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THE EFFECT OF FLUID FLOW CURRENT TO 30O BLADES ACHARD TURBINE PERFORMANCE

Dodi Tafrant[1*], M. Faizal[2]
[1]Department of Mechanical Engineering, University of Sriwijaya
[2] Department of Chemical Engineering, University of

ABSTRACT

Achard turbine is one kind of vertical axis water turbine that can use to low head water current. Achard turbine can use to river flow or irrigation canal. This is will make an additional function of river and irrigation canal to be a renewable energy resource. The experiment use three blades NACA 0020 Achard turbine in the irrigation canal at Belitang District, West Ogan Komering Ulu. The flow current is 0.55 m/s, 0.61 m/s, and 0.71 m/s. The result shows increasing of CP and CT by increasing of flow current. Maximum CP is 0.1797 at flow current 0.71 m/s. Maximum CT is 0.206 at flow current 0.71 m/s.

Keywords: Achard turbine, flow current, power coefficient, torque coefficient

1. INTRODUCTION

The increase of human population is accompanied by the increase of energy needs. Furthermore, the quantity of energy resource is decreases. Some of world energy supplies are considered encounter reduction in the number. In the consequence, the new resource of energy is required. Indonesia as a developing country requires a constant supply of energy to support development, especially the construction industry. According to the Director General of Electricity and Energy (2011) that the potential of mini / micro hydro in Indonesia exceeded 228 GW, while the new installed capacity 229 MW. On data released by the Directorate General of Electricity and Energy in 2011 showed understanding of the potential use of of water energy was still high but has not yet been optimally. As you can see, Indonesia has the potential energy of water by more than 228 GW, but which can be used not yet reaches 1% of all the potential that exists. Water energy can be convertion by using a turbine is can be used to drive a generator or other machinery.

Petroleum, coal, and natural gas is the main energy source used in Indonesia. The depletion of world oil supplies and Indonesia have leading to levels that made many governments worry. This has encouraged many governments to issue a policy to reduce reliance on petroleum. The Indonesian government has issued several policies on energy saving and alternatives energy research. Among them: Presidential Decree No. 13 of 2011 on Saving Energy and Water, and Presidential Decree No. 4 Year 2010 on Assignment to PT PLN (Persero) to Performing Acceleration of Development Power Generation Using Renewable Energy, Coal and Gas. This shows the government's seriousness in reducing the dependence on petroleum energy and divert it to the other energy sources which are cheaper and more able to be renewable.

Draft of Rencana Umum Ketenagalistrikan Nasional (RUKN) 2012 delivers the growth of electrical energy demand of 10.1% per year up to 20 years. The requirement includes the need for Java-Bali 8.6% per year, and for outside Java-Bali 13.5% per year. For 2012, the electricity needs amounting to 171 TWh. By paying attention to growing energy needs of 10.1% per year, the estimated the electricity needs amounting to 244 TWh in 2016, 389 TWh in 2021, 632 TWh in 2026, and 1,075 TWh in the year 2031. From a number of these requirements, the needs of households dominating of all the energy demand up to 2026, followed by a business group in 2027 to 2031. in order to meet all the energy requirements, it takes a total of 237

*Corresponding author's email: tafrantd@gmail.com

GWh of the additional power in the year 2031. That means that too the supply of electricity should continue to grow by 11.7 GW per year. (RUKN 2012-2031).

Indonesian energy problems in the long run will be more emphasis on security-related developing of national energy supply by partially redirect to the resources of new and renewable energy such as geothermal, coal, natural gas, and energy of water. These energies more been selected to be developed because it is cheaper, and also has great potential. Moreover, these energies also included to the categories of environmentally friendly energy.

The main challenge in the field of the energy research is to resolve some problems of the energy in Indonesia by integrative innovation, and multidimensional accordance to national capabilities. One focus of the short term energy problems is how to provide a source of energy other than petroleum to meet the needs of society and industry.

Some of the energy research that became the focus of governments is the use alternative of energies such as geothermal energy, coal bed methane, coal liquefaction, solar energy, biofuels, nuclear, ocean currents, the flow of the river, and micro hydro energy. Presidential Decree No. 5 of 2006 on National Energy Policy (KEN) indicates the government efforts to increasing the use of new and renewable energy. Blue print of the National Energy Policy (KEN) 2005-2025 provides the mandate for the new research of energy that continues to sustainability in the medium term and long term that emphasizes to the optimizing the use of energy resources, improvement of economical technologies, conservative, and environmentally friendly, and the priority to the fulfillment of energy needs. In order to optimize the national energy resources, the expected role of new and renewable energy can be increased significantly to 3.64% in 2009 and 17% in 2025 (ARN 2005 to 2025).

