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HYDRAM PUMP PERFORMANCE CHARACTERIZATION OF WATERFALL ANGLE VARIATION

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KeyWords
hydram pump, waterfall angle, debit, efficiency, head maximum

ABSTRACT

Water is one of the most important and necessary factors in the life of living things. Water must be available whenever and wherever in sufficient quantity, time and quality. A hydram pump is a pump that does not require external energy as its power source. The purpose of this study was to determine the effect of the waterfall angle on the discharge and efficiency of the hydram pump. This study uses a hydram pump with a compressor tube diameter of 3 inches and a height of 24 cm. The height of the waterfall is 2 meters with five variations of the angle of the pump are 45°, 40°, 31°, 26° and 22°. The method of analysis is done by analyzing the data obtained during the study, where the results are quantitative data which is presented in tabular form and displayed in graphical form. The results showed that the best efficiency of the hydram pump with the ILK arrangement was 22.3%, which was obtained at a waterfall angle of 26°. Meanwhile, the IKL arrangement is 14.2%, which is obtained at a 45° angle. The best debit is obtained at a 45° waterfall in the ILK arrangement, the hydram pump discharge debit is 0.088 lt / second with a maximum discharge head of 30 meters, and for the IKL arrangement, the hydram pump discharge debit is 0.068 lt / second with a maximum head discharge of 25 meters.

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INTRODUCTION

Water is one of the most important and necessary factors in the life of living things. In addition to the physiological development of living things, water is also an input for various efforts or activities of living things in order to produce something for their survival. The emergence of problems related to water caused by the increase in the various needs and interests of living things, in turn, has an impact on the disruption of conditions for water demand and supply.

Some areas that are located far from the water source or above the water source will certainly have difficulty getting water. Therefore we need a technology that is able to lift water from a lower place to a higher place. One of the efforts to meet water needs, especially in locations that are higher than the springs, is to use a water pump. Types of pumps commonly used today are water pumps powered by electric motors and pumps that use fuel oil (diesel or gasoline). For urban areas, the need for fuel is not a problem. Meanwhile, the data collected shows that in rural or remote areas the presence of BBM is very scarce, if any, the price is very expensive. To solve this problem, the idea emerged to use a water pump without an electric motor and a pump that does not require fuel.

The hydraulic ram pump utilizes the power of water flow that falls from a water source and part of the water is pumped to a higher place. In various situations, the use of a hydram pump has advantages compared to other types of pumps, namely it does not use fuel or additional power from other sources, does not require lubrication, simple shape, low cost of manufacture and maintenance and does not require high skills to make. This pump can run twenty four hours.

Hydram pump capability can be represented in the form of D'aubuisson efficiency.

$$\eta = \frac{Q_2}{Q_1} x \frac{H_2}{H_1} x100\% \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Where,

- η = hydram pump efficiency (%)
- Q_1 = waterfall debit or input (lt/dtk)
- Q_2 = increased water debit or output (lt/dtk)
- H_1 = waterfall or input height (m)
- H_2 = water lift or output height (m)

The equation used to measure water debit

$$Q = \frac{V}{T} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

Where,

- Q = debit (lt/dtk)
- V = volume (lt)
- t = time (dtk)

The performance of the hydraulic ram pump with the load variation of the sewage valve aims to determine the performance of the hydraulic ram pump with variations in the weight of the waste valve and the input head. The hydraulic ram pump used has an inlet pipe diameter of 1.5 inches and an outlet pipe diameter of 0.5 inches. The variations in the weight of the waste valve used are 410 g, 450 g, 490 g, 540 g, 580 g and 630 g. The results showed that the maximum flow capacity, maximum head discharge and maximum efficiency were achieved at the waste valve weight of 410 g. The maximum flow capacity is 11,146 × 10-5 m³ / s, the maximum discharge head is 7.378 m and the maximum efficiency is 16.302% [1].

The longer the inlet pipe size, the greater the resulting hydraulic pump discharge (Q). This is also directly proportional to the efficiency value of the hydram pump, the longer the inlet pipe used, the greater the debit value (Q) produced. The maximum debit value for the hydram pump (Q) is at the inlet pipe length of 2.5 m, with a weight of 0.46 kg, with a value of Q = 142.126 cm3 / s. The maximum pump efficiency value is the efficiency by using a weight of 0.46 kg at an inlet pipe length of 2.5 m and a lead pipe head (H + h) of 200 cm, with a debit efficiency of 24.40% and a D'Aubuisson efficiency of 35.87 %. [2].

