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Performance Characteristics of Hydram Pumps Against Variations of Waterfall Height

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ABSTRACT: The availability of water in agricultural cultivation is a very strategic factor. Especially for areas that are close to water sources or are located under springs, the need for water is not too much of a problem. Areas with higher ground level than water sources and bumpy areas will have difficulty getting a continuous supply of water. Therefore, it is necessary to find an alternative to reduce the burden. An alternative that can be developed is a hydraulic ram pump that works without using an engine. Hydram pumps have been applied for drinking and household water purposes. However, the use for irrigation in agriculture has not been implemented. The method used in this research is to make a model in the laboratory by simulating the independent variable in the form of the height of the waterfall, while the dependent variables measured include the maximum head and output discharge. Furthermore, the results of the research were analyzed in the form of correlations between the independent variables and the dependent variable to obtain the efficiency of the hydraulic ram pump. Pumps used in research in the laboratory have the following specifications: input diameter = 1.5 inches; output diameter = 0.5 inch; piston stroke on the waste valve = 5 mm ; air tube diameter = 3 inches; length of air tube = 30 cm; galvanized pipe pump material. The results showed that the pump with a size of 1.5 inches had the best efficiency at a plunge height of 2 meters which was 18.4% with an input discharge of 1.44 liters/second while the output discharge produced was 0.11 liters/second while the lift height of pump which is 26.1 meters.

KEYWORDS: Hydram Pump, Waterfall Height, Irrigation, Maximum Head, Output Discharge

I. INTRODUCTION

It will be easier to meet water needs in areas adjacent to springs with an elevation lower than the water source, because it can be channeled using gravity. But in fact, there are areas that are located higher than the water source. One of the efforts to overcome water shortages, especially in areas whose elevation is higher than water sources such as those areas, is to use pumps. In general, a water pump requires an electric motor to drive it. The electric motor itself requires electrical energy as a source of propulsion. Meanwhile, if a diesel engine is used to meet their electricity needs, there will be financial problems faced by the community in operating it because of the low economic condition of the community [1].

[2]. The greater the plunge angle, the smaller the suction and thrust forces of the hydraulic ram pump. From the results of research on hydraulic ram pumps at a plunge height of 2 m, the largest suction force value is 194.1 N at a plunge angle of 35° and the smallest is 164.6 N at an angle of 55°. While the largest thrust is 19.9 N at a plunge angle of 35° and the smallest thrust is 17.2 N at an angle of 55°.

[3]. Conducted research on a 1.5-inch hydraulic ram pump with an input-waste-compressor arrangement on a hydraulic ram pump that has the best efficiency at a drop height of 2.5 m with an input discharge of 2,458 liters/sec, while the output discharge that can be lifted by the pump is 0.087 liter/sec while the lift height or vertical height of the pump is 30 m and the hydraulic ram pump efficiency is 13.6%. As for the input-compressor-waste arrangement, the hydraulic ram pump has the best efficiency at a plunge height of 2 m with an input discharge of 2,302 liters/sec, while the output discharge that can be lifted by the pump is 0.068 liters/sec, while the lift height or vertical height of the pump is 25 m. and the efficiency of the hydraulic ram pump, which is 14.2%.

Judging from the existing studies, there are many factors that affect the efficiency of the hydraulic ram pump, but these studies have not discussed the efficiency of the hydraulic ram pump with the addition of a pressure divider. In this study, the author will further develop a hydraulic ram pump with the addition of a pressure divider by varying the length of the pressure divider tube and varying the installation height of the pressure divider.

The ability of the hydraulic ram pump can be represented in the form of D'aubuisson efficiency.

$$\eta = \frac{Q_2}{Q_1} \text{ x } \frac{H_2}{H_1} \text{x}100\%$$

where is the efficiency of the hydraulic ram pump (%), Q1 is the waterfall flow or input (liters/sec), Q2 is the output discharge (liters/sec), H1 is the height of the waterfall or input (m), H2 is the height of the water lift or output (m).

Variations in the volume of air tubes of 330, 600, 1000, 1500 and 2000 ml on the hydraulic ram pump, each variation was tested three times in order to obtain accurate data. There was an increase in the efficiency of the hydraulic ram pump starting at a volume of 600 ml, then at a volume of 2000 ml it decreased. At a volume of 1000 ml, the maximum efficiency reduction is 2.46%. This value is smaller than the change in efficiency from a volume of 600 ml to 1000 ml and from a volume of 1500 ml to 2000 ml. These results indicate that there is no significant change in efficiency in variations in the volume of the tube. Based on data analysis, that the greatest efficiency is obtained at the volume of the 1500 ml air tube, which is 17.21%. While the output discharge (q) is obtained, the output volume produced in one day reaches 281.66 liters. This volume of water is equivalent to the water needs of 2 people with the assumption that each person needs 140.5 liters of water per day [4].

