Proceeding of International Conference on Green Technology
Vol.8, No.1, October 2017 Page 45-52
p-ISSN: 2580-7080 | e-ISSN: 2580-7099

Engineering of Floating Power Plant for River Flow Type Undershot 2 Waterwheels With 9 Fixed Blade and Butterfly Blade on Picohydro Scale

Suhartono*, Sri Fatmawati, Rahmat Rudianto***, Yanuar eko******
*, **, *** Departement of MIPA, IAIN Palangka Raya

Article Info

Article history:

Received Jul 12th, 2017
Revised Aug 20th, 2017
Accepted Oct 26th, 2017

Keyword:

Picohydro
Fixed Blade
Butterfly Blade

ABSTRACT

Central Kalimantan has the potential for very large water resources to discharge and relatively sufficient height when used as a source of new and renewable energy. Electrical energy needs of homes in remote areas such as rural areas in Central Kalimantan is necessary because of the uneven supply of electricity to all the villages, it is because it can not reach the electrical grid to a certain region of the city, although the area is a lot of source stream of flowing water can be used. From these things do research whose goal is to create a floating power plant that can work in a gentle stream picohydro scale and easy to maintenance and assembly, made with materials that are affordable and easy to obtain and can work well with the speed of water in Central Kalimantan. The results of field testing that has been done in a location that has the characteristics of the water velocity of 0.78 m / s up to 1.83 m / s can play a prototype design of a floating waterwheel well, the results of tests on 9 watt lamp load can turn on the lights and to produce power average lamp of 0.56 watts with an average water flow of 1.23 m3 / s with a waterwheel blade shape of butterflies as a more efficient form than the fixed blade remains in the research and can turn a generator up to 155.8 rpm and maximum power produced by the generator in the testing field is 115 Watts with an average voltage of 50 volts and an average current of 2.3 A

Corresponding Author:

Third Author,
Departement of MIPA, Study program Tadris physics
IAIN Palangka Raya
Jl. G obos Komplek Islamic Centre 73111
Email: suhartono@iain-palangkaraya.ac.id,
srifatmawati84@yahoo.co.id

1. INTRODUCTION

The energy source used to meet energy needs in the province of Central Kalimantan is still largely an energy that comes from petroleum. While the use of coal as a primary energy in the province of Central Kalimantan is still very small in which this area is one of the major sources of coal producer in Indonesia. In addition, the utilization of renewable energy is still limited to the use of solar panels as a source of electricity for households with solar home system. Utilization of renewable energy derived from biomass is still limited in the form of a pilot project. Central Kalimantan province has the characteristics of large rivers and creeks more gentle and can be used as a power plant by utilizing the power of flowing water. Of the overall potential of this renewable energy, the use of which has been done is still very small compared with the availability of renewable energy resources such existing. Data from the Department of Mines and Energy of the Province of Central Kalimantan, said in Murung Raya and Katingan has the potential to be developed MHP (Power Mikrohydro) and PLTPH (Power picohydro) as a provider of electric energy in rural areas. This potential is supported by the natural conditions of this area which consists of lowland and partly hilly, forest and rivers large and small ramps and cascade. Development picohydro and mikrohydro Power as an alternative energy to

rural areas in Central Kalimantan is a very necessary thing besides also does not use environmentally friendly fuel [1]. Based on the reference category of water power plant in the world that the Power category <5kW included in class generation pico [2].

The energy source used to meet energy needs in the province of The problem of electricity supply and networks in homes remote areas such as rural Central Kalimantan is not all met, it is caused not accessible remote area by the electricity network because it is still constrained separated by rivers and forests are state geography still not able to connect to electricity networks , whereas in some areas of the many sources of flowing water can be utilized as a source of new and renewable energy. Also look at the social and economic conditions of rural communities who may still underneath and uneven, then the utilization of water resources that flow required power plants easy to maintain, easily and cheaply made and the material used is widely available in the market. According to a study published World Bank (ESMAP, 2007) to the cost of energy generation projects under 5kW for some types of plants, such as picohydro is a plant with the construction financing smaller at around 10-18 US cents / kWh. The huge difference between a diesel generator with picohydro, so it can be applied in remote areas or places not reached by electricity will use a diesel generator or fossil fuels, while the potential for generating picohydro made so many [3].