In fulfillment of energy, water energy is one kind of the energy that has high potential, but has not been utilized to the fullest. Micro scale of hydro energy potential in Indonesia is spread almost 500 MW, while use of, which reached 6.5% of their potential. Application of technology and research in micro hydro energy needs to be maintained in order to continue to contribute and enhance its role in the energy needs of Indonesia. One of the ideas is to use a water turbine applicative mini or micro scale of hydro energy as prime movers. Turbines that can be used are the types of low pressure water turbine that can be utilized on the streams without the need of a waterfall. Utilization of low head current will provide savings in infrastructure such as dams and transmission lines. This concept can utilize some type of open channel flow such as irrigation canals, river flow, and others of similar stream. The use of this type of water turbine will save the investment budgets with better results that can be expected. Moreover, the use of microhydro water turbine with low pressure can also solve of the environmental problems that caused by emissions from coal and petroleum power plants.

Achard turbine is a new concept of the vertical axis, cross-flow turbines were first built as energy exploration project of the French state in 2001 with the support by the R & D Division of Electricite de France Group. Using three or four delta shaped vertical blade. The main advantage of water turbine Achard is modularity and the ability to be operated regardless of the direction of the water flow. Thus, similar modules can be superposed on the the same vertical axis. An exploration site under the sea or river may consist of a group of floating barge. It will be easier to transmission of. So that can produce energy with the greater efficiency.

Takao, et. al. (2009) conducted a study of guide vane geometry of the influence on the performance of vertical axis wind turbines using the Darrieus blade NACA 4518. The results are the coefficient of power and torque will be increased due to the effect of the angle and distance of the guide vane of the rotor blade. Where CP produced was 0.25, up 180% if compared to the turbine that not using a guide vane.

Antheaume (2007) conducted a simulation modeling for a cross flow water turbines. The application has been evaluated on a single machine compared to the Sandia experiments. A 2D version of the code has been created and then used to optimize the barge which is made of lining column of Cross Flow Water Turbine. The

results showed an increase in the efficiency of the tower with the closer distance between of the blade. The average efficiency is 39.4% better a maximum lateral distance of 1.5 Dt (Dt distance between water turbine by barge). This is 4.55% higher a single turbine isolated 2D and 10.4% better than the reference 3D hydraulic turbines.
Sargolzaei, et. al. (2007) estimates the ratio of power and torque of a savonieus wind turbine using Artificial Neural Networks (ANNs). The experiment is using seven prototipes of Savonieus turbine with six blades, and different Reynolds number. Power and torque are simulated in different Reynolds numbers and different blades angles. The experimental results showed the increasing Reynolds number will cause an increase in power and torque ratio. For all rotor maximum and minimum results of torque each occurring at an angle of about 60o and 120o.

Takamatsu, et. al (1993) explain the experimentally the unsteady flow around of Darrieus turbine blades are not symmetrical flow around blades stall. Darrieus turbine efficiency can be increased if the turbines installed in narrow channels and draft tube (Matsushita, et. Al. 2008).

Georgescu (2011) simulated the 7 Achard turbines arranged on two parallel lines that do not overlap by using unsteady flow. Research carried out by using a model created by application FLUENT and COMSOL Multiphysics provides the conclusion that increased efficiency is equivalent to an increase in the number lines of turbine. Moreover Georgescu (2008) conducted a study of the turbine Achard using air fluid. Georgescu wrote it because a large turbine geometry (diameter 1 m, height 1 m) is difficult to test it in the water. Basically, the scale of the viscosity of air and water causes the air must have the speed 15 times higher than the water flow. Thus, the rotational speed of turbine in the air will be 15 times higher than the rotational speed of turbine in the water. For 10 m/s air speed, turbine rotation speed reaches 380 rpm.

Zanette (2007) compared three different blade shapes with the same circumstances, are: Darrieus, Gorlov, and a new form named HARVEST 2007 (whales tail blade-shaped). The result is a new geometric shape that has some mechanical advantage. Pressure drop means on the value and amplitude of cyclic loading can significantly reduce the fatigue phenomenon, improve the durability and performance of turbines. Harmonization of whales' tail blade with chord length variation can provide potential ways to increase the efficiency of the turbine.

Khalid (2013) simulated the two turbines achard are arranged parallel and investigated the characteristics of the fluid flow through using CFD. The main idea is how to utilize the hydrodynamic interaction between two adjacent turbines. Vertical axis turbine is the type turbines that utilize the lift force that occurs due to the interaction between the fluid blade premises. Lift force can be increased by reducing the turbulence by increasing induction on the blade. In addition, the hydrodynamic interaction of twin turbine system depends on several key parameters: the relative distance between them, the incoming flow angle, tip speed ratio (λ), relative rotary direction, and the ratio (L / R). Where, L is the distance between the two turbines and R is the radius of the turbine. From the analysis it can be said that the turbines would have a maximum CP when the distance L relative = 0.5 m. The distance between the two domains are not spinning from the center of the turbine. Less than or greater than this distance has resulted in less of CP, due to the smaller distance makes the vortices interaction will become more dominant and have a damaging effect. At this distance the maximum, CP observed at λ = 2. For V = 1.2 m/sec. As the distance between the turbine increases CP gradually decreases and at a certain distance, they operate and behave like independent turbine system. Moreover, if the speed of the inlet or TSR increase at this distance, vortices will serve as rotary effect increases.