[5]. The effect of the diameter of the air tube and the distance of the pressure pipe hole with the delivery valve on the efficiency of the hydraulic ram pump. The air tube used is a tube with a height of 1.2 m with various diameters of 2, 2.5, 3 and 4 inches and the distance between the introduction valve and the delivery pipe hole is 0.15, 0.175, 0.20, 0.225 and 0.25. m. The results showed that the use of air tubes and the distance of the pressure pipe bore each had the highest and lowest efficiency values in each condition, but overall the highest efficiency occurred at a 2 inch diameter air tube with a pressure pipe hole distance of 22.5 cm by 35, 30% while the lowest efficiency is 19.57% in the use of a 2.5-inch air tube at a pipe hole distance of 25 cm.

Research on hydraulic ram pumps was conducted to determine the effect of plunge height, air tube volume and discharge height on hydraulic ram pump performance. The hydraulic ram pump used is a hydraulic ram pump which has an inlet pipe diameter of 1 inch and an outlet pipe diameter of 0.5 inches. The variations in the height of the falls are 1.5, 1.75, and 2 m. Meanwhile, the air volume was varied in 3 variations which included 0.00024, 0.0028 and 0.0032 m3 and the discharge height variations were 2.5, 3 and 3.5 m. The results showed that the optimal performance of the hydraulic ram pump was obtained at a height of 2 m with a volume variation of 0.0028 m3 of air tube and a discharge height of 2.5 m, with a discharge capacity of 10.2 liters/minute, volumetric efficiency of 49%, and pump efficiency 57%. The results of the analysis in this study indicate that the higher the plunge, the higher the energy entering the hydraulic ram pump, the balance between the incoming pressure and the pressure in the tube causes the delivery valve to open faster so that the discharge capacity also increases [6].

[7]. research on hydraulic ram pumps which shows that for every 1 m increase in plunge height, the output discharge will increase on average by 36.6% and the maximum head will increase by 5-6 m. Variations in the d/h ratio of the compressor tube affect the output discharge but do not affect the maximum head of the hydraulic ram pump. While the highest efficiency is obtained at a height of 2 m and a compressor tube d/h ratio of 0.198, which is 33.98%.

II. RESEARCH METHODS

The method used in this study is a pure experiment with a research instrument scheme as shown in Figure 1 where the variations in the height of the waterfall (H1) are 2 m, 2.5 m, 3 m, 3.5 m and 4 m. All variables that are determined and searched for are measured directly except for variables that must be calculated based on the variables being measured.

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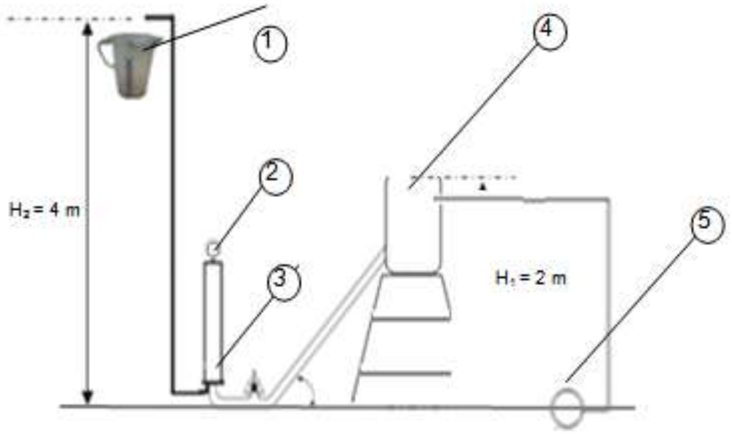

Figure 1. Schematic of the hydraulic ram pump research tool. 1. measuring cup (output), 2. pressure gauge, 3. hydraulic ram pump, 4. reservoir (input), 5. pump water source filling.

Table 1. Tools and materials

Nama	Spesifikasi
Pompa hydram	Badan pompa 1,5”, tabung kompresor 3”
Presure gauge	Max 2,5 kg/cm^2
Reservoir	1500 liter
Gelas ukur	1,5 liter

The data collection in this study was carried out with three repetitions for each variation used, from the three repetitions the average value was taken for the results to be used in the calculation. With the research that has been done, data on variables such as waste discharge, pumped water discharge, output pressure, maximum pressure and efficiency are obtained.

