ENHANCE A DESIGN OF A MINI HYDROELECTRIC POWER PLANT BY UTILIZING RICE FIELD IRRIGATION RIVER FLOW

Solly Aryza[1], Zulkarnain Lubis[2]
Faculty Of Science Technology
Universitas Pembangunan Panca Budi
Medan, North Sumatera
Indonesia

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***Correspondence Address:**
sollyaryzalubis@gmail.com

Abstract: A microhydro power plant is a technology in the field of electricity generation from renewable energy sources. Indonesia presents a significant opportunity for the development of renewable electrical energy sources, such as microhydro. This potential stems from Indonesia's tropical climate, characterized by high rainfall and an abundance of rivers and tributaries across various regions. As a result, Indonesia can harness the power of renewable energy by utilizing the flow of irrigation water from rice fields through turbines and generators. In this system, a turbine is connected to a generator using a pulley and belt mechanism as a rotary energy transmission system. Experimental results have demonstrated that this power plant can produce a voltage of 33.8 volts DC with a water discharge rate of 0.138 m^2/s and an RPM (revolutions per minute) of 2,400. Based on these experimental findings, it can be concluded that the flow of water from rice field irrigation can be effectively harnessed as a source of renewable electrical energy.

INTRODUCTION

The increasing demand for electrical energy in Indonesia is directly correlated with the country's growing population. According to the results of the population census conducted in September 2020, Indonesia's population reached 270.20 million people. This figure represents an increase of 32.56 million people compared to the population recorded in the 2010 census.

This population growth has significantly contributed to the escalating demand for electricity. However, the limited capacity of the state electricity company, PLN, to meet this growing demand has led to disruptions in various community activities, both at the micro and macro levels. To address this issue, the government is committed to developing renewable energy sources, such as solar power, seawater waves, wind energy, and water-

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based sources.

Indonesia possesses substantial potential for the development of renewable electrical energy sources, including micro-hydro power. This potential is attributed to Indonesia's tropical climate, characterized by high rainfall and an extensive network of rivers and tributaries spanning the country's various regions. Consequently, Indonesia has the opportunity to harness renewable energy from river flows and tributaries, primarily by using turbines as a medium.

In the village of Jatikesuma Namorambe, there are two major rivers, the Deli River and the Baburah River, each of which has numerous tributaries flowing into rice field irrigation channels. The majority of the local population in Jatikesuma Village engages in farming activities. Despite the presence of these irrigation channels, they have not yet been utilized as a potential source of micro-hydro renewable energy.

In a mini water power plant or micro hydro there are several main components and supporting components or buildings that make up a mini water power plant, namely:

a. Dam (Dam)

Dam is a building that is built across the middle of a river that aims to stem the flow of the river so that it is able to raise the elevation of the water surface so that it can flow to the place that needs it or flow into the hydropower plant PLTA.

b. Carrier channel (Headrace)

The carrier channel or headrace is a channel following the contours of the higher side to maintain the elevation of the flowed water.

c. Mud bag (Sand trap)

Mud bags function as a separator between sand and water in order to maintain or protect further components.

d. Headtank

Calming tub is located at the end of the carrier channel (headrace) setra serves to regulate the water output between the rapid pipe and the channel, and separator between impurities or particles such as wood, plastic, and sand.

e. Rapid pipe (Penstock)

Rapid pipe is a channel that is connected from a lower elevation to a turbine.

f. Turbine

The potential energy caused by the flow of water moves the propeller on the turbine to produce mechanical energy.

g. Generator

The generator functions as a converter of mechanical energy from propellers into electrical energy.

h. Power house

Power house is a place where all installations are installed as well as a power plant control room.

i. Waster channel

The waster channel is a place to dispose of water that has been used.

The use of components is adjusted to the situation or geographical location or water flow and the culture of the surrounding community because each MHP can have different components depending on the geographical situation.

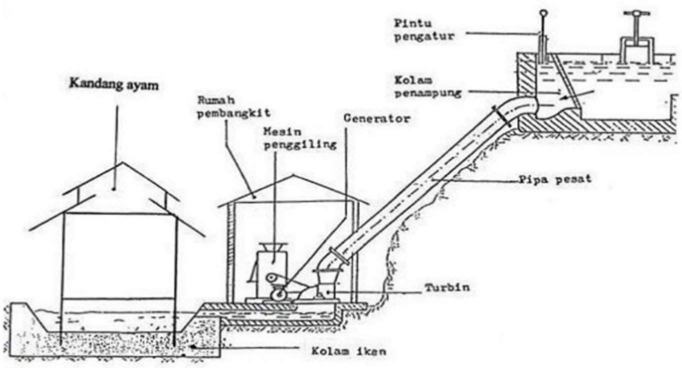

Figure 1. Design Micro-hydro

METHOD

The data collection method is one way to obtain correct information so that it can be held accountable. The data methods in this research are as follows.

a. Field Study

In this field study the author carried out a design system for a mini hydroelectric power plant using river flow for rice field irrigation so that he could find out whether or not rice field irrigation could be used to produce electrical energy and be useful for the community.

