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The Effect of Output Pipe Location in the Compressor Tube on Hydram Pump Efficiency

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ABSTRACT: *A hydram pump is a tool used to raise water from low places to higher places with energy that comes from the water itself. The working principle of a hydram pump is to produce dynamic pressure which allows water to flow from low places to higher places. Hydraulic pumps are not only used to provide water for household needs, but can also be used for agriculture, animal husbandry and land fisheries. In this research, we want to examine the effect of variations in the location of the output pipe from the bottom of the compressor tube on the resulting efficiency. In this research, a hydraulic pump with a compressor tube specification of 3 inches with a height of 60 cm is used. In the hydram pump compressor tube, five variations in the location of the output pipe were made with output heights of 10, 20, 30, 40 and 50 cm respectively from the bottom of the compressor tube. The water level used is 2 meters from the pump and the water lift height is 4 meters. Meanwhile, the parameters measured are input discharge and output discharge. The results of the research show that the location of the output pipe greatly influences the pumping power or output power and the resulting efficiency. The input power obtained is uniform for all variations, namely 33.84 watts. The highest output power is 2.24 watts when the output pipe is located 10 cm from the bottom of the compressor tube. Meanwhile, the lowest pumped output power of 1.65 watts occurred when the 50 cm output pipe was used. The highest D'Aubuisson efficiency was obtained at 6.63% when using a 10 cm output pipe location. The lowest efficiency was obtained at 4.86% when using an output pipe location of 50 cm. The highest Rankine efficiency was obtained when the output pipe was located 10 cm from the bottom of the compressor tube, namely 3.43%. The lowest Rankine efficiency of 2.49% was obtained at the output pipe location 50 cm from the bottom of the compressor tube.*

NOMENCLATURE

Symbol	**Description**	**Unit**
Q	Debit	M^3/s
h	Head	*m*

Greek letter

η	Efficiency	%

Subscripts

D	D'Aubuission
R	Rankine
p	Pumping results (output)
w	Waste
s	Suction
d	discharge

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I. INTRODUCTION

The hydram pump comes from the word hydraulic ram pump and the operating principle of the hydram pump is to use gravity which will produce energy from the impact of water colliding with other water systems to push it to a higher place. The water will be raised continuously because it has a hydraulic force generated by the impact of water falling from the inlet or supply pipe. Under various conditions, using a hydraulic pump has more advantages than using other types of water pumps. Some of them require no fuel or additional power from other sources, require no lubrication, are very simple and very cheap to build and maintain, and do not require high technical skills to operate. Apart from that, this pump works 24 hours per day, making it suitable for areas that are located higher than water sources and areas that do not have electricity.

A hydram pump is a pump whose energy or driving force comes from the pressure or impact of water entering the pump through a pipe. The entry of water from various water sources into the pump must run continuously or continuously. The working principle of this tool is to produce dynamic pressure which allows water to flow from low places to higher places. The use of hydrams is not limited to providing water for household needs, but can also be used for agriculture, animal husbandry and land fisheries. The efficiency and effective performance of a hydram pump is influenced by many factors including plunge height, diameter and length of the air tube, pipe diameter, pipe length and piston length on the waste valve.

Install the pressure dividing valve at a height of 2 m from the pump body. Pressure dividing valve tube length: 20, 25, 30, 35, 40, 45 and 50 cm. The research results showed that the highest input power was 5.53 watts when using a tube length of 20 cm and the lowest input power was 5.32 watts when using a tube length of 50 cm. The highest output power that can be pumped is 1.75 watts when using a tube length of 20 cm. Meanwhile, the lowest pumped output power of 1.56 watts occurred when a tube length of 50 cm was used. The highest D'Aubuisson efficiency was 31.6% when using a tube length of 20 cm. The lowest efficiency was obtained at 29.3% when using a tube length of 50 cm [1].

The mass of the waste valve and the lifting height affect the efficiency of the hydram pump. The highest hydram pump efficiency of 60.6% was obtained at a lifting height of 5 m and a waste valve mass of 1.5 kg. Meanwhile, the lowest hydraulic pump efficiency was 27.1% at a lifting height of 7 m and a waste valve mass of 3.0 kg [2]. The highest D'Aubuisson efficiency was obtained at a waste valve diameter of 2.75 inches and a delivery valve diameter of 2 inches at 67.66%. The lowest efficiency was obtained at a waste valve diameter of 2.25 inches and a delivery valve diameter of 0.6 inches at 36.14% [3]. Hydraulic pumps using a ball-shaped delivery valve model have the best efficiency [4].

