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PH (piezoelectric on hydraulic ram pump) media supplier of water and producing electrical energy environment-friendly

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Abstract. Water and electricity are some of the most important components of human life in this 20th century, both in daily activities and in work. Water and electricity are also resources that should be massively exploited for the benefit to be felt by all elements of society. However, problems occur when geographical factors and infrastructure factors become an obstacle in supporting the availability of these resources. Geographical factors in the form of areas far from water sources, as well as the location of areas far from the reach of the government so that there is a gap in the development in the distribution of infrastructure within a region. This causes some elements of society, especially in backward villages, cannot benefit fully from these resources. To overcome the crisis, we try to innovate by making a development of a hydraulic ram (hydram) pump by adding piezoelectric material as a source of electricity. Then, we will put the piezoelectric material into the series of hydram pump so that the rural community will be left behind will be able to feel the water and electricity resources of our innovations are simultaneously environmentally friendly.

1. Introduction

1.1. Background

Energy is a fundamental need in this millennium, conservation and research has long been pioneered by humans accompanied by the development of science and technology periodically, this proves that energy is very important for humans. Energy is believed to have eternal properties, such as the first law of thermodynamics and the law of conservation of energy, which states that energy can't be created or destroyed, energy can only change from one form of energy to another. From the existence of these laws make people continue to innovate and think creatively to be able to continue to produce and consume the energy generated as life support.

One of the life supporting energy is water and electricity. Water is a fundamental primary need for humans used for everyday activities such as washing, bathing, and others. Based on data from the Meteorology Climatology and Geophysics Agency [1] the availability of groundwater in Java is mostly at levels <0% to 20%. If a groundwater availability level of less than 0% indicates that the water content of the area is below the permanent wilting point.

Java has experienced a water deficit since 1995. During the dry season there will be a water deficit of about 130 thousand million m³ per year. The water deficit caused a water crisis and caused a disruption of water supply stability for the community. Many people have difficulty accessing water so they have to walk far to get water [1].



The main obstacle in the provision of clean water in Indonesia is the limited supply of water. Most PDAMs operate by relying on raw water from rivers. While existing rivers are already experiencing degradation caused by watersheds, anthropogenic problems, and weakening of river protection. Based on data from the Ministry of Research and Technology, about 70% of PDAMs in Indonesia have decreased water quality [1].

While electricity is the main energy source as a power source of various electronic devices. Electricity is the basic necessity of a nation. However, until this problem of electricity in Indonesia has not been resolved. Based on information from the General Chairperson of the Indonesian People's Poor Union, there are 3 fundamental issues of national electricity. First, the uneven access of electricity service in Indonesia. Referring to official data from the Ministry of Energy and Mineral Resources, electrification ratio in eastern part of Indonesia as of June 2017 reached 48.74, especially in Papua Province [2].

Large energy generating centers tend to be used to meet industrial and commercial energy needs while remote areas are neglected so that their energy needs are not sufficient. There are several other factors that cause the distribution in remote areas not evenly distributed, such as the difficult geographical conditions, in addition to the economic factors of society also influence, it can be per capita income and social inequality.

The incident as experienced by Sendang village Trawas sub district that geographically has a source of water that is difficult to reach by the community, then the idea arises to create a hydram pump as a means of distributing water from the source to the settlement of citizens. In addition to difficult to reach, the road to the source of the springs has no illumination and it is also not possible to establish a power pole there then arise the idea to provide lighting by utilizing the pressure generated by the hydram pump by piezoelectric material.

The hydram pump is a device used to raise water from the lower place to higher ground automatically with the energy coming from the water itself that is because of the falling water level used to push the valve on the hydra pump and result in water hammer [3]. Piezoelectricity is one of the energy harvesting converter media that is being developed, this tool converts mechanical strain into electric current or voltage, and most piezoelectric power sources produce power at the size of milliwatt [4]. From this idea, by combining hydram and piezoelectric pumps, the tool is expected to be able to benefit the water and electricity needs of the community in Penanggungan village, Trawas sub-district through harvesting technology from piezoelectric materials and water dispensing media without energy outside the hydra pump.

1.2. Research question

To limit the problem formulation of this writing, the writer refers to design the research question like a; "How do I make a hydram pump with an additional piezoelectric transducer material to produce water and electricity simultaneously?"