2. METHODOLOGY/ EXPERIMENTAL

The experiment conducted on the flow of irrigation gates at BK-19, BK-24 and BK-25 in District Belitang, West Ogan Komering Ulu. The sosurce of water is Komering River that dammed in Perjaya Dam at Muaradua, South Ogan Komering Ulu. The water flow can be set on the gates of water located along the irrigation channels, so that water flow can be set. Irrigation flow velocity is calculated by washed away floats tie to a weight at the end as far as 10 m. The

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distance between the floats and the pendulum is 30 cm. Thus, the flow rate obtained is the flow velocity on the optimum flow conditions. Measurement speed is done with a distance of 10 m is done by calculating the time using a stopwatch as many as 10 times.

The turbine that use have 50 cm at hight and 40 cm diameter with 30o Achard blade. In this experiment, the blade have NACA 020 water foil geometry, solidity 0.20. So that, the blade that use is 3. In this research, the turbine put into irrigation flow and calculated rotational speed for 1 minute. Data was collected to no-load turbine, and then the load is added gradually until the turbine stopped. At each additional load, the load in the turbine is observed at the scale were hung on the opposite side of the loads. Besides calculating of the load of the turbine, every additional load is also done counting turbine rotation speed for 1 minute. Furthermore, the same thing is done on the of water flow in the other gates.

3. RESULTS AND DISCUSSION

Flow current on three water gates is 0.55 m/s, 0.61 m/s, and 0.71 m/s. This flow current is constant. In this study, the performance parameter of turbine that observed are Power Coefficient, Torque Coefficient, and Tip Speed Ratio. Power Coefficient was obtained by dividing the power that generated by turbine to the power flow. The Torque Coefficient was obtained by dividing the Power Coefficient that generated by turbine to Tip Speed Ratio. The Tip Speed Ratio was obtained by dividing the Tangential Speed of turbine to the Flow current.

The result is showed at Figure 3.1 below:

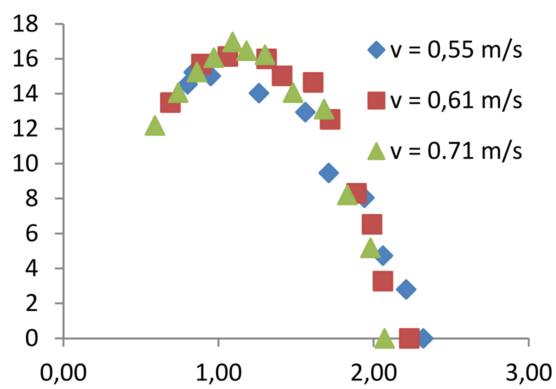

Figure 3.1 C_P vs λ in the some flow current

Figure 3.1 shows the effect of increasing the flow current to operational point of Achard turbine. Increasing of flow current makes the operational point is increasing slower. This is caused the operational area is even further. The effect of the increasing flow current is showed in Figure 3.2 below:

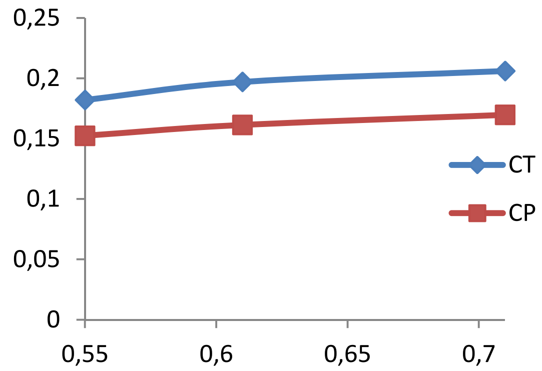

Figure 3.2 The effect of increasing flow current to CP max and CT max

The effect of increasing flow current to Tip Speed Ratio is showed in Figure 3.3 below:

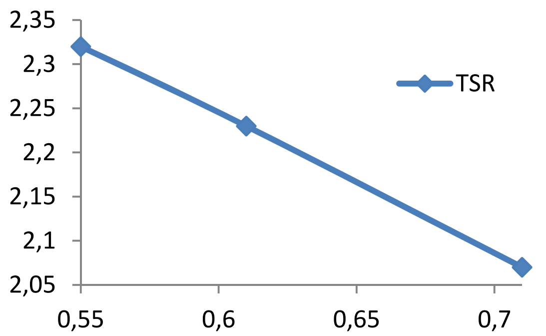

Figure 3.3 The effect of increasing flow current to TSR

Figure 3.1 and 3.2 shows the effect of increasing flow current to CP and CT where increasing flow current is caused to increasing of CP and CT. The highest CP is 0.1697 at flow current 0.71 m/s. the highest CT is 0,206 at flow current 0,71 m/s. Different result is showed by TSR, where TSR is decrease by increasing of flow current. The highest TSR achieved is 2.32 at flow current 0.55 m/s.

4. CONCLUSION

Based on the data above, it can be concluded:

1 Increasing in the flow current cause to increasing the operating point of Achard turbine.
2 Increasing in the flow current cause to increasing of CP and CT.
3 Increasing in the flow current provides inverse effect on TSR, where TSR decreasing by increasing of flow current.

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