Engineering of power plants floating scale picohydro to a remote area on the outskirts of the river is very expensive condition footed current river levels that will drive the wheel as a player generator, from observations acquired the characteristics of most of the rivers and creeks in the area of Central Kalimantan has a stream of weak to moderate due to the difference in height river surface which tends ramps on the middle and downstream of these conditions should be noted that the plant was designed to be able to turn properly when positioned on the surface of fast-flowing water is weak as well as affordable and easy to manufacture raw materials for the community. In the design of the floating power plants picohydro scale river flow is restricted to the surface currents of the river with a low to moderate speed that characterizes the flow of a river in Central Kalimantan. To determine the power that can be generated are estimated ability to rotate waterwheels to the generator so that the energy of water can be calculated by obtaining the speed parameter of water before and after pushing wheel and wheel rotation speed also when the generator is loaded lights directly measure how much current and voltage.

2. LITERATURE REVIEW

In the design of floating power plants pikohidro scale is limited to the river flow with a medium water speed is usually obtained in the middle of the river between the upstream and downstream. Viewed from the movement of water flow which is a liquid fluid brings kinetic energy that will be converted into electrical energy. Rate of flow fluid flow is the amount of fluid volume that flows per unit time [4].

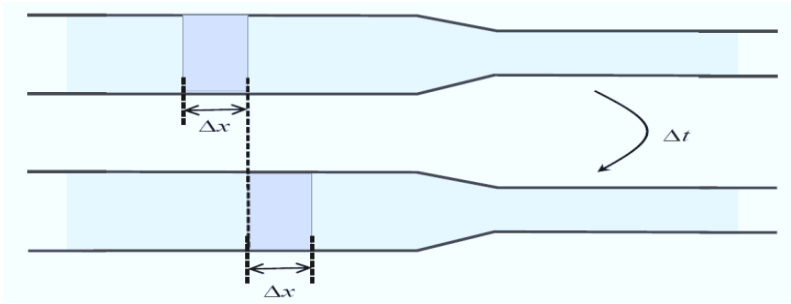

Figure 1. Elements of fluid in the form of cylinders with a thickness of Δx moves as far as Δx during the time interval Δt

Elements of the flowing fluid volume is

$$\Delta V = \vec{v} A \Delta t \quad (1)$$

Discharge of fluid flow is defined as

$$Q = \vec{v} A \quad (2)$$

Where: A = cross-sectional area of the blade

To waterwheel that only use the flat water flow or the flow velocity of the river, the water available energy is the kinetic energy (Kadir, 2010:538)

$$Ek = \frac{1}{2} m \vec{v}^2 \quad (3)$$

Where: $\vec{v}^2$ = flow velocity of stream(m/s)
So that water power is available

$$P = \frac{1}{2}\rho Q\vec{v}^2 \quad (4)$$

Because $Q = \vec{v}A$ the power of water

$$P = \frac{1}{2}\rho A\vec{v}^3 \quad (5)$$

Mechanical power waterwheels is

$$P_{waterwheel} = ½ (\rho A_1)(v_1^3) – ½ (\rho A_2)(v_2^3)$$
$$= ½ \rho(A_1v_1^3 – A_2v_2^3) \quad (6)$$

v_1 is the velocity of the water before passing waterwheel, current velocity V is about waterwheel and v_2 is the velocity of the water after the waterwheel
By measuring the magnitude of the voltage and current is generated, it can be seen the amount of power generators, such as the following equation:

$$P_{generator} = V \text{ x } I \quad (7)$$

Waterwheel design using type Undershot working when water flows against the wall of the blade which is located on the bottom of the waterwheel. Undershot water wheel types have no additional advantage of the difference in height but directly from surface water movement. This type is suitably mounted in shallow water on a flat area. Type is also called the "Vitruvian". Here the water flows in the direction opposite the rotating blade wheel. [5]

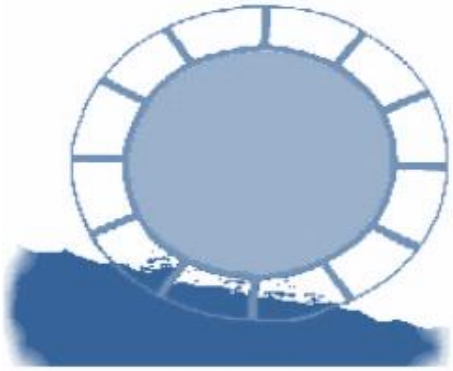

Figure 2. Undershot Waterwheel

Advantages of Undershot waterwheel, among others, the construction is simpler, more economical, easy to move. The loss of Undershot waterwheel includes small efficiency (25% -70%), a relatively small power generated.

