The Study of Syphon and Applied in Hydroelectricity Power Production

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***Abstract*— Hydro power is the clean power from flowing water which can generate the electricity power by hydro turbine. Normally, the hydro power is from flow water resource such as river, canal or brook and so on. But this research studied hydroelectricity power which generated from standing water. The syphon is use to pump the water flow through hydroturbine, and then the water was applied in agriculture. In order that, the syphon composes with 4 conjugated tanks, 200 liter and connect to 100 watts generator. The electricity is charge to battery formerly. So, this research focuses on the parameters which affect to hydroelectricity power generation for increase the efficiency of water's useful. The parameters are the design of hydro turbine and the angles of outlet pipe which flow the water to hydroturbine were tested at 45 and 90 degree, test and record the electricity and voltage data. The results show the hydro turbine which designed by stainless spoon and the angles of outlet pipe with 45 degree can generate the highest electricity power, current averages is about 204.4 mA ,voltage is 4.68 V and power is 956.59 mW. It could be conclude that the syphon which connected to electric generator can generate the hydroelectricity power and increase the amount of electricity by improving the design of hydroturbine and change the angles of outlet pipe to suitable direction.**

***Index Terms*— hydro power system, syphon, hydro turbine**

I. Introduction

Nowadays, water is important and usefully for daily life. Additionally, when the water work, motion, or falling by the force of gravity, it can be used to turn turbines and generators that produce electricity, calling "hydroelectric power". In America, hydro power provides about 96 percent of the renewable energy such as geothermal, wave power, wind power, and solar power. Because of hydro power friendly environment energy resource with high potential for producing electricity, it has more interested [1-4]. Moreover, it is currently the least expensive source of electrical power and much cleaner than power generated using fossil fuels [2]. However, the production of electricity form water is necessary to build large dams which have an effect to the people in the area. It is only during the last two decades that there is a renewed interest in the development of small hydro power (SHP) projects mainly due to its benefits particularly concerning environment and ability to produce power in remote areas. So, producing electricity form flowing water is interested form the researchers and demanded from industrials [2,4,5]. But there are many criteria to affect to produce the electricity as the level of head and flow rate. By having suitable water supply management and technology, generating energy is possible from these alternative resources which are potential energy resources and low environmental impact [3,6]. Moreover the alternative resources, the researchers are interested on designing and developing turbines into various patterns to catch energy from water flow to generate the most electricity power [3].

So, this study presents a new concept of hydroelectric power, using the standing water to resource by designed the syphon to the small water resources of water under vacuum tanks as pumps. There produces flowing water and drives the hydro turbine to generates the electricity. Then, investigation of the parameter which affect to hydroelectricity power generation for increase the efficiency of water's useful as design of hydro turbine and the angles of outlet pipe.

II. Design of Syphon and Blade

A. Designing of Syphon

The syphon was designed to vacuum system by 200 L for 4 water tanks which conjugated by water pipes and

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valves to close the system. It connects with 100 W generators and 12 V 20 Ah batteries. The syphon was stand up 1 meter form ground. This design was developed from Panmek Pomsila [7] syphon model. The schematic as component and design of syphon are show as figure 1 and 2, respectively.

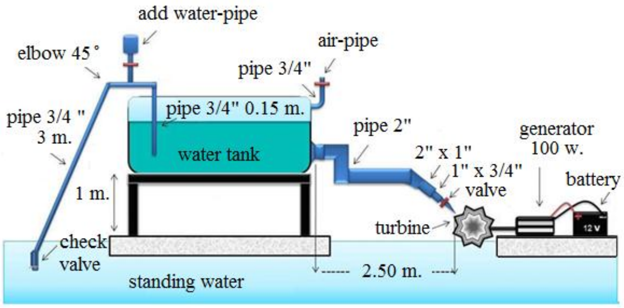

Figure 1. The schematic of component of syphon.

Figure 2. The design of syphon

B. *Design of Turbine*

This research studied 2 types of turbine as stanless blade type and plastic blade type. Firstly, stainless blade type was made from stanless spoon with a 3.5 inch in diameter with 9 blade as shown in Figure 3a. Another one, plastic blade type was made from plastic with a 3.5 inch in diameter with 9 blade as shown in Figure 3b. They are same size but different materilas and design.

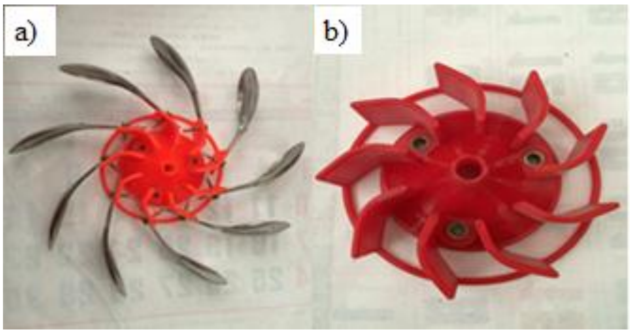

Figure 3. The designs turbine by a) stainless and b) plastic blade type

III. Experimental

The experimental was design to test syphon and turbines to find the best prototype design of syphon and hydro turbines for hydro electricity generation. First of all, we filled the water to tank till full, then open water valve in front of the turbine. The water flowed to drive the turbine. At the optinum vacuum, the system was suck the standing water at check vavle and the system was continous. Comparative of 2 types of turbine and the angles of outlet pipe which flow the water to hydroturbine were tested at 45 and 90 degree for 10 times repeat.

