International Journal of Latest Engineering Research and Applications (IJLERA) ISSN: 2455-7137

Volume –06, Issue – 04, April 2021, PP – 84-88

The Influence of Flow Direction Angle on Kinetic Turbine Performance

Kennie A. Lempoy[1], Nita C.V Monintja[2], Arwanto A.M Lakat[3]

[1](Sam Ratulangi University, Manado, North Sulawesi, Indonesia)
[2](Sam Ratulangi University, Manado, North Sulawesi, Indonesia)
[3](Sam Ratulangi University, Manado, North Sulawesi, Indonesia)

Abstract: Alternative energy sources provide energy wherever it is needed and convert energy from one energy to another without causing pollution that will damage the environment, including water energy. One of the water potentials in Indonesia, especially river water potential, is very much where one of the enormous energy potentials is kinetic energy, which occurs due to flow velocity. From the above problems, it is necessary to think about efforts to improve the performance of the bowl-angle kinetic turbine with variations in the flow direction angle. This study uses experimental research methods and is made on a laboratory scale. The tested kinetic turbine is limited to the flow direction angle with a specific number of blades 8, channel cross-sectional area of 0.26 x (0.1 and 0.12) m3, diameter of turbine shaft 11.5 cm, length and width of blades, namely 13 and 12 cm, the flow direction angle is varied by 10 °, 20 °, and 30 °. From the observations it will be found that the flow direction angle will affect the performance (power and efficiency) of the kinetic turbine.

Keywords: Water Energy, Energy Potensial, Kinetic Turbine

I. INTRODUCTION

Water energy can be used as electricity generation by utilizing the potential energy available (potential waterfalls and flow velocity). Indonesia has great potential to develop hydroelectric power. This is due to Indonesia's mountainous and hilly topography and is fed by many rivers (large and small) and in certain areas there are lakes and / or reservoirs that are quite potential as a source of water energy. Hydroelectric Power (PLTA) is a technology that has been proven not to damage the environment, supports energy diversification as the use of renewable energy, supports the program to reduce the use of fuel, and most of its construction uses local materials. According to Harsono in the Kompas Daily, October 24, 2004, the large potential for water energy in Indonesia is 74,976 MW, and 70,776 MW is outside Java, and 3,105.76 MW has been utilized. Apart from PLTA, mini hydro power plants with a capacity of 200–5,000 kW have a potential of 458.75 MW which is very feasible to be developed to meet the needs of electrical energy in remote villages or rural areas on small islands with narrow river basins. Water potential in Indonesia, especially river water potential is very large, where in river water one of the very large energy potentials is kinetic energy due to flow velocity and if this flow rate can be utilized properly, the energy crisis in Indonesia can be overcome. In this study, the shape of the blade used is the shape of the bowl blade which one of the advantages is that the sides can hold water so that most of the speed can be used to drive the turbine. Kirke Brian (2007) developed kinetic turbines by conducting research, especially vertical shaft kinetic turbines. What Brian concerns, in every research is how to improve the efficiency of this vertical kinetic turbine. There have been many attempts, including by providing a bulkhead at the entrance of the turbine so that the turbine back that rotates against the current can avoid water pressure. Another research is to tilt the turbine wheel so that the calculation of the speed triangle becomes optimal and the turbine return blade does not get back pressure from the water flow. From research that varies the shape of the blade (Backward, Forward and radial) and the variation in the angle of entry of the velocity of water flow into the turbine, this team can improve kinetic turbines until 38%. *Bono and Indarto (2008), held a study and collect that the power and efficiency characteristics between the half-cylinder blades are almost the same, but the power and efficiency of the bowl blades are better than the half-cylinder blades. The mover angle of the kinetic turbine flow largely determines the rotation of the turbine, where it is located*. The flow direction angle is not always in line with the increase in turbine rotation, therefore this research is directed to determine the ideal flow steering angle with constant speed to produce maximum rotation.