1.3. Objective of writing

In response to the problem of this study above, this writing is defined as follows: Make a hydram pump with additional piezoelectric transducer material can produce water and electricity at the same time.

1.4. Objective of research

The data of this writing is expected to give significance in the following positions: The tool we will design is a hydram pump with the addition of piezoelectric material that aims to produce electric current and water which can be directly channelled to the inland villages that have not been powered and far from water sources to meet daily needs. The benefits we get from this tool is to provide convenience to rural communities in the interior for access to water and electricity that is environmentally friendly and with high efficiency

2. Methods

2.1. Approach methods

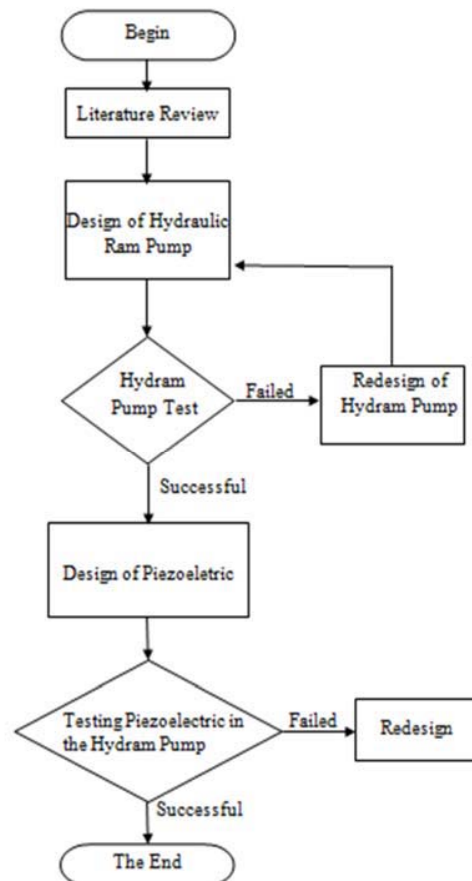


Figure 1. Approach methods

2.2. Testing methods

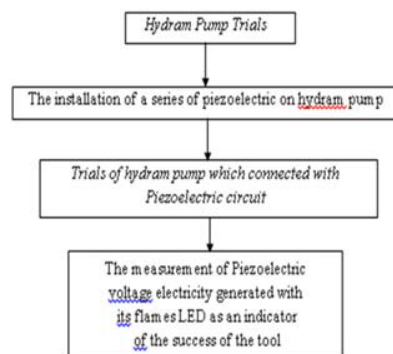


Figure 2. Testing methods

3. Results and discussion

3.1. Results

On the experiments has been performed, the obtained several improvements being done in order to get a hidram pump series can work optimally. The improvement in the form of addition, subtraction or replacement of some components of the pump hidram. Of these changes also done change the design on a whole series of pump so that the pump he made goals can be achieved. Some of these changes include: Before testing the lead content on the leaf, first to test the physical and chemical parameters of air at the point of sampling. The first point in the area of Campus C Unair and the second point on Jl. A. Yani Surabaya. Data collection was conducted in April 2018. At both points measured dry temperature, wet temperature, humidity, light intensity, and wind speed.

3.1.1. Hydrum pump version 1 (Hydrum v1.0). This pump is the first experiment that has been done on May 28, 2018, in this version the prototype assembled by using inlet and outlet with 100% pvc pipe, profile tank 250 liters, to the input pipe using size $\frac{3}{4}$ " and the output pipe $\frac{1}{2}$ ". After running there are some shortcomings and constraints among them such as leaks in connections L/funnel inlet pipe elbow, and less effective pipeline inlet 90-degree corner that have made (waste a.k.a. waste valve) is not able to move because of the lack of pressure to move the water generated a.k.a. so the pump cannot run.

3.1.2. Hydrum pump version 2 (Hydrum v2.0). This pump is the second experiment that has been done on 7 June 2018 with changed on the overall design of the earlier (Hydrum v1.0) which is considered less effective. Although the design was modified, all components of the pump (inlet to outlet) still use 100% pvc pipe. Design of pipe inlet on this version is replaced with the 45 degree slope angle of 90 degrees, this is done so that the rate of flow of water towards the core of the hydrum pump faster and also reduce leakage from previous designs.

