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Design of Clean Water Distribution System in Saibi Samukop Village

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ABSTRACT

In Saibi Samukop Village some wells are used by the community for daily needs, but the water is drawn from the wells using a bucket simultaneously, so the water becomes cloudy. For this reason, researchers designed a clean water distribution system using 2 100 Wp solar panels to charge 2 batteries to turn on the pump. The pump specifications used have a maximum power of 180 Watts, a Head of 15 meters with 12 Volts. From the test results with a head of 9.32 meters, the required power is 67 Watts and a strong current of 5.5 Ampere so that it can run the pump for 17 hours. Based on the need for clean water in Saibi Samukop Village for Massogunei Hamlet of 1053 liters/day and Pangasaat Village of 9420 liters/day, the pump is required to operate for 6.03 and 6.4 hours/day with pump efficiency of 34%.

Keywords: Solar Panel, Water Distribution System

INTRODUCTION

Humans need water, water is a very important natural resource, and water greatly determines the survival of human life on earth [1]. Lack of water intake will result in disruption of the performance of the brain so that it appears drowsy, difficult to think and remember things, to headaches [2].

Solar panels or (PV) have the role of changing the intensity of sunlight into electrical energy. The greater the intensity of the sun, the greater the energy that can be converted [3]. To meet the electricity needs to supply the water pump machine through the battery, it is necessary to have a sufficient size in its implementation. The PV used to convert sunlight into electrical energy has a capacity of 100 WP consisting of 2 pieces of 50 WP PV arranged in parallel [4].

Saibi Samukop Village is a village in the Mentawai islands that can be visited by boarding the MV (Mentawai Vast) ship from Padang City, which departs three times a week [5]. Even though, the Saibi area does not have a dock where the ship docks, because the absence of a dock or port causes passengers to only stop in the middle of the sea, after that there will be a small boat that picks up passengers in the middle of the sea to go to Saibi [6]. The absence of a pier is one of the problems that makes the lack of development in the Saibi Samukop area, the government it difficult to reach the area, and this is what makes it difficult for the community including difficulty in getting clean water for daily life [7]. The purpose of this research is to design a clean water distribution system for the community, especially in the village of Saibi Samukop, Mentawai islands using a pump with a 100 Wp solar panel charger.

RESEARCH METHOD

This research was conducted at the UKI Mechanical Engineering Laboratory by designing tools and conducting testing. In this study, the method used is a literature study (library). This research is a clean water distribution design that will be built in the village of Saibi Samukop to facilitate the local community in providing clean water from available wells. The design phase of clean water distribution in Saibi Samukop village is shown in Figure 2.

Before carrying out the test, first measure the distance and height between the water source in this case the well and the reservoir, as well as the layout of the equipment needed as shown in Figure 1.

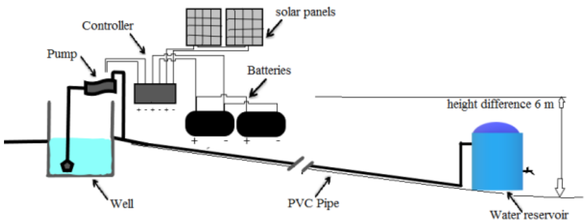

Figure 1. Water distribution scheme

In this design, initial data obtained from design calculations are several auxiliary materials shown in table 1.

Table 1. Auxiliary materials are needed

Material	Size	Amount
PVC pipe	1,5 in	180 pcs
Elbow	1,5 in	10 pcs
Valve	1,5 in	1 pcs
Filter	1,5 in	1 pcs