II. METHODOLOGY

Research using water flow in rivers as the main object by considering the fluid flow that is moving and has a very large kinetic energy. Water kinetic turbine is a form of water turbine that only utilizes flow velocity

 2021 IJLERA – All Right Reserved

and does not require a nozzle, besides this water turbine does not need a protector or a housing. The kinetic turbine used is Overshot with varied flow direction angles, namely; 0 °, 15 ° and 30 °. Research variables on:

A. Independent variable: the direction of the flow of the waterwheel with a variation of 10 °, 20 °, and 30 °
B. Dependent variable: power and efficiency

III. THE PREVIOUS RESEARCH

According to David L. F. Gaden (2006), conducted research on modeling turbines which observes the turbulence that occurs in kinetic turbines. In his research, the turbine observed was a kinetic propeller turbine whose axis is parallel to the direction of the incoming water flow in the turbine.The kinetic turbine is given a flow pattern that forms a flow from a small cross-section channel which then enlarges with a diameter ratio of four times larger (D = 4 d). The distance between the flow and the small flow section and the larger flow section is 12 d. Taking this distance is in accordance with the calculation of changes in flow velocity to be four times greater and there has been no turbulent water flow. The shape of the flow with a cross section below 1: 4 will cause turbulence, and this turbulence causes pressure to return to the turbine blades, resulting in slowing of the turbine rotation which results in low turbine efficiency.

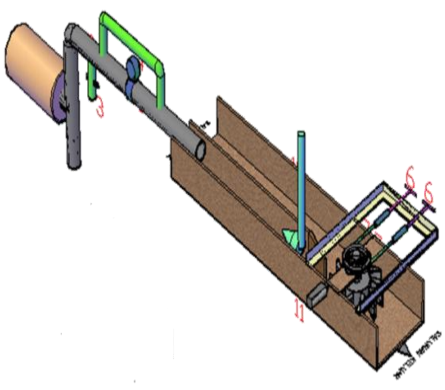
KirkeBrian (2007) developed kinetic turbines by conducting research, especially vertical shaft kinetic turbines. What Brian concerns in every research is how to improve the efficiency of this vertical kinetic turbine. There have been many attempts, including by providing a bulkhead at the entrance of the turbine so that the turbine back that rotates against the current can avoid water pressure. Another research is to tilt the turbine wheel so that the calculation of the speed triangle becomes optimal and the turbine return blade does not get back pressure from the water flow. From the research that varied the shape of the blade (Backward, Forward and radial) and the variation in the angle of entry for the velocity of water flow into the turbine, this team was able to increase the turbine kinetic up to 38%.

Bono and Indarto (2008), conducted research that the power and efficiency between the blade bowl and half cylinder is almost the same, but the power and efficiency of the blade bowl is better than half cylinder blades.

3.1 Kinetic Turbine

Kinetic turbines are turbines that only rely on water speed, thus of turbine does not require water headss. This turbine is very suitable for use in flat areas and has river flow. Until now, the known type of kinetic turbine is what is called a water wheel. This waterwheel is a very simple kinetic turbine, the type of waterwheel used in Indonesia is the Overshot type. One of the causes of low efficiency of waterwheels in Indonesia is that their manufacture is far from precise and waterwheels are made of wood, there are also parts of the construction that are not precise so that many water leaks occur.

Meanwhile, there are three types of kinetic turbines, namely flat kinetic turbines, upright kinetic turbines and aisle kinetic turbines. And what is used in this research is a horizontal kinetic turbine, which is a turbine that is placed horizontally and its axis is placed vertically so it is called an axial turbine.



NO	NAMA KOMPONEN
1	POMPA
2	PIPA SALURAN AIR
3	KATUP PENGATUR DEBIT
4	PIPA BYPASS
5	FLOWMETER
6	PENGATUR BEBAN PUTARAN TURBIN
7	NERACA PEGAS
8	TALI
9	PULLY
10	PENGARAH ALIRAN
11	TACHOMETER
12	RUNNER
13	KERANGKA DUDUKAN NERACA PEGAS
14	SALURAN
15	FLOWATCH

Fig 1. Research Installion

3.2 Bowl Blade

Bowl blades are blades whose sides are curved in order to withstand the flow of water and increase the efficiency of tangential forces. Bowl angle as shown in Fig 2.