Hydraulic Ram Pump is a pump that does not require external energy as the main driving force. Besides not requiring external energy as the main driving power source, the hydram pump also has other advantages, namely: simple construction, no need for lubrication, can work continuously for 24 hours without stopping, easy operation, low cost of manufacture and maintenance [3].

Research on hydram pumps with a size of 3.75 cm and an ILK arrangement has the best efficiency at a waterfall height of 2.5 meters with an input debit of 2.458 lit / s while the output debit that can be lifted by the pump is 0.087 lit / s while the lift height or vertical height of the pump is equal to 30 meters and the efficiency of the hydram pump is 13.6%. Whereas for the IKL arrangement has the best efficiency at a 2 meter waterfall height with an input debit of 2.302 lit / s while the output debit that can be lifted by the pump is 0.068 lit / s while the lift height or vertical height of the pump is 25 meters and the efficiency of the hydram pump is equal to 14.2% [4].

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RESEARCH METHODS

The hydram pump used in this study has the following specifications: input diameter of 1.5 inches, output diameter of 0.5 inches and piston stroke of 5 mm waste valve, with the position of the waste valve located before (input - waste - compressor, ILK) and after (input - compressor - waste, IKL) the compressor tube and the compressor tube size with a diameter of 3 inches and a height of 24 cm. The height of the waterfall is 2 meters with five variations of the angle of the pump are 45^o, 40^o, 31^o, 26^o and 22^o.

The variables to be examined in this study are divided into independent variables and dependent variables

a. Independent Variable

The independent variables in this study are the height of the water fall from the source to the hydram pump (H_1) in meters (m), the input debit (Q_1) in units of lit / minute or m3 / s and the dimensions of the pump in mm.

b. Dependent variable

The dependent variable in this study is high output height (H_2) in meters (m), and output debit (Q_2) in units of lit / minute.

To find out the input and output parameters, measurements are made with the following criteria:

- High input pressure (H_1; waterfall height) is measured by the vertical distance from the water level in the reservoir to the hydram pump. In this study, the waterfall height of 2 meters was used and the angle of the waterfall was also varied, namely 45^o; 40^o; 31^o; 26^o; 22^o.
- High output pressure (H_2) is measured using a pressure gauge, which is the vertical distance from the pump to the reservoir.
- The input debit (Q_1) and the output debit (Q_2) are measured directly.

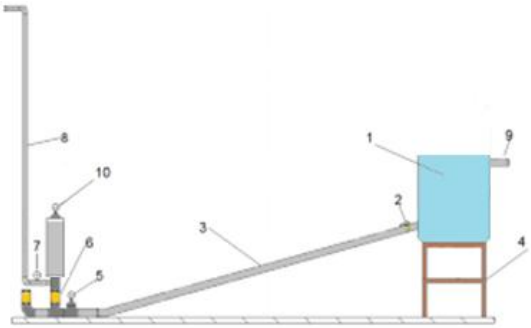

Figure 1. Series of test equipment. 1. reservoir tub, 2. ball valve, 3. inlet pipe, 4. reservoir tub holder, 5. pressure gauge inlet pipe, 6. hydram pump, 7. pressure gauge conduit pipe, 8. conduit pipe, 9. overflow hole, 10. pressure gauge air tube.

RESULTS AND DISCUSSION

Based on the results of research that has been carried out on a hydram pump which has a size of 1.5 inches with a 2 meter waterfall height which varies the angle of the fall (5 variations), it shows that in Figure 2 it can be seen that for the IKL arrangement the greater the angle of water entering the pump means the horizontal distance between hydram pump with a shorter source, the higher the water that can be pumped, and along with the greater the angle of the fall, the greater the water that can be flowed or the greater the water that can be pumped upwards. This is more so because the speed of the water entering the pump is getting bigger along with the increasing angle of water fall. However, this is not the case with the ILK arrangement, that along with the increasing angle of water fall, the maximum head tendency that can be achieved is constant or constant, however, the debit that is able to flow upwards or the output debit tends to increase with the increasing angle of the water fall.