The angle of the inlet pipe has a very big influence on the performance of the hydram pump. The largest suction force obtained at a plunge angle of 35° was 194.1 N and the smallest was 164.6 N at an angle of 55°. The largest thrust force is 19.9 N at a plunge angle of 35o and the smallest thrust force is 17.2 N at an angle of 55o [5]. Variations in the installation angle of the compressor tube on the performance of the hydram pump with results showing that the best output discharge is 0.035 lt/s when the compressor tube is installed at 90° with a water lift height of 4 meters. Meanwhile, the lowest output discharge was 0.011 lt/s when the compressor tube was installed at 0° at a water lift height of 5 m [6].

The research results show that for every 1 meter increase in waterfall height, the output discharge will increase by an average of 36.6% and the maximum head will increase by 5÷6 meters. Variations in the d/h ratio of the compressor tube affect the output discharge but do not affect the maximum head of the hydram pump [7]. For every 0.25 meter increase in the height of the plunge, the output discharge will increase by an average of 12.7%, the waste flow rate will experience an average decrease of 1.3%, the drive power will experience an average increase of 15.2% and the pumping power will experience an average increase -average of 13.6%. The largest output discharge was produced at a waterfall height of 2.5 meters, amounting to 1.78 lt/s. The greatest pumping power is obtained at a plunge height of 2.5 meters at 1.5 watts and a drive power of 3.5 watts [8].

This research uses two hydram pump efficiency equations, namely D'Aubuission efficiency and Rankine efficiency.

a. D'Aubuission Efficiency

Efficiency according to D'Aubuission is the ratio between the height of the pumping side multiplied by the pumping water capacity by the sum of the pumping water capacity and the discharge water capacity multiplied by the height of the water fall. [9]:

$$\eta_D = \frac{(Q_p \ x \ h_d)}{(Q_p + Q_w)\, h_s} \ x \ 100\% \qquad \ldots\ldots \qquad (1)$$

b. Rankine efficiency

Efficiency according to Rankine is a comparison between the difference between the suction head and the exhaust side times the suction capacity, with the suction head multiplied by the capacity of the water displaced where in Rankine efficiency the head loss is ignored [9]:

$$\eta_R = \frac{Q_p(h_d - h_s)}{(Q_w)\, h_s} \ x \ 100\% \qquad \ldots\ldots \qquad (2)$$

II. RESEARCH METHODS

The research method used is direct experimentation in the field. The hydram pump used in this research has the following specifications: input diameter 1.5 inches, output diameter 0.5 inches and piston stroke on the waste valve 5 mm, and compressor tube size 3 inches diameter and 24 cm high. The height of the waterfall is 2 meters. The installation height of the pressure dividing valve is 2 meters from the pump body. The water lift height is 4 meters.

The variables examined in this research 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 in meters (m), the input water discharge in lt/s units and the pump dimensions in mm units.
b. Dependent variable
   The dependent variables in this research are waste water discharge and pumped water discharge in units of lt/s.

To determine input and output parameters, measurements are carried out using the following criteria:

- The input pressure height (plunge height) is measured by the vertical distance from the water level in the reservoir to the hydram pump.
- Location of output pipes with respective output heights of 10, 20, 30, 40 and 50 cm from the bottom of the compressor tube
- The output pressure height is measured using a pressure gauge, namely the vertical distance from the pump to the reservoir.
- Input discharge and output discharge are measured using a flowmeter.

Arrangement of testing equipment

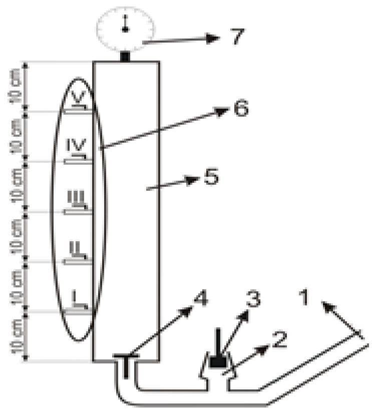

Fig 1. Compressor tube with five variations in output position. 1. input discharge, 2. waste valve, 3. ballast, 4. delivery valve, 5. compressor tube, 6. output position