 2021 IJLERA – All Right Reserved

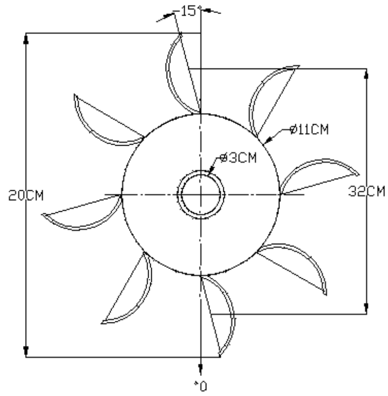


Fig 2. Corner Shape of The Bowl

3.3 Triangle Velocity

The speed triangle is often used in determining the parameters in turbine planning, its purpose is to determine the shape of the turbine blade at each point of change. The velocity triangle at each point of change is different in shape according to the velocity of the moving water.

In the speed triangle there are three components of velocity]. The first is the tangential velocity U, which is the circumference of the rotor. Second, is the velocity of water flow or absolute velocity V, and the third is the velocity of water relative to the blade or what is called relative velocity.

There are two very important forces in analyzing speed, namely; tangential and axial forces in the velocity triangle. This force is needed to calculate the amount of torque produced, the amount of torque multiplied by the amount of rotation will obtain the turbine power. The velocity triangle is shown in Fig 3.

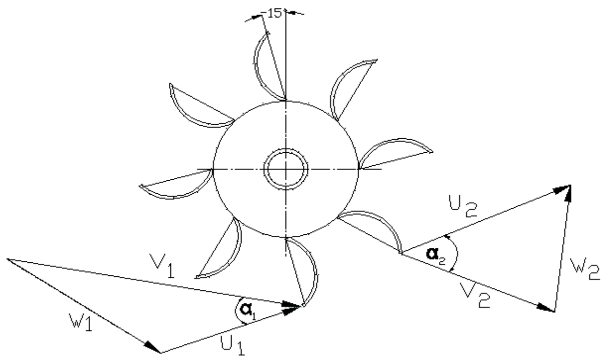


Fig 3. Triangle Velocity Components

3.4 Research Equipments

The tools and materials used in this research include:

A. Kinetic Turbine Runner: includes 3 main parts, namely the turbine shaft, the turbine disc with a diameter of 11.5 cm, made of steel, and a flow direction angle of 10 °, 20 ° and 30 ° made of acrylic with a thickness of 4 mm,
B. The water flow guide channel used has a cross-sectional size of 250 cm x 55 cm, made of wood 3 cm thick and 25 cm high.
C. Tachometer: to record turbine speed.
D. Flowmeter: to measure the speed of water entering the turbine.

Performance is a characteristic shown in tools that involve independent variables (operational indicators) and dependent variables (performance indicators). In this study, the independent variable used is the direction of the flow and the dependent variable is efficiency. The equations used are:

1. Water Power

$$P_a = \frac{1}{2}.\rho.\mathrm{Qa}.V^2$$

Which :

P_a = Water Power (watt)

 2021 IJLERA – All Right Reserved

ρ = Type of Mass Water (kg/m^3)
Q = Water Debit (m^3/s)
V = Water Velocity (m/s)

2. Turbine Energy

$$P_t = T.\omega$$

Which :
`T = Torque (3,9 Nm)
ω = Speed Corner (10,467 rad/sec)

3. Efficiency

$$\eta = \frac{P_t}{P_a}\, x\ 100$$

Which :
P_t = Turbine Power (watt)
P_a = Water Power (watt)
η = Efficiency (%)

4. Torque

$$T = F\ .\ l$$

Which :
F = Number of force, (F_1- F_2) (N)
L = Sleeve (0,15 m)

5. Debit

$$Q_3 = A_3\ .\ V_3$$

Which :
Q = Water Debit (m^3/s)
A = Wide section (m^2)
V = Water Velocity (m/s)

