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An Analysis The Distinction Of Generator And Efficiency Gear Ratio PLTMH Vortex Turbine In Reservoir At Bujel Village

Muh Qidam Agwalul Santoso [a,1*], Karimatun Nisa [a,2], Zainal Abidin [a,3], Ulul Ilmi [a,4]

[a] Program Studi Teknik Elektro, Fakultas Teknik, Universitas Islam Lamongan, Jl. Veteran No. 53A Lamongan
[1] Muhammadqidam0036@gmail.com*, [2] karimatunnisa@unisla.ac.id, [3]zainalabidin@unisla.ac.id,
[4]ulul_ilmi@unisla.ac.id
*Muhammad Qidam Agwalul Santoso
*Corresponding Author

ABSTRACT

Keywords
PLTMH Analysis
Vortex Turbin
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Generator
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Energy requirements are needed by modern society in this digital era. Today the most widely used energy is fossil energy. It makes fossil energy can run out at any time. Therefore, alternative energy is needed, especially energy from nature. Indonesia has a lot of potential for the development of hydroelectric power plants. It happens because Indonesia has a tropical climate with very high rainfall and many of rivers with a fairly swift flow. The study done at Bujel village in Ngimbang Sub-District, Lamongan. DC generator is superior because the DC generator used is a low rpm generator, so by low rpm can have a higher voltage level of 25V, while AC generator has a maximum voltage of 11V. Based on the standard level of water turbine efficiency of 70%-90%, it means that the second generator can be said to be efficient because the load used is only a 50 Ω. The selection of gear ratios also affects the efficiency value of a water turbine because therefore in this study will examine the difference in gear ratios, namely 46:16, 46:18, 46:20. Considering the test results of the three gears, the gear with a ratio of 46:16 has a high rpm level of 468 rpm.

1. Introduction

Energy needs are very much needed by modern society in this digital era. The energy that is very widely used today is fossil energy, this makes fossil energy can run out at any time[1]. Therefore, alternative energy is needed, especially energy from nature.Indonesia has enormous potential with abundant natural resources such as geothermal energy, water energy, wind energy and others. Along with the development of the era of innovation to make tools that utilize alternative energy, many have been developed, for example, water turbines. Utilization of a river that is given a dam and given a water turbine is an effective innovation for supplying electricity, especially people who are on the edge of the river [2]. This is because the main advantage of a water turbine is that it has a higher average efficiency of 82% and can save costs [3].

Indonesia has the potential to develop hydroelectric power plants, this happens because Indonesia has a tropical climate with very high rainfall and results in many rivers with fairly heavy flows. Bujel village in Ngimbang sub-district, Lamongan district is an example because there is a river that is good enough for a water turbine to be installed, with a dam that has a dam makes turbine installation easier and more efficient for electrical energy needs, which will later supply street lights. Selection of vortex turbine [4]. Based on this background, the author takes the theme of "analysis of generator differences and the efficiency of the gear ratio of the Vortex Turbine Power Plant in the Bujel Village Reservoir" which can be used as a reference for development and can be useful for the surrounding community [5].

2. The Proposed Method

2.1. Vortex Turbine

Vortex turbine is a type of micro hydro turbine that uses a whirlpool as the driving force for the blades. The vortex turbine has a relatively low head of 0.7 m – 3 m with a discharge of 50 L/s. This type of turbine is very suitable for river flow, because most rivers have low heads [6]. The greater the value of water capacity, the resulting efficiency tends to increase. In this case, large turbine power does not always produce great efficiency. With a blade height of 21 cm with a capacity of 7,998 L/s, it has the lowest efficiency value at a loading of 10000 grams with an efficiency of 29.276% [7].

The largest turbine efficiency uses a turbine with 8 blades at a load of 20000 gr with a water capacity of 6.94 L/s obtained a turbine efficiency of 44.3% while the largest mechanical power uses an 8 blade turbine at a load of 25000 gr with a water capacity of 8.89 L/s obtained by a mechanical power of 21 ,84 watts.[8].