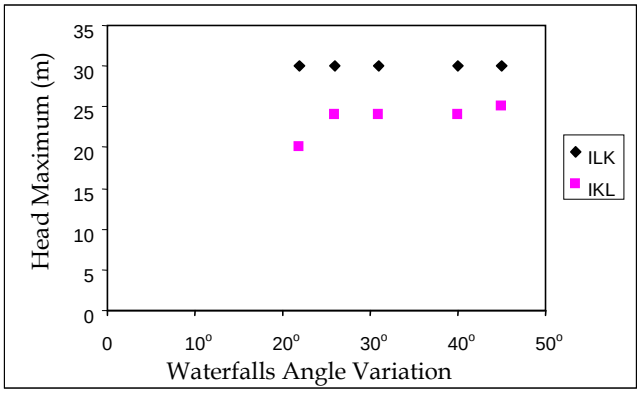

Figure 2.Graph of comparison of variations in the angle of the waterfall with the maximum head

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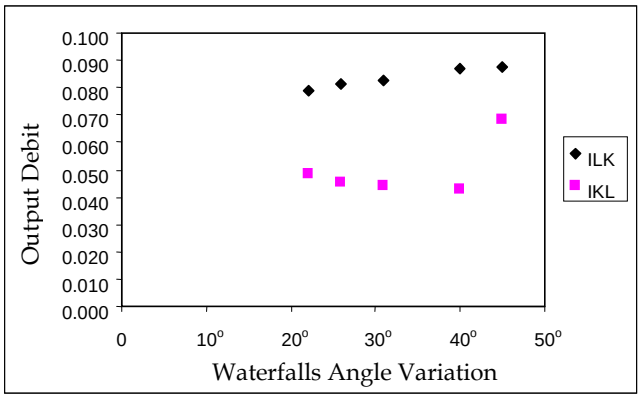

Figure 3.Graph of comparison of variations in the angle of the waterfall with the output debit

In Figure 3, it can be seen that the greater the angle of the waterfall, the greater the output pressure, this means that the higher the water lift force obtained and indirectly the higher the head discharge that the hydram pump can pump, for a 45o slope angle in the ILK arrangement. obtained the output debit that can be flowed by the hydram pump is 0.088 lt / second with a maximum lift height, namely the vertical direction of the pump of 30 meters, while for the IKL arrangement, the output debit that can be flowed by the hydram pump is 0.068 lt / second with maximum lift that is, the vertical height of the pump is 25 meters.

In Figure 4, it can be seen that the best efficiency of a hydram pump with a size of 1.5 inches with an ILK arrangement is 22.3%, which is obtained at a 26o angle, from this graph it can be seen that the tendency of the efficiency of the hydram pump with the ILK arrangement decreases with increasing size. water fall angle, this is more due to the ratio between the output debit and the input debit there is a tendency to decrease so this has an impact on decreasing the efficiency of the hydram pump. Whereas in the IKL arrangement it is 14.2%, which is obtained at a 45o angle of inclination, but the efficiency of the hydram pump with the ILK arrangement tends to increase along with the increasing angle of water fall, this is more due to the ratio between the output debit and the input debit there is a tendency to experience increase so that this has an impact on increasing the efficiency of the hydram pump.

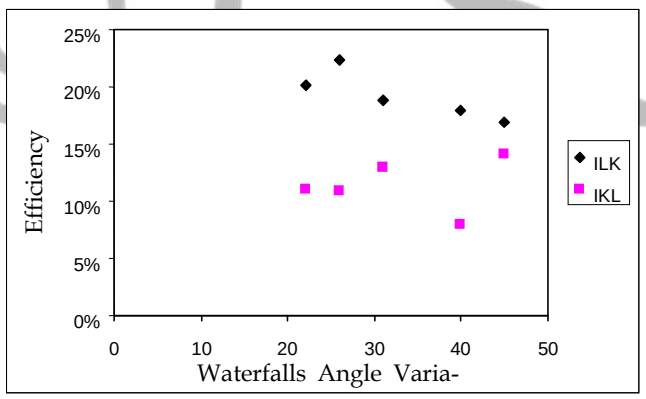

Figure 4.Graph of comparison of variations in the angle of the waterfall with efficiency

CONCLUSION

The results showed that the best efficiency of the hydram pump with the ILK arrangement was 22.3%, which was obtained at a waterfall angle of 26°. Meanwhile, the IKL arrangement is 14.2%, which is obtained at a 45° angle. The best debit is obtained at a 45° waterfall in the ILK arrangement, the hydram pump discharge debit is 0.088 lt / second with a maximum discharge head of 30 meters, and for the IKL arrangement, the hydram pump discharge debit is 0.068 lt / second with a maximum head discharge of 25 meters.

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