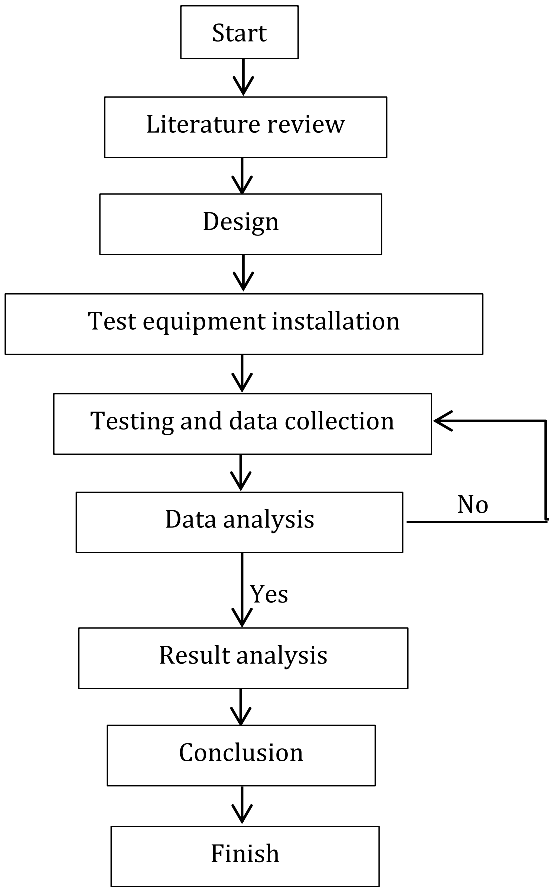

Figure 1. Research flowchart

RESULTS AND DISCUSSION

Based on the data from the design and manufacture of the tool, a test was carried out for the installation of clean water distribution with the amount of clean water needed shown by the formula $Q_{md} = P_n \times q$, where P_n is the number of the head of the family, q is the water consumption requirement assumed to be 30 liters for (family/day), then the need for clean water for Masoggunei hamlet which amounted to 335 households is 10,050 liters/day, and for Pangasaat hamlet with 314 households the water requirement is 9420 liters/day [8].

Pump Installation

Based on the water needs in Saibi Samukop village, the pump chosen is a solar pump with a 12 V LSWQB model with a discharge specification of $Q = 1{,}5\ m^3H$ or 1500 liters/hour or 0.42 liters/second, pump power P=180 Watts, and Head H=15m [9]. By knowing the pump specifications, the pump efficiency is $\eta_p = \frac{\rho \times g \times H \times Q}{P} = 34\%$. The pipe chosen is a pipe with a diameter of 2.54 cm, the pump capacity is 25 liters/minute or 1500 liters/hour so that the pump operating time in one day for the hamlet of Massogunei is $\frac{10.050\ \text{liters/day}}{1.560\ \text{liters/hour}} = 6{,}4\ \text{hours/day}$, and for Pangasaat hamlet it is $\frac{9.420\ \text{liters/day}}{1.560\ \text{liters/hour}} = 6{,}03\ \text{hours/day}$.

Discharge Side Pipe

Based on the discharge side, it takes a vertical pipe length of 720 meters and a horizontal pipe length of 1 meter, so the total length of the discharge side pipe is $H_d\text{discharge} = H_d\text{vertical} + H_d\text{horizontal} = 721$ meters. The discharge side pipe is a PVC-type pipe with a diameter of 1.5 inches or 0,381 dm, so the cross-sectional area of the pipe is $A = \frac{\pi}{4} d^2 = 0{,}12\ dm^2$ and the velocity of the water in the pipe at the discharge side is $V = \frac{Q}{A} = 1{,}25\ dm/s$ or 1.25 m/s [10].

To calculate the head loss on the discharge side pipe, first calculate the coefficient of friction on the pipe by calculating the Reynolds number first, $R_e = \frac{V \times D}{\upsilon} = 47{,}153$ and the roughness value on the pipe [11]. pipe is $\frac{\epsilon}{D} = 0{,}0004$, then the friction factor shown in the Moody diagram of the Reynolds number and pipe roughness is 0.01, so the head loss on the discharge side pipe is $H_{fdp} = f \times \frac{L \times V^2}{d \times 2g} = 15$ m [12].