3. RESEARCH METHOD

The method used in this research is to design and testing tools work. Furthermore, the manufacturing process in accordance with the design and look for materials by using materials easily found in the market and generator components in accordance with the design easy to construct as well as created. The test is carried out when the planning and assembly of the picohydro Power Plant design have been completed. Initial testing of that test is floating test in the pond then continued in the river stream. Testing is done by varying the type of corner blade waterwheels fixed and butterflies to some variation of discharge, to obtain parameters such as voltage, current, speed of water before pushing and after pushing to the system of the mill, and the speed of the play generator which can further be known ability waterwheel Such as efficiency and power generated. Voltage and current measurements made directly from the generator to the load 9 Watt lamp. The depth of the submerged waterwheel blades used in testing that is 15 cm, 30 cm.

Procedures or measures are conducted in collecting and analyzing data, namely: First, the preliminary study (characteristics of the river and raw materials); second, the design power plants picohydro; Third, Assembly / setting power plants picohydro (Model buoys, Frame buffer waterwheel, Number of Blade, Gear Box, Mounting generator / dynamo); Fourth, the implementation of testing; Fifth Field Test / Data retrieval; Lastly, analysis and conclusions.

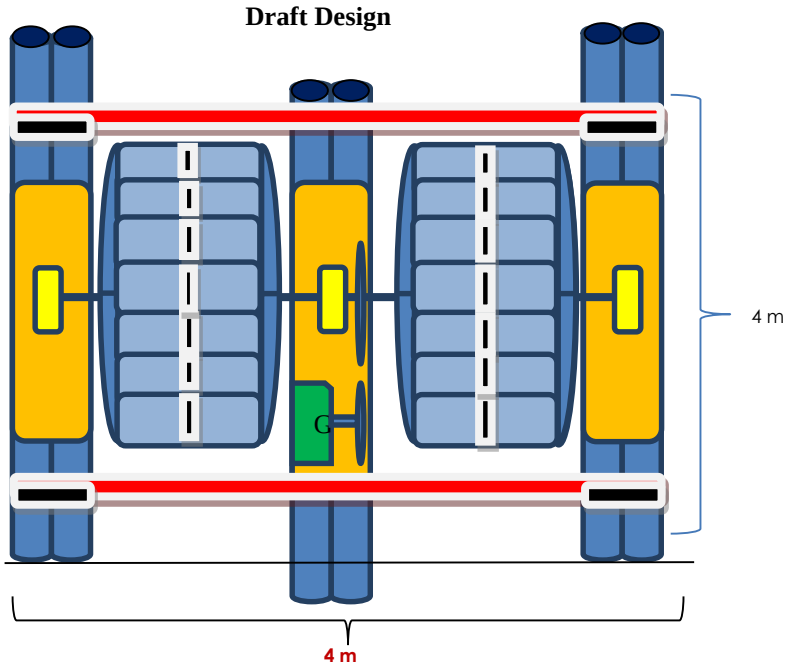

Figure 3. Design of a floating power plant streamside undershot type 2 waterwheels with fixed blade 9 and butterflies scale picohydro looked from above

Description: The size and number ofdimensions

The radius of the wheel	=	1 m
The width of the blade wheel	=	0.5 m
The length of the blade	=	1.2 m
Paralon Pipe 6 "side	=	4m
Paralon Pipe 6 "Middle	=	4 m
Width of construction	=	4 m
Long construction	=	5m
Length of iron shaft	=	5 m
Number of blades each wheel	=	9 pieces

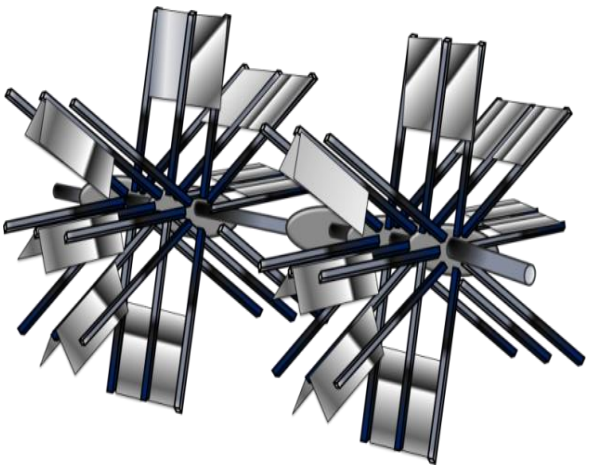

Figure 4. Design Waterwheel With 9 Fixed blade and butterfly blade

Table 1. Material Waterwheel and Generator

No.	Material Name	total

1.	Plate steel frame	2 sheets
2.	Hole angle iron	12 rod
3.	Iron round hole	2 rod
4.	Iron box 4x8 cm	4 rod
5.	Iron box 2x2 cm	10rod
6.	Round iron as 1 meter	2 rod
7.	*Bearing*	9 pieces
8.	Bolts and nuts	sufficiently
9.	PVC Pipe 6 "	6 pieces
10.	L pipe connections 6 "	6 pieces
11.	Pipe cover 6 "	12pieces
12.	Polley	4 pieces
13.	Copper wire of 1.2 mm	1 Kg