2.2. Gear Calculation And Efficiency

The gear ratio is a measure of how many revolutions the driving gear (the one connected to the input) must make to turn the driven gear (the one connected to the output) one full revolution. It can be calculated using the following formula:

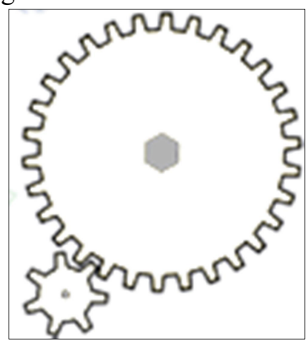

Fig. 1. Gear Ratio 30 : 1

Formula 1

130 rpm x 7=S2 x 30 (2.1)

130 rpm : Rotation speed

7 : Number of small gear teeth

S2 : Driven gear speed

30 : Number of big gear teeth

Formula 2

$$\frac{N_1}{N_2} = \frac{Z_2}{Z_1} \quad (2.2)$$

N1 = Rotation speed
N2 = Driven gear speed
Z1 = Number of small gear teeth
Z2 = Number of big gear teeth

B. Calculation of generated power

P = V x A (2.3)

P = Maximum Output Power (W)

V = Voltage (V)

A = Current (A)

C. Efficiency calculation

$$\text{Eff} = \frac{\text{Maximum P Output}}{\text{P Input raised}} \text{x } 100\ \% \quad (2.4)$$

Eff =Effisiensi (%)
P Output maksimal =Generator power
P Input yang dibangkitkan = Input power plus load

2.3. Generator

Generator testing was carried out several times by using AC and DC generators mounted on the gear [9]. The generators used in this study are the AC TAMAGAWA SERVO 24V generator and the AMETEK MOTOR DC 40V generator, both generators have the specifications presented in table 1

Table 1. Generator Spesification[10]

NO	Name	Type	Output Max	Voltage	RPM Max
1	*TAMAGAWA SERVO*	AC	200 W	24 V	3000 rpm
2	AMETEK MOTOR	DC	480	40	600 m

3. Method

The initial stages of the research are:

3.1. Literature study

This study is taken from journal reports and reference books that are used for the development of new innovations that discuss the efficiency of vortex turbines and the types of gear used.

3.2. Design stage

Making a difference in the form of replacing a generator and also changing the gear ratio to find which one is more efficient.

3.3. Selection of suitable tools and materials for research

Selection of tools such as gears and generators needs to be done to get the right efficiency for a vortex-type water turbine. The use of an ac or dc generator also affects the efficiency of a turbine to find which generator is more suitable for the vortex flow turbine in the Bujel village reservoir. The selection of the ratio of a gear is also very important to maximize the rotation produced by a turbine, I choose the use of a spedah gear because it is lighter

3.4. Testing and analysis

The test is carried out by removing the pairs of gears in the generator, and recording the amount of electrical voltage generated from each gear, after finding the gear that has the highest efficiency then replacing the generator from an AC generator to a DC generator and starting recording again to select which one is better for vortex flow turbulence.

3.5. Research Flowchart

This researched used any method which shown in figure 2. The test method of this research is to measure the current and voltage that will be removed from each generator and also change the gear ratio.

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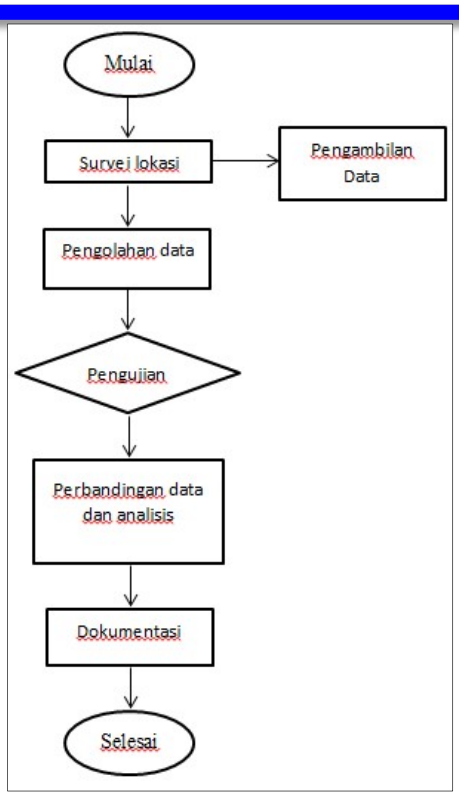

Fig. 2. Research Flowchart

Testing using digital avometer and rpm meter. Initial testing using 30T vs 16T gears then after the results have been recorded, change gears to 30T vs 18T and finally 30T vs 20T, after everything is recorded it is concluded from each gear which one is more efficient for the vortex flow turbine generator for placement in the Bujel Village Reservoir.

4. Results and Discussion

In this stage, the generator is tested several times by using AC and DC generators mounted on the gear. This aims to obtain effective results for the selection of generators on low RPM vortex turbines. Basically, vortex turbines have low RPM characteristics but have high torque..