b. System planning

This stage is the design of a mini hydroelectric power plant design system using rice field irrigation flows using literature studies and understanding the components and tools installed. This stage is also quite an important stage in order to be able to design the shape of this tool.

c. Implementation

At this implementation stage the author realizes what has been planned in the previous stage, so that it can be in accordance with what has been planned for the tool.

d. Trial and Evaluation

At this stage, it is an experiment on the tool that has been made so that results are obtained where there is a mistake or error in this tool that can be evaluated again so that it can operate according to what is desired.

e. Study of literature

This part of the literature study is the stage of collecting data and supporting documents that are appropriate to the discussion being carried out, such as books, journals, documents and other sources so that they can be used as references in making this tool.

In this design concept the author creates a block diagram and flowchart so that it can make it easier to understand and know how this tool works.

From the chart above there are six parts consisting of irrigation channels, dams, water turbines, pulleys and belting, generators, 12v DC lights. Where the explanation of the chart above is as follows:

1. Irrigation canal blocks are water flows created by humans to irrigate rice fields or provide water for the community and livestock.
2. The dam block is a place to hold back the irrigation flow so that the flow of water flowing into the turbine can be stable and another function of this dam is to hold rubbish or twigs that are carried away by the irrigation flow.
3. This water turbine block is a place to convert the mechanical energy of water so that the turbine can rotate before being connected to the generator via pulleys and belting.
4. The pulley and belting block functions as a connection between the water turbine and the generator so that it can rotate so that it can produce electrical energy.
5. A generator block is a device that can produce electrical energy.
6. This load block functions as consumption while the micro hydro power plant

is working, and the load used is a 12 V DC LED lamp.

At the start of assembling the micro hydro generator so that it is formed according to the design or initial manufacturing plan, after all the components are installed on the micro hydro generator, a trial is carried out starting with placing the generator in the middle of the irrigation flow, the irrigation channel does not yet have a stable flow or water discharge. where in order to get a stable flow of water or water discharge, the author made a dam where this dam functions so that the flowing water can be blocked so that the water flowing into the turbine will be stable, after the flowing water hits the spiral-shaped turbine fins it produces mechanical energy, namely rotation in the same direction. with clockwork.Where the rotation of the turbine is connected to the pulley and belting, where the function of the pulley itself is to fulfill or increase the turbine rotation or rpm required by the generator and the function of the belting itself is to connect the pulley to the generator.

The generator used in this plant has a capacity of 12V DC, where this generator also has a minimum rpm requirement of 600 rpm/minute in order to produce 12 volt DC voltage. After the generator produces a current of more than 12v DC, it is connected to a load, namely a 12V DC lamp and re-checked on all components or systems to see whether they are working properly, if not then repairs must be made to the components that are not working, after all the systems are running properly then the author take the analysis according to the tool experiment.

In the process of designing a mini hydroelectric power plant using rice field irrigation flows, the following components are required:

Table 1. List of Components for Mini Hydroelectric Power Plants Utilizing Rice Field Irrigation Flows

No	Component	Amount	Unit	Information
1	12 V DC Generator	1	Fruit	12v DC 1000 rpm
2	Iron plate	1	Fruit	Size 2.5mm
3	Iron axle	1	Fruit	1 Inch
4	Drum Pipe	1	Fruit	4 Inch
5	Ump iron (elbow)	2	Fruit	5cm

6	Iron Hose	1	Fruit	34.5 cm
7	Lava	2	Fruit	1 inch
8	Puli	2	Fruit	6cm and 1.5cm
9	Belting (pulley rope)	1	Fruit	M 30
10	Bolt	6	Fruit	12mm
11	Water Retaining Iron	1	Fruit	32 cm
12	Thread Leaf	4	Fruit	8 cm
13	DC12 V lamp	1	fruit	5 watts
14	Power cable	-+1	Meters	-

After all the materials and tools have been completed, the next step is to realize the design of a mini hydroelectric power plant using rice field irrigation flow. This process is divided into several parts, namely:

1. The process of making screw turbine blades

   Initially, the iron plate which was originally a square with a size of 2x2 square meters was given a circular pattern with a size of 30 cm, then the iron plate which had been given the pattern was cut using a cutting machine according to the pattern that had been made. After the iron pallet has been cut into a circular shape, it is then given a circular pattern again with a smaller size of 4 inches and cut again according to the pattern. This is so that the threaded leaves can be joined to the shaft pipe.

Figure 2. Making Screw Leaves

2. The process of making iron plates into threaded shapes

This stage aims to ensure that the iron plate that has been cut can stretch so that it takes a spiral shape. This aims to make it easier to install on the shaft pipe. Where this process is carried out by manually pulling the iron chain which is temporarily welded to the end of the plate.

Figure 3. Withdrawing threaded leaves

The process of installing AS iron on iron pipesThis stage is the stage of installing a 1 inch steel AS which is placed at the top and bottom ends of the shaft pipe, where the AS will be connected to the 1 inch sized lava which aims to hold the spiral turbine and allow it to rotate stably.