Table 2. Tools Used for Data Collection

No.	Material Name	total
1.	Anemometer modified	2 pieces
2.	Multimeter	2 pieces
3.	Tachometer	1 pieces
4.	led lamp 220 volt/9 watt	1 pieces

4. RESULTS AND ANALYSIS

Draft Prototype modified in this study is two-wheel with 9 blades per each wheel and is supported by an iron connected with pipe floating coupled with a system of pulleys and a generator producing AC power, the overall shape like a raft of pipe together, frame order prototype blades made of sheet iron bars and mild steel sheet.

Floating power plant design of river flow Picohydro scale

Figure 5. Assembly Generator, Pulley and Waterwheels

The generator used in this study is an AC generator which is an assembly generator. The generator in this research is used as a Waterwheel load, consisting of two rotor with permanent magnet and stator which is enamel wire coil with 16 coil.

Table 3. Component Generator Waterwheel

No	**Material Name**	**Size**	**Total**
1.	permanent magnet concave	L = 3 cm	12 piece
	shape Coil	Thick = 3 mm	
2.	(Wire email)	D = 0,8 mm	36 coil
3.	Bearing	Length = 20 m	
4.	Iron plate	P125	1 piece
		D = 16 cm	1 sheet
		thick = 3 mm	

Depth variations blades submerged in Waterwheelcan set the depth it aims to find out how much influence on the rotational speed wheel and changes the electrical power produced by the generator with the

same water velocity at each variation of the submerged depth of the blade. Depth regulatory framework and a submerged blade using long bolts have been modified as shown below.

(a) (b)

Figure6.
(a) Regulatory framework and anchoring waterwheel blade Depth
(b) Complete assembly of the floating power plant streamside undershot type 2 waterwheels with fixed blade 9 and butterflies picohydro scale

4.1 Trial Results

4.1.1 Fixed Blade

A. A submerged depth of 15 cm blade.

Table 4 shows that the average speed of the generator at a depth of 15 cm for a fixed blade is 127.6 rpm. Waterwheel power is influenced by the speed of the water inlet and water exit speed of the mill. From Table 4 it can be seen that the wheel will be even greater power when a change or difference between the inlet and outlet water increases. The average generated power generator blades remain submerged to a depth of 15 cm is 0.19 watts.

Table 4. Measurement Result Power Generator In Depth Blade 15 cm and $A_{waterwheel}(m^2)$ = 0,3

No	v_{in} (m/s)	v_{out} (m/s)	$v_{contact\ blade}$	Rotation Generator (rpm)	P_{water} (watt)	$P_{Waterwhell}$ (watt)	Power Generator (watt)
1	1,44	1,22	1,30	128	329,55	175,52	0,22
2	1,45	1,14	1,33	130	352,90	235,06	0,18
3	1,50	1,19	1,35	122	369,06	253,48	0,14
4	1,53	1,22	1,38	122	394,21	264,86	0,22
5	1,81	1,31	1,56	130	569,46	552,25	0,18

B. A submerged depth of 30 cm blade.

Table 5 shows that the average speed of the generator at a depth of 30 cm for a fixed blade is 132.4 rpm. Average power generator produced to remain submerged depth of 30 cm blade and wide wheel A_{wheel} (m2) = 0.6 is 0.23 watts. The greater the velocity of water coming in, the power of water and power waterwheels are also getting bigger.

Table 5. Results of Measurement Rate of flow Play Generator In Depth Blade 30 cm and$A_{waterwheel}(m^2)$ = 0,6

No	v_{in} (m/s)	v_{out} (m/s)	$v_{contact\ blade}$	Rotation Generator (rpm)	P_{water} (watt)	$P_{Waterwhel\ l}$(watt)	Power Generator (watt)
1	1,39	1,17	1,28	128	629,15	325,20	0,22
2	1,50	1,22	1,36	130	754,64	467,75	0,18
3	1,53	1,28	1,40	138	823,20	445,33	0,31
4	1,56	1,25	1,40	130	823,20	552,99	0,18
5	1,61	1,28	1,45	136	914,59	622,84	0,25

4.1.2 Butterfly blade

A. A Submerged depth of 15 cm blade.

Table 6 shows that the average speed of the generator at a depth of 15 cm for butterfly blade is 131.2 rpm.Rata average generated power generator blades remain submerged to a depth of 15 cm was 0.22 watts.

