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MULTI NOZZLE PARALEL TO IMPROVE EFFICIENCY CROSS FLOW TURBINE

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ABSTRACT

Cross flow turbine is a rotating device that takes energy from the flow of water emitted through a nozzle. Energy potential water can be converted into kinetic energy on nozzle of water turbine. A stream of water coming out from a nozzle that has a high speed hits the turbine blade. After hitting the blade the direction of the flow velocity changes so that a momentum changes which results in the turbine runner spinning. The impulse turbine is the same pressure turbine because the flow of water coming out of the nozzle is the same as the surrounding atmospheric pressure. All high energy places and pressures when entering the turbine road blade are converted into speed energy. The use of parallel multi nozzle is very effective to improve the performance of cross flow turbines as a driver of electricity generation.

Keywords: turbine cross flow, multi nozzle parallel.

1. INTRODUCTION

Conditions of limited energy resources as a result of increasing world energy demand from year to year with growth in energy consumption of 4.3 percent [1}. Then the demands to protect the earth from global warming and environmental pollution through the use of new technology and renewable energy sources. One alternative energy that has the opportunity to be developed is water energy. An analysis of the current situation in the energy sector is the use of water energy shows clearly the difference in the situation between industrialized countries and developing countries [2].

Energy is the most basic sector for the progress of a nation [3]. It cannot be avoided by a country to survive and is indispensable for development activities to promote education, health, transportation and infrastructure to achieve a decent standard of living and also an important factor for economic development and employment [4]. Urbanization, economic development, industrialization and a rapid increase in population growth have increased the demand for energy supply from power plants [5]. Human populations and increasingly progressive activities are developing, causing energy demand worldwide to increase, and this trend will most likely continue in the future [6]. To meet energy demand as a result of increasing population by maintaining economic growth is an alternative form of energy such as renewable energy needs to be expanded [7].

A very good energy to meet the needs of electricity is energy from hydropower is one of the cleanest renewable energy sources [8]. The power of water can be utilized in many ways, namely the energy of tidal currents to generate power by building dams along the estuary and releasing water in a controlled manner through turbines, large dams holding water that can be used to provide large amounts of electricity, the power of ocean waves is also used in various ways [9]. Micro-hydro power plants are one of the most operationally cost-effective energy technologies to be considered in the countryside to increase electrification in developed countries [10].

Micro hydro power is referring to electricity energy that comes from the power of moving water as a form of water kinetic energy as an electrician to drive the economy of a small household or village [11]. Micro-hydro systems can be considered as renewable energy sources resulting from natural hydrological cycles, sustained due to lack of water retention and assumed negligible environmental impacts [12]. This technology was originally used in rural areas of Indonesia in the form of water wheels to drive water pumps, rice grinders and other agricultural products 10]. Micro hydro power plants have various levels of simplicity that can be done in remote villages.

The existence of this water energy potential has a great influence on the use of water energy by optimizing its use in the energy sector. Currently energy supply in many industrial countries is only enough for their needs. Then the technology of water energy utilization can be used freely from nature, must compete with high-efficiency technology and conventional technology. Under these conditions, water energy technology can only be competitive if production costs can be reduced without reducing its reliability and efficiency. In many developing countries, it is estimated that soon food production cannot catch up with energy needs and food needs from the rapidly increasing population [13]

Most of the piko and micro hydro power plants in Indonesia are built using the flow from the river or commonly referred to as the waterfall. In general, the location of the waterfall is quite far from the settlement and difficult to reach by land transportation so often it must be taken on foot to arrive at the point in question. Waterfall can also be obtained by blocking the flow of the river, but with the cost of civil construction is quite expensive [14].

While on the other side of the river flow is flat, many are found passing near the settlements, both in rural

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and urban areas. Until now the flat flow has not been widely used as a power plant. Whereas, by utilizing the flat flow there is a lot of potential electrical energy that can be explored because the plant can be built along the flow. The technology to convert the river's flat flow into electrical energy is commonly referred to as low head turbine or very low head turbine [15].