RESULTS AND DISCUSSION

3.1. Specifications for mini hydroelectric power plants

The working system of the Piko Hydro Power Plant (PLTPH) is the discharge or flow of water that flows at a certain time unit through the turbine fins. The turbine fins function as a converter to the mechanical energy provided by the water flow which causes the turbine fins to rotate. The mechanical energy in the turbine fins is channeled through the pulley and belting as a connection to the generator.

When the turbine fins rotate, the alternator also rotates because the two objects are connected to each other using pulleys and belting, where the function of the pulley itself is to provide sufficient rpm for the generator so that it can produce electrical energy.

Table 2. Shows the specifications of a mini hydroelectric generator. The following is a table of specifications for a mini hydroelectric generator

No	Parameter	Mark	Unit
1	Generator length	45	Cm
2	Generator width	35	Cm
3	Front height	45	Cm
4	Back height	30	cm
5	Fin width	8	cm
6	Width between fins	15	cm
7	Number of turbine fins	4	fruit
8	Bottom water retaining iron	32	cm
9	Underwater casing	34.5	cm
10	Generator mount	25	cm

3.2. Data from direct voltage measurements withou3.t using a 12 volt DC lamp load.

In this test, voltage measurements were carried out using a digital multitester to measure the voltage produced by the 12 volt DC generator. This stage aims to ensure the voltage produced by the generator by adjusting the multitester switch selector at the 200 volt DC position.

Where the positive and negative poles are connected to each pole of the 12 volt DC generator. So the results of this PLTMH measurement are as follows:

Table 3. Data from direct voltage measurements without using a 12 volt DC lamp load

NO	Duration (minute)	*Revolution Per Minutes*(RPM)	Water discharge	DC Voltage
1	1	2,400	0.138 m2/s	14.8
2	3	2,400	0.138 m2/s	20.3

3	5	2,400	0.138 m2/s	33.8

From the results of the voltage measurements that have been obtained, around 33.8 volts DC is sufficient and sufficient to be given a load, namely a 12 volt DC 5 watt LED lamp.

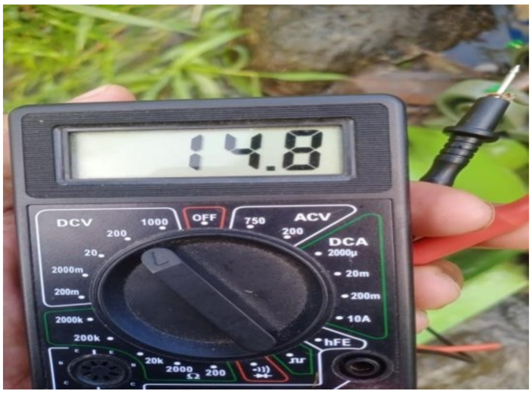

Figure 5. Generator Voltage Measurement for 1 Minute

Figure 6. Generator Voltage Measurement for 3 Minutes

In this test, the output voltage and current are measured by adding a load, namely an LED lamp with a capacity of 12 volts DC 5 watts. This aims to determine whether this power plant produces current and is able to turn on the LED lamp.

In this test, to measure the generator voltage, the digital multitester switch selector was positioned at 20 volts DC, where the positive and negative poles of the digital multitester were connected to each pole on the lamp that was connected to the generator.

Meanwhile, to measure current, the switch selector is positioned at 10 A, where to measure this current you must use a parallel system where the positive pole of the digital multimeter is connected directly to the positive pole of the generator and the negative pole of the lamp is connected to the negative pole of the generator, while the negative pole of the multimeter is connected to the positive pole. light. So the following measurement results are obtained:

Table 4. Data from voltage and current measurements using a 12 volt DC lamp load

NO	Time Test	*Revolution Per Minutes*(RPM)	Water discharge	Voltage	Current
1	1	2,400	0.138 m2/s	8.67	0.06
2	5	2,400	0.138 m2/s	9.16	0.07

CONCLUSION.

Based on the description and research that has been carried out, it can be concluded as follows:

a. The water discharge and speed greatly influence the rotation of the turbine and generator so that the greater the water discharge and speed, the greater the voltage produced.
b. The water discharge in the rice field irrigation flow in Jatikesuma village is 0.138 m2/s and the water speed is 0.23 m/s so it is enough to rotate the electricity generating turbine.
c. The Rpm or (Revolution Per Minute) produced by the turbine is 600 Rpm and the Rpm produced by the generator is 2,400 Rpm.
d. The amount of energy produced by the power plant is a voltage of 9.16 vollt DC, with a current of 0.07 A.
e. The power produced was 0.64 Watts in an experimental time of 5 minutes with a water discharge of 0.138 m2/s. The amount of power produced depends on the speed of rotation of the generator which is rotated by the turbine which is transmitted via pulleys and belting.
f. The load used is a 5 Watt 12 Volt DC LED lamp.
g. The generator used is a 12V DC generator where 12 Volts can be

produced at 600 Rpm.

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