure 5.

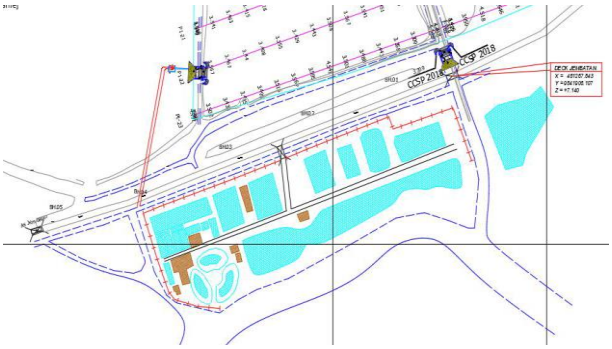

Figure 3. Turbine Situation

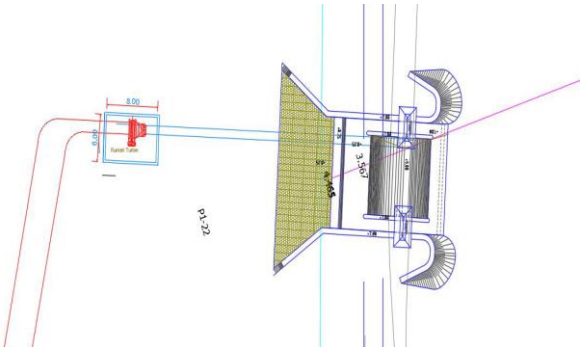

Figure 4. Turbine Placement Plan

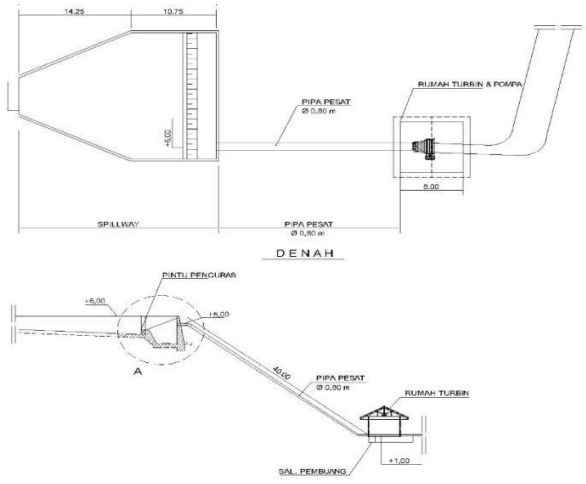

Figure 5. Tool Placement Scheme

4. CONCLUSIONS

From the analysis results, the design of the MHP in the Kelekar River is as follows: pipe dimensions 0.8 m, rapid pipe thickness at least 4 mm, effective energy height 3,476 m, runner dimensions 0.65 mx 1.50 m, and the output power is 11,508 kW.

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