Very low turbine heads are applied to the head or the height of falling water starting from 0.5 m. This type of turbine has several advantages including the cost of installing an inexpensive system, without the costs of civil works, high reliability, simplicity, ease of operation, and friendly to fish populations.

Very low turbine head is very suitable to be applied in areas that have the potential of a river with a low head as in an irrigation channel.

Figure-1. Potential of water energy in the villages.

Several types of very low head turbines have been researched and made prototypes on a laboratory scale. One of them is a cross flow turbine that can work on low head and cross flow turbines that can be mounted across the weir in a river.

In addition, a modified or modified closed cross flow turbine flow from the water resources research project was also developed for applications on the channel. The very low head turbine in these studies still uses a separate and not terraced generator in one shaft with its turbine. [16]

The availability of energy derived from fossil fuels is increasingly decreasing, which for some developing countries is still imported, is very expensive in rural areas. Therefore the supply of energy derived from alternative sources is very urgent.

Rural migration to urban areas is caused by unfavorable living conditions due to social problems in the area of origin. These problems which must be a top priority include the provision of electricity for lighting, telecommunications and agricultural mechanization activities such as rice grinders, water pumps, drying of agricultural commodities and others. One alternative to overcome these problems is the provision of energy derived from water energy. The use of energy must first be assessed technically and economically before being applied widely in rural areas. Micro-hydro technology provides potential resources regarding the opportunities for small-scale water energy utilization in terms of mechanization and economics [17].

Renewable energy is a definition of a natural renewable energy resource with an unlimited amount and if managed properly, such as water, wind, biomass, biogas, sea and geothermal waves [18] The renewed energy concept was introduced as part of the maximum effort to move away from nuclear and fossil fuels to realize the year of the International Year of Sustainable Energy for All, the United Nation stated in its general session in December 2011. Officially the United Nation launched the Energy Program Renewed in 2012 at the World Future Energy Summit in Abu Dhabi, United Arab Emirates. The target of setting 2012 as the International Year of Renewable Energy is in 2030, everyone in the world has used energy from renewable sources.

The aim of the decree is as the International Year of Renewable Energy to increase the awareness of the world community on the issue of energy shortages and show that access to clean, safe and affordable energy can improve the quality of life of the community. In the past, the earth has not been filled by humans as much as it is now and fossil fuel is still abundant, so we are not worried about environmental issues.

But now fossil fuels such as petroleum, coal and liquefied gas are located in previously untouched forest, sea and village locations that are exploited and are in the depths of the earth that are deeper and harder to mine, the cost of the environment is enormous. So that the more deforestation, the remaining gases are burned and thrown into the air will increase pollution and increase the effects of greenhouse gases, groundwater is polluted by oil and gas seepage, and sea pollution [19].

In the province of South Sulawesi as part of the country, Indonesia is a vast region and many villages have not been reached by the electricity network from the government. The energy source used to generate electricity is still dominated by fossil fuels. Hydro-micro is a renewable and environmentally friendly energy source that has the potential to replace fossil fuels.

2. LITERATURE REVIEW

The research was carried out as a basic analysis to develop micro hydro power plants located in remote villages. The results show and illustrate that the head and discharge of river water can generate power capable of generating electricity in the countryside. Electrical energy that can be raised will be able to increase the productive activities of the community so that the village economy is increasingly developing and advancing.

Based on the observation that the investment costs required to realize the micro-hydro power plant in the village are not large. Before the construction of a micro hydro power plant is realized, it is very necessary to do an economic and energy analysis of the planning of a micro hydro power plant to get maximum results

For the supply of electricity from the central government and regional governments, funds are provided for: (1). Poor community groups; (2).Construction of electricity supply facilities in undeveloped areas, (3). Electricity development for remote and border areas. (4). Rural electricity development. The potential of water

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energy sources in the region of South Sulawesi is quite large and spread throughout the districts in the countryside with a very large amount of energy for energy that can be used for the prosperity of the village and Indonesian people in general.