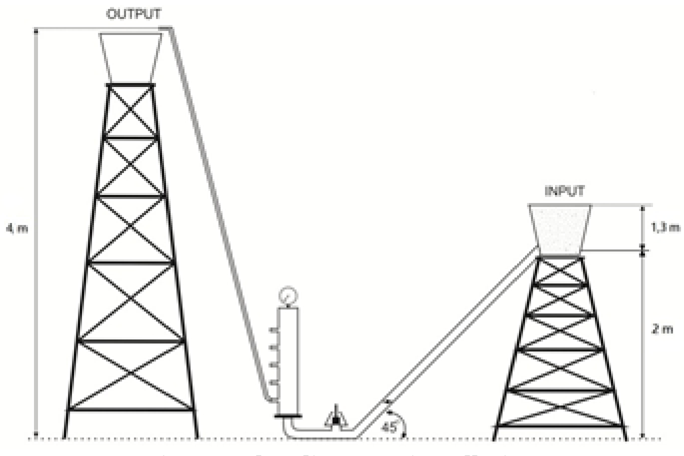

Fig 2. Hydraulic pump installation

III. RESULTS AND DISCUSSION

Table 1. Input power data at various output pipe locations on the compressor tube

The location of the output pipe on the compressor tube (cm)	10	20	30	40	50
Input Power (watt)	33.84	33.84	33.84	33.84	33.84

Figure 3 shows that the location of the output pipe on the compressor tube does not affect the input power achieved. The input power achieved for various variations in the location of the output pipe on the compressor tube is constant at 33.84 watts. In this study, the input discharge remained constant for various variations in the location of the output pipe on the compressor tube, namely 1.73 lt/s, so that the input power was constant for all variations in the location of the output pipe on the compressor tube.

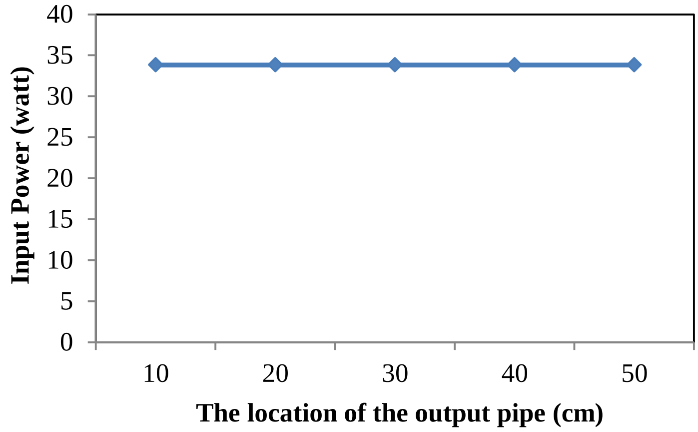

Fig 3. Graph of the relationship between variations in the location of the output pipe and input power

Table 2.Output power data at various output pipe locations on the compressor tube

The location of the output pipe on the compressor tube (cm)	10	20	30	40	50
Output Power (watt)	2.24	1.85	1.75	1.66	1.65

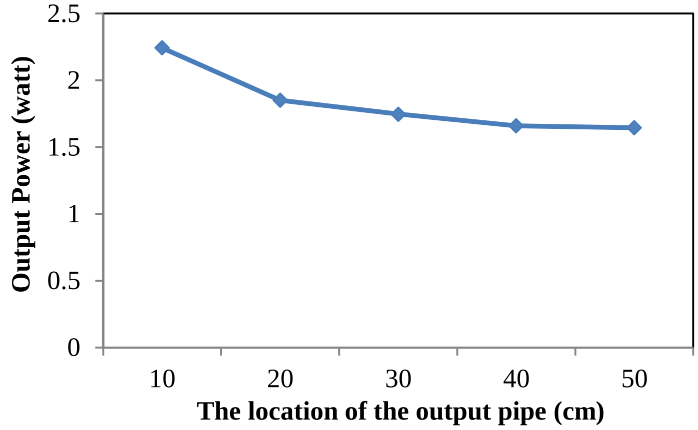

Fig 4. Graph of the relationship between variations in the location of the output pipe and output power.

Figure 4 shows that the location of the output pipe on the compressor tube is inversely proportional to the output power achieved. The highest output power was obtained from the hydram pump which uses an output pipe located at 10 m from the bottom of the compressor tube, namely 2.24 watts. The lowest output power was obtained from a hydram pump which used an output pipe located at 50 m from the bottom of the compressor tube, namely 1.65 watts. This happens because the pressure that occurs at the 10 m output pipe location, the pressure produced is the greatest when compared to other output pipe locations, so the output power produced is also the largest.