4.1. AC and DC Generator Test Results

Testing of this generator was carried out on 3 different gear ratios, namely 46 to 16, 46 to 18, and 46 to 20, with the loading using a 50Ω resistor. This gear ratio was chosen because it has good stability in terms of speed and weight when used on fixie type bikes. The generator test results are shown in the following table:

Table 2. Voltage and current test results generator

No	Voltage		Current		RPM
	DC	AC	DC	AC	
1	25V	11V	0,12A	0,04A	468 RPM
2	22V	10V	0,11A	0,03A	419 RPM
3	20V	8,8V	0,08A	0,02A	365 RPM

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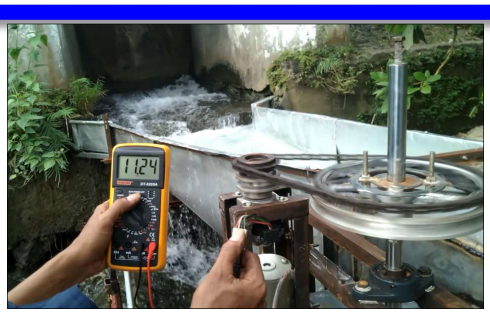

Fig.3. AC Generator Test

Fig.4. DC Generator Test

4.2. Gear Ratio Test Results

It is known that the rotation on the turbine shaft is 163 rpm, to find the rotation of the gear in the turbine, the following equation or calculation can be used:

$$\frac{N_1}{N_2} = \frac{Z_1}{Z_2}$$

$$\frac{163}{N_2} = \frac{46}{16}$$

N_2 = 368,625 RPM

Fig.5. RPM Test Gear 46 : 16

Table 3 Test Results RPM And Torque Of The Gear

NO	Rasio Gear	RPM	Torsi
1	46 : 16	468 RPM	± 20 KG
2	46 : 18	419 RPM	± 15 KG
3	46 : 20	374 RPM	± 10 KG

Shown by Table 3 the gear ratio test result. The N2 is 368.625 RPM with rasio gear 46:20. Whwn rasio gear 46:18, the value of RPM is 419 RPM and torsi 15 KG.

4.3. Efficiency of AC and DC generator

The DC generator used has a voltage of 24V using a 50Ω resistor. For this reason, the efficiency formula is used with the following calculations:

A. Effisiensi generator AC gear 468

$P = 11V \text{ x } 0{,}04A$

$P = 0{,}44 \text{ Watt}$

$\text{Eff} = \frac{200}{200 + 0{,}44} \text{ x } 100\%$

$\text{Eff} = 99{,}78\ \%$

B. Effisiensi generator DC gear 468

$P = 25V \ x \ 0{,}12A$

$P = 3 \ Watt$

$\text{Eff} = \frac{480}{480 + 3} \ x \ 100\%$

$\text{Eff} = 99{,}37\ \%$

Table 4. The Test Results From The Generator Efficiency Calculation.

No	RPM	Voltage		Effisiensi	
		AC	DC	AC	DC
1	468RPM	11V	25V	99,78 %	99,37 %
2	425RPM	10V	22V	99,85 %	99,49 %
3	365RPM	8,8V	20V	99,91 %	99,66 %

From the results of the analysis and calculations that have been carried out the efficiency of the generator reaches the highest 99.91%, this is because the losses used in this study are resistors of 50 by ignoring losses that could occur such as friction losses and so on.

5. Conclusion

Based on a series of trials that have been carried out in research on vortex turbines in Bujel village, it is concluded that:

1. The use of efficient generators is very important for use as hydroelectric power plants such as vortex turbines. Vortex turbine has a low rpm but has a high torque, the generator used in this experiment is an AC generator and a DC generator. In the series of trials that have been carried out the DC generator is superior because the DC generator used is a low rpm generator, so with a low rpm it can have a voltage of up to 25V, while the AC generator has the highest voltage of 11V.
2. The selection of gear ratios also affects the efficiency of the generator. In this test, gears with a ratio of 46:16, 46:18, 46:20 are used. This gear was chosen because of its stability, usually the gear ratio is used on the type of spedah fixie. In a series of trials that have been carried out, the results obtained where the 46:16 gear is better at 468rpm with a torque of ±20KG with this result almost 3x the rotation of the shaft gear, while for the lowest rpm there is a 46:20 gear ratio with 375rpm rpm and a torque of ±10KG. With a gear ratio of 46:16 rotation of the turbine can be optimized. When viewed from the standard level of efficiency of the water turbine of 70-90%, the second generator can be said to be efficient because of the loading at the time of testing using a 50Ω resistor by ignoring the losses that usually occur such as friction losses, copper losses and others.

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