Natural resources in general can be divided into renewable resource and natural resources that are non-renewable resources or deplectable resources. Renewable natural resources are natural resources that can be continuously available as production inputs with an infinite time limit. Water, forests, solar heat, etc. are included in renewable natural resources. While natural resources that cannot be renewed are natural resources whose supply as production inputs is very limited in a certain period of time will run out. Included here are petroleum, natural gas, coal, and so on. Energy sources can be seen in terms of usage, consisting of primary energy and secondary energy. Primary energy is energy provided by nature and has not undergone further processing. While secondary energy is primary energy which has undergone a further process [18].

Electric energy sources are still dominated by conventional fuels, and currently they are already available very limited. While there are still many potential sources of new and renewable energy such as energy water, solar energy, wind energy, coal, peat and uranium, have not been used optimally. Potency New and renewable energy in Indonesia which has been developed temporarily is: water energy as a small-scale power plant.

While coal, peat and uranium are still in the development stage. Topography of rural areas consisting of lowlands, highlands, hilly mountains with many abundant water sources and huge potential water resources to be developed as electricity generators.

The free river flow can be used to generate electricity by installing an appropriate water turbine. Various sources of flow such as flow like tides, marine current, canal irrigation, and industrial. The use of water flow energy can be done by making a power plant source by installing a water turbine rotor. Turbines for free flow are primarily intended for rural areas in locations that are far from the grid's existing electricity, and they are machines that are useful for improving the quality of human life and increasing economic activity [19].

Development of new and renewable energy in rural areas that have vast areas that are abundant with abundant natural resources such as forests, mining materials, plantations, water, peat and others, but all of its generation uses fossil resources, namely diesel fuel and marine fuel oil. The source of energy by utilizing the energy potential possessed by flowing water has long been used. One of them is the use of it to generate electricity. Therefore, hydropower is one of the renewable energy sources that contribute the largest electricity production in the world.

This indicates the low utilization of available green energy potential. Some of the obstacles that cause it to be still low in utilization are large investments, environmental impacts and geographic constraints where the potential is located. One potential water flow that has not been widely used at present is the potential for a relatively low head. This potential is very large and large; it's just that it hasn't been exploited well because of the limitations of the conventional bin that exists today.

Turbines that are widely used for low head potential are cross flow turbines that can operate on low heads of other types of turbines. It's just that the turbine system is designed and made to operate at a very low head. The turbine chosen is a type of cross flow because this type of turbine works at a low head, ie starting between 0.5 meters.

Indonesian nature is very rich and provides a variety of energy sources in very large quantities because it is almost always there and ready to be processed into a source of energy, but the irony is a fact that up to now Indonesia has not optimally utilized available renewable energy and is still very energy dependent made from fossils. As much as 95 percent of the energy used is still fossil-fueled, while the maximum use of renewable energy can be a solution to the energy crisis that occurs in Indonesia.

The following are various types of renewable energy that have been widely used by various countries including a small number in Indonesia. Solar energy is energy collected directly from sunlight by using solar cell devices, a technology to convert sunlight into electrical energy by using photovoltaics.

Wind energy wind power as a source of energy has been used for several hundred years. This was originally used through large screens commonly known as slow-moving windmills.

Water energy can be used in the form of motion or temperature differences. Because water is thousands of times heavier than air, even the slow flow of water can produce large amounts of energy. This energy can be changed mechanical energy then converted into electricity through turbine equipment.

Geothermal energy with the term geothermal is used for heat energy from the bowels of the earth. The more downward, the deeper from the ground, the earth gets hotter. However, the temperature of the earth varies depending on its geography.

The use of renewable energy sources in our country is still at the level of this small commitment as evidenced by the Presidential Decree Number 5 of 2006 concerning National Energy Policy. In the decision on the master plan for energy use in Indonesia, it was stated that in 2025 it was targeted that energy consumption would be used in Indonesia, 30% would use natural gas, 33% use coal, 20% use petroleum, 5% use biofuels (biodiesel and bioethanol), 5% geothermal, 5% water, and the rest are other sources of energy. Calculation of water energy potential for electricity generation, before making development decisions, it is important to consider an important solution by estimating the power availability of the river discharge and the isolated high energy in the location for produce useful potential power [20].