IV. Calculation

Energy conservation

To calculated the energy conservation, the continuity equation. So long as the flow Q is continuous, the continuity equation, as applied to one-dimensional flows, states that the flow passing two points [8,9]

$$Q = Av$$

Where, Q = volumetric flow rate
A = cross section of area of flow
v = average flow velocity

$$A = \frac{\pi D^2}{4}$$

Where, D = diameter of the pipe

$$v = \sqrt{2gH}$$

Where, H = high

$$M_w = \rho Q$$

Where, Mw = mass flow rate
ρ = the fluid density

The Bernoulli Equation

The Bernoulli equation states that the sum of the pressure, velocity, and elevation heads is constant. The energy line is this sum or the "total head line" above a horizontal datum.[10,11]

$$\frac{P_1}{\gamma} + \frac{v_1^2}{2g} + Z_1 = \frac{P_2}{\gamma} + \frac{v_2^2}{2g} + Z_2$$

Where, P1, P2 = pressure at sections 1 and 2
v_1, v_2 = average velocity of the fluid at the sections
Z_1, Z_2 = the vertical distance from a datum to the sections (the potential energy)
γ = the specific weight of the fluid (ρg)
g = the acceleration of gravity

Head Loss Due to Friction

In a pipe line, in addition to frictional loss, head loss is produced through additional turbulence arising when fluid flows through such components as change of area, change of direction, branching, junction, bend and valve. The loss head for such cases is generally expressed by the following equation.[12]

The energy equation for incompressible flow is

$$\frac{p_1}{\gamma}+\frac{v_1^2}{2g}+Z_1=\frac{p_2}{\gamma}+\frac{v_2^2}{2g}+Z_2+h_f+h_m$$

Where, h_f = the major head loss
h_m = the minor head losses

The Darcy-Weisbach equation is

$$h_f = f\frac{L}{D}\frac{v^2}{2g}$$

Where, f = f(Re, e/D), known as a Moody diagram
D = diameter of the pipe
L = length over which the pressure drop occurs
e = roughness factor for the pipe, and all other symbols are defined as before.

Reynolds Number

The critical Reynolds number (Re) is defined to be the minimum Reynolds number at which a flow will turn turbulent.

$$R_e=\frac{vD\rho}{\mu}$$

Where, R_e = the Reynolds number
ρ = the mass density
D = the diameter of the pipe
μ = the dynamic viscosity

Head losses also occur as the fluid flows through pipe fittings (i.e., elbows, valves, couplings, etc.) and sudden pipe contractions and expansions. [11]

$$h_m = K\frac{v^2}{2g}$$

Where, h_m = the minor head losses
K = Loss Coefficient

$$h_L = h_f + h_m$$

Where, h_L = total head losses

Speed of Turbine

$$n=\frac{60u}{\pi M_t}$$

Where, n = speed of turbine
u = tip speed turbine
M_t = moment of tip

$$u = v_2 - \frac{F}{2M_w}$$

Where, v = average flow velocity
F = force to tip

$$F = M_w v_2$$

From the overall of the equations coulde be calculated the paprametrs of this research, as shown in table 1. There are focused to the speed of turbine (n) that affect to the amount of elctricity generation. It’s observed that the degree of outlet pipe of syphon with 45 ° can make the speed of turbine more than 90 ° with 89.22 and 83.80 n/s, respectively.

TABLE I. THE PARAMETERS FORM CALULATION OF THIS RESEARCH

Parameter	Degree of outlet pipe of syphon		Unit
	45 °	90 °	
v	5.425	5.425	m/s
Q	0.002785	0.002785	m^3/s
A	0.000531	0.000531	m^2
M_w	2.785	2.785	kg/s
f	0.0115	0.0115	-
V_2	3.65	3.43	m/s
h_f	0.22	0.22	m
h_m	0.60	0.68	m
F	10.16	9.55	N
u	3.13	2.94	m/s
n	89.22	83.80	n/s

TABLE II. CONSTANT PARAMETER [13]

Parameter	Constant	Unit
D	0.026	m
ρ	1000	kg/m^3
g	9.81	m/s^2
γ	9806.6	N/m^3
μ	0.001003	Pa
K for Head Loss at Entrance	0.05	-
K for Head Loss at Discharge	1	-
K for gradual contraction 45 °	0.04	-
K for gradual contraction 60 °	0.02	-
K for Ball valve	0.05	-
K for elbow 45 °	0.35	-
K for elbow 90 °	0.75	-