Table 6. Results of Measurement Rate of flow Generator Turn On
Blade depth of 15 cm

No	v_{in} (m/s)	v_{out} (m/s)	$v_{contact\ blade}$	Rotation Generator (rpm)	P_{water} (watt)	$P_{Waterwhell}$ (watt)	Power Generator (watt)
1	1,53	1,22	1,38	128	394,21	264,86	0,22
2	1,53	1,33	1,42	134	429,49	184,34	0,23
3	1,56	1,39	1,43	136	438,63	166,62	0,25
4	1,61	1,22	1,47	128	476,48	353,61	0,22
5	1,67	1,28	1,47	130	476,48	384,05	0,18

B. A Submerged depth of 30 cm blade.

Table 7 shows that the average speed of the generator at a depth of 30 cm for butterfly blade was 151.6 rpm. Average power generator produced to remain submerged depth of 30 cm blade is 0.49 watts.

Table 7. Results of Measurement Rate of flow Generator Turn On
Blade depth of 30 cm

No	v_{in} (m/s)	v_{out} (m/s)	$v_{contact\ blade}$	Rotation Generator (rpm)	P_{water} (watt)	$P_{Waterwhell}$ (watt)	Power Generator (watt)
1	1,45	1,31	1,24	152	571,99	325,20	0,50
2	1,50	1,19	1,32	150	689,99	467,75	0,44
3	1,53	1,31	1,38	151	788,42	445,33	0,50
4	1,56	1,25	1,40	150	823,20	552,99	0,44
5	1,81	1,22	1,50	155	1012,20	622,84	0,55

Analysis of energy conversion in Waterwheel Water drives includes energy waterwheel blades, causing waterwheel spinning and has a waterwheel which is then forwarded by axis waterwheel to the generator which converts mechanical energy into electrical energy in the form of electric power. Power electrical energy generated by the waterwheel blade butterfly larger than the fixed blade waterwheels. Rated power in this study has several sections southwest Converted namely: power Water, power wheel, and power generators this is the case for their losses style ie, the frictional forces Waterwheel with water, friction force axis waterwheel with skeletons, comparative wheel liaison and style the load from the generator and lights. In the field testing, there are obstacles caused by factors fanbelt and Polley were wet from water that occurred between fanbelt slip and Polley. The number of blades is one of the factors that are very significant effect on electric power, wheel rotation, rotation generator and give real effect to the stress [6]. This study is not a variable number of blades that were tested, only the control of a fixed amount.

5. CONCLUSION

The results of field testing that has been done in a location that has the characteristics of the water velocity of 0.78 m / s up to 1.83 m / s can play a prototype design of a floating waterwheel well, the results of tests on 9 watts lamp load can turn on the lights and produce power average lamp with a rate of 0.56 watts of average water flow of 1.23 m3 / s with a waterwheel blade shape of butterflies as a more efficient form than the blade remains in the research and can rotate up to 155.8 rpm generator and maximum power generated by the generator in the testing field is 115 Watts with an average voltage of 50 volts and an average current of 2.3 A.

ACKNOWLEDGMENTS

Thank you, we say to LP2M IAIN Palangkaraya who have funded this research to the Lab. Integrated physics that has been providing a place of research, told Mahad hostel daughter who has been providing an on-site testing and the BLK floating city of Palangkaraya that has provided a home and assembly.

REFERENCES

[1] Abdullah, Mikrajuddin.2016. Basic Physics I, Bandung: Bandung Institute of Technology
[2] Hendarto, Aryo P. 2012. Utilization of Public Bathing Hydro Micro Power Plant (PLTMh) Using a Type Overshot wheel.
[3] General Plan of Regional Energy (RUED) Central Kalimantan 2012-2025. Central Kalimantan Province 2014
[4] Shantika, Tito, et al. Engineering Power Plant For Small Scale Electricity 100 Watt.Journal of Industrial Research Vol. 7 No. 2, 2013, p. 139-148
[5] Sopian, K and Razak, J.Pico Hydro: Clean Power from Small Streams.Proceedings of the 3rd WSEAS International Conferenceson Renewable Energy Sources, 2009
[6] Siregar, Amanda Buna Satria, et al. (2013). Agricultural Engineering. J. Food Engineering and Pert., Vol.4 No. 1 Th. 2016