The potential power of water from a stream that has a high water fall and discharge capacity which can be calculated theoretically with the equation is (water

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density) x (acceleration of gravity) ((water discharge), (high water fall) or $P_{Hidrolis} = \rho.g.\ Q.\ H.$ (Watt)

Turbine power can be calculated by the equation that is torque) x (angular velocity) or $P_{Turbine} = \tau.\omega$ (Watt)

Turbine efficiency can be calculated by the equation that is (turbine power) divided (water power) , or

$$\eta_{Turbin} = \frac{P_t}{P_h}\ x\ 100\%$$

3. MATERIAL AND METHODS

The supporting materials used in this study are arcrilic, iron plate, elbow iron, welding wire, paint, belt, pully, bearing, blade, shaft, bolt and nut. The instrument needed is in the form of a measuring glass, tachometer, flow meter, dial gauge, thermometer, meter, multimeter, stabilizer, manometer, stop watch and regulator. In summary, the methods used are preparation, tools of installation, calibration of measuring instruments, testing, data collection, data validation, processing and data analysis, conclusions.

4. RESULTS AND DISCUSSIONS

The results showed that the parameters measured were water flow velocity of water, head, water power, turbine rotation, to calculate turbine power and turbine and power system efficiency. While head measurements are made using a water pressure manometer and a meter to measure the height of falling water or water level. Measurement of water discharge by using a flow meter to determine the amount of water discharge that can generate kinetic energy. At each change in load that is determined in accordance with the research stage, then measurements are taken for all parameters of the variables needed

Figure-2. Installation of unit experiment.

Figure-3. Experiment activities.

The data obtained is the water discharge with a height (head), on the basis of the water resources available at the test installation and the calculation process, the design or specification of the impulse turbine with a cross-flow multi-nozzle turbine type is 3 pieces and installed on the runner a turbine that has 24 blades with a nozzle angle is 30 degrees.

Then data analysis based on literature review and well discussed research results obtained a condition and phenomenon that the higher the water discharge will produce greater water power which results in increased runner rotation, power and efficiency of cross flow turbines with parallel multi nozzle [17]. The performance of the turbine cross flow multi nozzle that is three parallel nozzle is hydraulic power (P_H) = 4,103 Watts, Turbine Power (P_T) = 3,476 Watts, and Turbine Efficiency ($\acute{\eta}_T$) = 84,71%. Turbine efficiency is very dependent on load conditions, type of turbine, head and water discharge.

The relationship of mass influence on torsion testing on turbine rotation can be seen the influence of the amount of mass giving to turbine rotation. Where before loading the turbine turns reach a high rotation, but when loading the turbine turns decreases along with the addition of the load. So it can be concluded that the greater the load given, the turbine rotation decreases. The results of the testing of the power produced by the turbine by comparing the water power used can determine the efficiency of the cross-flow water turbines that have been made [19].

From the results of calculations that have been done it can be seen that the mechanical efficiency of the turbine, making the water cross-flow turbine is applied as a microhydro power plant where the power produced with low capacity. In addition to water power testing also tested the effect of turbine power usage on turbine rotation.

Then the turbine efficiency also depends on how much potential energy the water is converted into kinetic energy in the multi nozzle of the cross flow water turbine. The water coming out from the nozzle that has a very high speed hits the turbine blade. After hitting the blade direction the velocity of the flow changes so that the momentum changes which causes the turbine wheel to rotate and produce the mechanical power of the water turbine [20].

5. CONCLUSIONS

The conclusion obtained from the data analysis that the performance of the cross flow turbine with the multi-nozzle parallel to the generator increases with a stable turbine shaft rotation because the turbine runner blade is more effective at absorbing water energy from the parallel multi nozzle i.e. water power (P_H) = 4,103 Watts and turbine power (P_T) = 3.476 Watts, as well as turbine efficacy ($ή_T$) = 84.71%

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