3.1.3. Hydrum pump version 3 (Hydrum v3.0). This pump is the third trial was done on 1 July 2018 by changed on the overall gist of the hidram pump (excluding the pipeline inlet and outlet). This version also made modifications to the air tube (air tube) that are replaced with pvc plus sizes 3 "with the closing of the pipeline, and waste valve with the addition of waste valve, of which only 1 is now 2, but due to the debit water judged less sufficient to run 2 waste valve simultaneously, we switch back to version 2 by doing the modification again.

3.1.4. Hydrum pump version 4 (Hydrum v4.0). This pump is the fourth trial was done on 5th July 2018 by performing changes to the components of the pipe inlet and outlet pipes, where the component is replaced with the hose. Once replaced, there is no leakage that occurred at the hose inlet, on the hose outlet, we add a tap intended to pressure generated by the waste a.k.a. movements can be stored continuously in the air tube (air tube) and also in order to facilitate the setting of discharge water to be issued, then when the tube air hardened and tap outlet is opened, then the water flowed into the destination faster and motion from valve waste will move constant. This is later used for piezoelectric tranduser work.

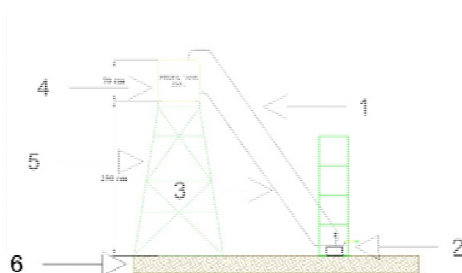


Figure 3. Hydrum pump v4.0

Information:

1. Inlet (hose)
2. Component of hydrum and piezoelektrik
3. Outlet (hose)
4. Water source (profile tank)
5. Tower
6. Ground level

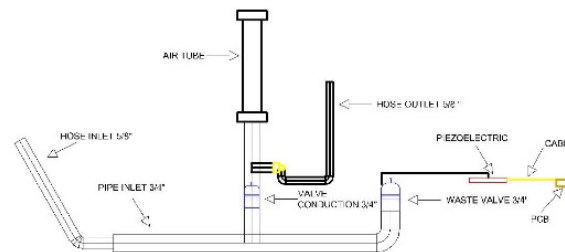


Figure 4. Details of hydram pump and piezoelectric v4.0

3.1.5. Piezoelectric circuit. Piezoelectricity is a tool that can change the pressure into a voltage. This tool is a slab-shaped if are pressure can produce voltage. The advantages of this material that is more environmentally friendly as only with input in the form of pressure that comes from the series so that it can generate electrical energy. For the design of the PH, we put 13 piezoelectric assembled parallel connected to the components on the PCB that contains a LED, diode, capacitor, and switches.

3.2. Discussion

Hydram pump basically works by using the concept of the law of conservation of mechanical energy, where the mechanical energy that happens is a mix between kinetic energy and potential energy that is present in the components of a mechanical system. The concept of a very influential factor against application hydram pump performance in taking action against channel water. Some of these factors in detail include:

3.2.1. Force of gravity. On the mechanism, hydram pump in the beginning can work if it gets a steady flow of water from the higher ground of the hydram pump, hydram pump because basically it can work without using the help of electrical energy as in the pumps in General. In this case, the gravitational force is a factor that can affect the performance of the pump, due to the gravitational force of the water source toward the pump, then the water will go to the pump by itself and it also results in water will have the speed and pressure that can affect the performance of the pump is hydram.

3.2.2. The pressure. Pressure is the factor that affects the operation of the hydram pump, the greater the pressure is generated, the greater the speed of the generated, this indicates that the events that occurred in accordance with the law of conservation of energy, where the pressure of factors affecting the change in mechanical energy.

3.2.3. The speed of water flow. The speed of the flow is also an important factor affecting the performance of the other pump, the faster water flow from the inlet toward the source, then the higher the pressure, it causes the faster water flowed toward the goal area of the water flow.

4. Conclusions

The conclusions in this study are:

1. The gravitational force, pressure, and velocity of water flow are interrelated factors in affecting the performance of the hydra pump.
2. Harvesting electrical energy obtained from piezoelectric circuits is highly dependent on the magnitude of piezoelectric pressure and the amount of piezoelectric attached to the circuit.
3. If the pressure generated by the hydra pump's waste valve is greater, the electrical energy generated by the piezoelectric circuit is also greater.

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