The discharge side pipe has 1 valve with a friction factor of 0.01 so the valve losses are $H_{fv} = n \times f \times \frac{V^2}{2g} = 0{,}0007$ m, and 10 elbows on the discharge side with a friction factor of 0.294 so that the total losses on the elbows are $H_{f\,el} = n\,f \times \frac{V^2}{2 \cdot g} = 0{,}23$ m [13]. With the head loss obtained for each pipe and accessories on the discharge side, the total head loss on the discharge side pipe is $H_{fdp} + H_{fv} + H_{fell} = 15{,}23$ m [14].

The discharge side pipe also has 12 auxiliary materials with a friction factor of 0.01, so the head loss on the auxiliary material is $H_{fass} = n \times k \times \frac{V^2}{2 \cdot g} = 0{,}009$ m, Then the total head loss on the pump is $H_{fTot} = H_{fdp} + H_{fass} = 15{,}239$ meter [15].

Suction Side Pipe

On the suction side, the total suction height is the difference between the height of the pump and the depth of the well [16]. On the suction side, the length of the vertical pipe is 3.5 meters and the horizontal pipe is 0.5 meters. The selected pipe is a 1 inch pipe, the surface area is $A = \frac{\pi}{4} d^2 = 0{,}12\ dm^2$ and the water velocity is $V = \frac{Q}{A} = 1{,}25$ m/s [17].

The head loss on the suction side pipe along 4 meters is $H_{fhp} = f \times \frac{L}{D} \times \frac{V^2}{2g} = 0{,}07$ m where the coefficient of friction for the pipe is 0.01 [18].

On the suction side, one 90^0 elbow is used with the elbow losses $H_{fell} = n \times f \times \frac{V^2}{2g} = 0{,}02$ m, where the factor friction is 0,294. The suction side also has 1 valve with a size of 1,5 inches with a friction factor of 0,01, so that the friction losses on the valve are $H_{fv} = n \times f \times \frac{V^2}{2g} = 0{,}0007$ m, and the suction side has 1 filter and the filter friction factor is 0,01 so the friction losses on the filter are $H_{fsar} = n \times f \times \frac{V^2}{2g} = 0{,}0007$ m. By obtaining losses on the pipe and losses on accessories used on the suction side, the total head loss on the suction side is $H_{fhp} + H_{fv} + H_{fell} + H_{fsar} = 0{,}09$ m [19].

Total Head

The location of the well is near a hill, so the position of the well is higher than the community water reservoir, which is 6 meters above sea level then the total H is $\Delta_{el} - H_{total} = 9{,}32$ m [20].

Pump Power

The pump power required for water distribution is $P = \frac{\rho \times g \times H \times Q}{\eta_p} = 67$ Watt.

Power Storage Planning

The power storage used for this design are 2 batteries with 12 Volt 70 Ampere hour which are installed in parallel. This battery serves to anticipate cloudy weather [21]. Based on tests conducted at the Mechanical Engineering Laboratory Universitas Kristen Indonesia the resistance of the battery to start the pump is 2 batteries x 70 Ah = 140 Ah. To maintain the safety factor of the battery, the battery current must be set aside as much as 30% [22] so that the current that can be used is 140 x 30% = 98 Ah, while the power required for a 67 watt pump is $I = \frac{67\ \text{watt}}{12\ \text{volt}} = 5{,}5$ A and the battery life is $\frac{98\ \text{Ah}}{5{,}5\ \text{A}} =$ 17 hours, so from the calculation using 2 batteries connected in parallel can turn on the pump for 17 hours [23] [24].

CONCLUSION

The results of designing and testing the distribution of clean water needs in Saibi Samukop village, 2 solar panels with a capacity of 100 Wp and 2 12 Volt 70 Ampere batteries are used in parallel to charge the battery. The pump specifications used have a maximum pump power of 180 Watts, Head 15 meters with a voltage of 12 Volts, so based on the need for clean water in Saibi Samukop Village for Massogunei Hamlet 1053 liters/day and Pangasaat Village 9420 liters/day, the pump is required to operate for 6.03 and 6.4 hours/day with a pump efficiency of 34%.

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