V. RESULTS AND DISCUSSION

The efficiency of syphon and turbine was studied and use to produce hydroelectricity and observed the amount of current, voltage, and power. The results were compared 2 types of turbine at 45 and 90 degree of outlet pipe with 10 times repeat, as shown in table 3. The first, the stainless type of turbine with 45 angle degree of outlet pipe, the syphon can generated current is about 204.4 mA, voltage is 4.68 V and power is 956.59 mW. Then, increasing angle degree of outlet pipe to 90 degree, current is about 143.2 mA, voltage is 4.15 V and power is 594.28 mW, too. The second, the plastic type of turbine with 45 angle degree of outlet pipe, the syphon can generated the current is about 100.9 mA, voltage is 8.28 V and power is 835.45 mW. Then, increasing angle degree of outlet pipe to 90 degree, current is about 75.9 mA, voltage is 7.00 V and power is 531.30 mW, too.

TABLE III, CURRENT, VOLTAGE, AND POWER OF THE DIFFERENT TURBINE

Parameter	Stainless type		Plastic type	
	Degree of pipe 45 °	Degree of pipe 90 °	Degree of pipe 45 °	Degree of pipe 90 °
Current (mA)	204.4	143.2	100.9	75.9
Voltage (v)	4.68	4.15	8.28	7.00
Power (mw)	956.59	594.28	835.45	531.30

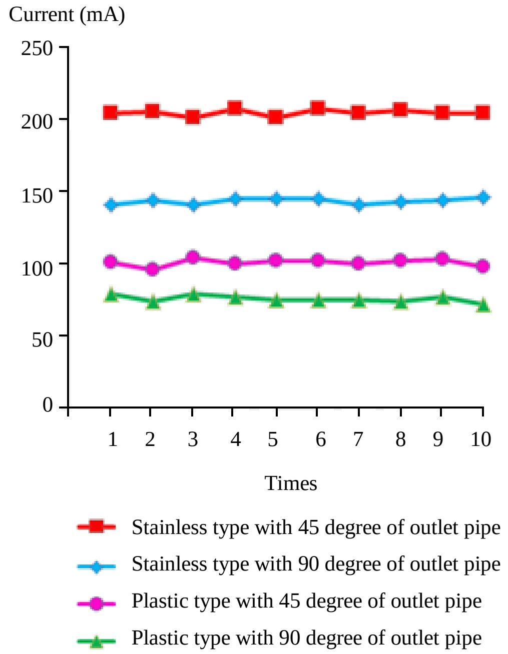

Figure 4. The electricity current from different types of turbine with 10 times repeat.

Form the results in table 1, there can be plot the graphs show the current (Fig. 4.) and voltage (figure 5.) compared the different types of turbine with 10 times repeat. The graph shown the systems are stable. The stainless turbine type with 45 angle degree of outlet pipe is the highest efficiency of current and voltage. The plastic type is suitable for make the turbine more than stainless type.

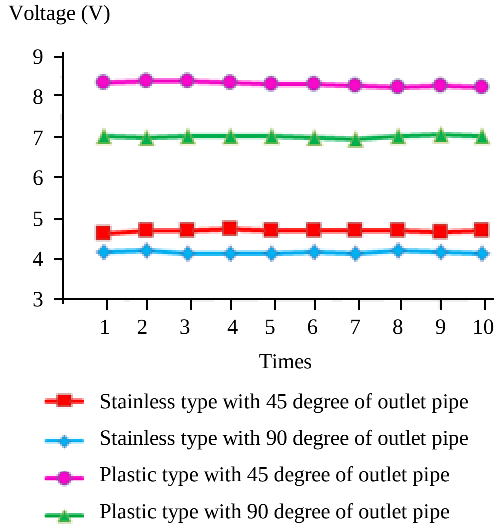

Figure 5. The voltage from different types of turbine with 10 times repeat.

To comparing the calculation and the currents results, the calculation of speed of turbine at 45 degree of outlet pipe of syphon is more than 90 as 89.22 and 83.80 n/s, respectively. It's coresponding to the electricity current which generate at 45 degree of outlet pipe of syphon is more than 90, in two types of turbine too. Then comparing the type of turbine, the stainless turbine is curved and weighed than plastic turbine [14]. It's suitable for hold the water and generated more electricity. In the future, we will apply this syphon to generate the electricity for agriculture and study the new materials to make the syphon.

VI. CONCLUSIONS

This research studied of syphon and applied in hydroelectricity power production. There are design syphon and turbines (stainless and plastic turbine) to find the best prototype design of syphon and hydro turbines for hydro electricity generation. It could be concluded that the parameters which affect to hydroelectricity power generation are design of hydro turbine and the angles of outlet pipe. The most suitable turbine is the stainless turbine with 45 angle degree of outlet pipe. The speed of turbine at 45 degree of outlet pipe is more than 90 which effect to the electricity current generation is the highest about 204.4 mA, voltage is 4.68 V and power averages about 956.59 mW.

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