III. RESULTS AND DISCUSSION

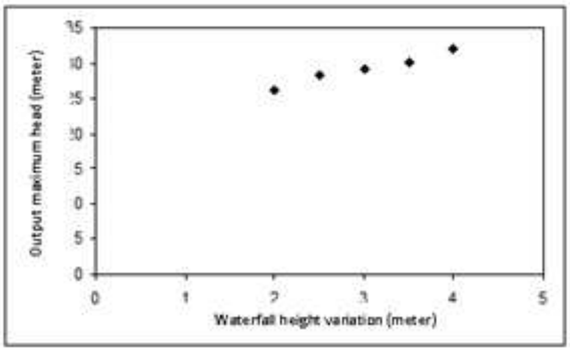

Figure 2.Graph of the relationship between the variation of the height of waterfall and the output maximum height

The results of laboratory research obtained input and output pressure. Figure 2 shows that the higher the waterfall that enters the pump, the higher the water that can be pumped, as well as the higher the plunge, the greater the input water discharge so that the greater the water that can be pumped up (figure 3). This is because the higher the waterfall, the greater the pressure in the input pipe. If the input pressure is increasing, it will be followed by an even greater output pressure, thus the resulting water discharge will be even greater (figure 4).

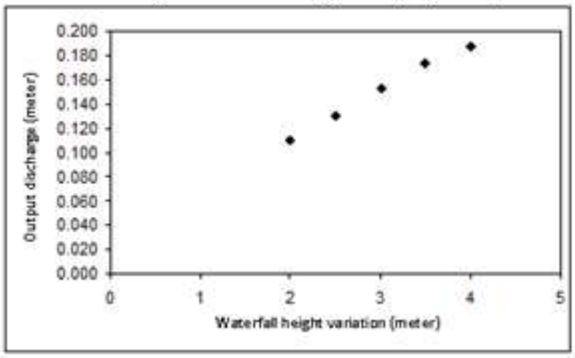

Figure 3.Graph of the relationship between the variation of the height of waterfall and the output discharge

On a hydram pump with a size of 1.5 inches on the pump input pipe and 0.5 inches for the pump output pipe, the data obtained as shown in Figure 3 shows that the higher the waterfall, which means the greater the flow of water flowing into the pump, the higher the output discharge. can flow larger.

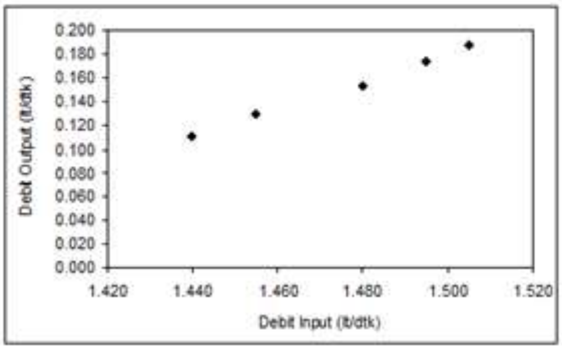

Figure 4. Comparison graph of input discharge with output discharge

Whereas in Figure 5, the tendency for efficiency will decrease, this is more because the pump's ability has limitations or the pump's ability has a maximum dynamic energy limit that can be utilized for a pump size, so that most of the water discharge is fed into the pump (the higher the plunge; in this case, This is the greater the water input discharge) is simply discharged through the sewage valve and a small portion can be raised or utilized. So that the pump with a size of 1.5 inches has the best efficiency at a drop height of 2 meters which is 18.4% with an input discharge of 1.44 liters/second while the output discharge produced is 0.11 liters/second while the lift height of the pump is of 26.1 meters as shown in Figure 5.

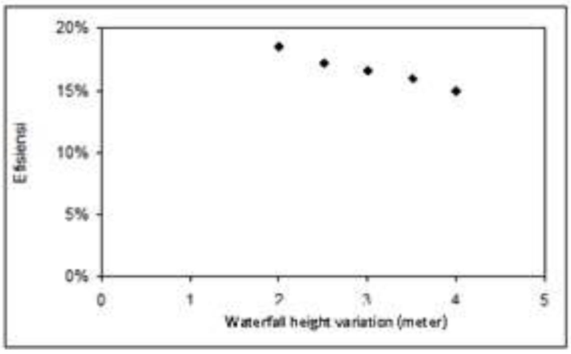

Figure 5. Comparison graph of the variation of the height of the plunge with efficiency

IV. CONCLUSIONS

4.1. Conclusion

a pump with a size of 1.5 inches has the best efficiency at a plunge height of 2 meters which is 18.4% with an input discharge of 1.44 liters/second while the resulting output discharge is 0.11 liters/second while the lift height of the pump is 26 ,1 meter

4.2. Suggestion

1. In future research, it is expected to measure the input pressure when the intake pipe is connected to the pump.
2. Accuracy in reading measuring instruments really needs to be considered so that the results obtained are precise.

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