6. Blade Speed Ratio

$$\frac{U}{V} = \frac{\omega.R}{V}$$

Which :
$\frac{U}{V}$ = ratio of tangential velocity and river flow velocity
R = turbine radius

7. Momentum

$$M = \beta.\rho.Q.v$$

Which :
M = Momentum (Kg.m / sec)
β = Angle between W and U
Q = Discharge of water (m3 / s)
ρ = Density of water
V = Water Velocity (m / s)

IV. RESULTS AND DISCUSSION

The data from the results of testing the effect of variations in the flow and discharge direction of water on the performance of the bowl-angle kinetic turbine can be seen in the following image:

 2021 IJLERA – All Right Reserved

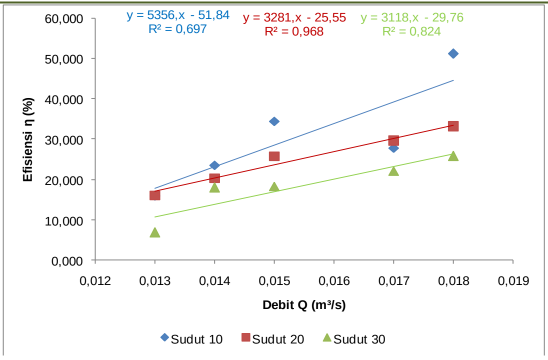


Fig 4. Discharge and Efficiency Relationship Graph

Fig 4. shows that the flow direction angle with the maximum efficiency value is at an angle of 10 °. With the flow direction angle, the smaller the momentum will increase which causes the torque to increase, and the efficiency of the turbine increases. The results of data processing on testing the flow direction angle on the performance of the kinetic turbine show that at an angle of 10 ° the maximum efficiency is 51%. This is because the energy at which water enters the turbine is more utilized because the water hits the right front of the turbine blade.

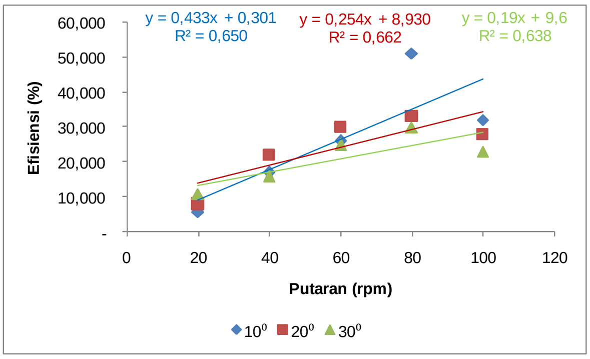


Fig 5. Turn and Efficiency Relationship Graph

Fig 5, it can be seen that the rotation has an effect on turbine performance. And the maximum rotation is at 80 rpm and the efficiency is 51%.

V. CONCLUSION

From the results of the study, it can be concluded that the flow direction angle affects the performance (power and efficiency) of the bowl-angle kinetic turbine. In the test, the 10 ° angle produced the greatest efficiency, namely 51%. And the 20 ° angle produced 33% and 30 ° efficiency by 30%.

REFERENCES

[1] Arismunandar Wiranto.2004. Penggerak Mula Turbin; Edisi Ketiga Cetakan Kesasatu, Bandung, Penerbit ITB.

[2] Bono dan Indarto, 2008 " Karakterisasi Daya Turbin Pelton Mikrodengan Variasi Bentuk Sudu.

[3] Dafid L. F. Gaden. 2006, Performance Enhancements, Turbine Modelling Techniques, and Assesmen of Turbulence Models.

[4] Dietzel Fritz, 1993, Turbin Pompa dan Kompresor, Erlangga, Jakarta.

[5] Soenoko, R., Rispiningtati, Sutikno, D. 2011. Prototype of a Twin Kinetic Turbine Performance as a Rural Electrical Power Generation, Journal of Basic and Applied Scientific Research, Universitas Brawijaya Malang.