The effect of changing the location of the output pipe on the compressor tube shows an inverse relationship between the location of the output pipe and D'Aubuission Efficiency. The highest D'Aubuission efficiency of 6.63% was obtained when the output pipe was located 10 cm from the bottom of the compressor tube. Meanwhile, the lowest D'Aubuission efficiency of 4.86% was obtained at the output pipe location 50 cm from the bottom of the compressor tube. The higher the output pipe is located on the compressor tube, the lower the D'Aubuission efficiency obtained will be, as seen in Figure 5. This is more due to Every time you increase the location of the output pipe in the compressor tube, the pressure that occurs in the compressor chamber will become smaller and most of the pressure is only retained at the bottom of the compressor tube. This results in a decrease in the pumping flow so that the D'Aubuission efficiency decreases as the location of the output pipe in the compressor tube increases.

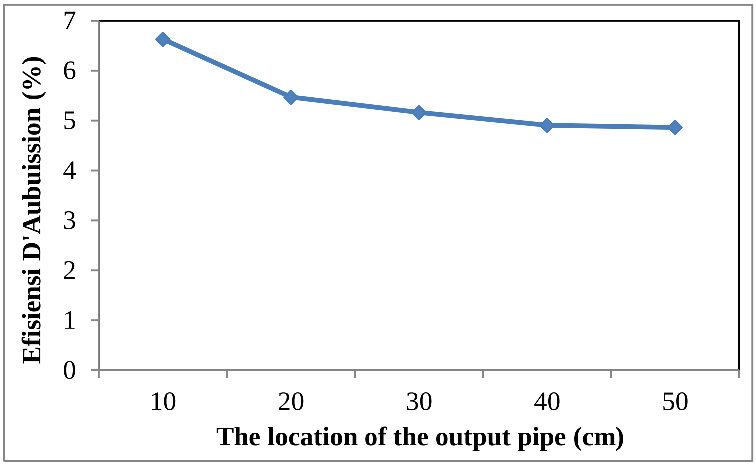

Fig 5. Graph of the relationship between variations in the location of the output pipe and D'Aubuission efficiency

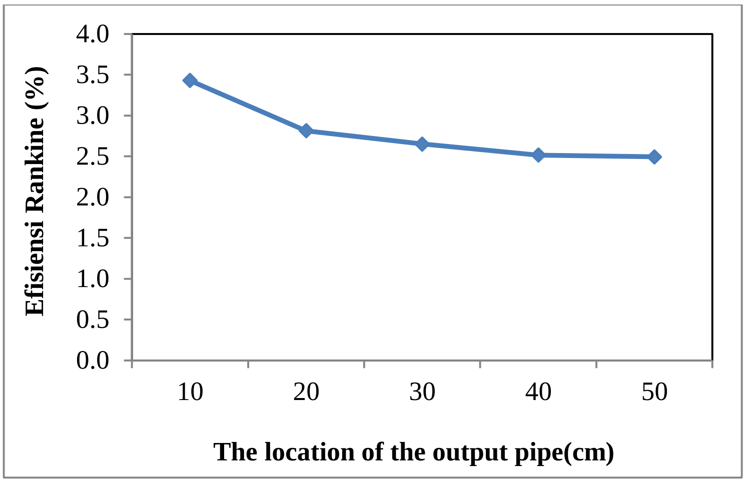

Fig 6. Graph of the relationship between variations in the location of the output pipe and Rankine efficiency

Figure 6 shows that Rankine efficiency will decrease as the location of the output pipe in the compressor tube increases. The highest Rankine efficiency was obtained when the output pipe was located 10 cm from the bottom of the compressor tube, namely 3.43%. The lowest Rankine efficiency of 2.49% was obtained at the output pipe location 50 cm from the bottom of the compressor tube. This is more because for every increase in the location of the output pipe, the output pressure will decrease further. This results in Rankine efficiency decreasing as the location of the output pipe in the compressor tube increases.

IV. CONCLUSION

The research results show that the location of the output pipe greatly influences the pumping power or output power and the resulting efficiency. The input power obtained is uniform for all variations, namely 33.84 watts. The highest output power is 2.24 watts when the output pipe is located 10 cm from the bottom of the compressor tube. Meanwhile, the lowest pumped output power of 1.65 watts occurred when the 50 cm output pipe was used. The highest D'Aubuisson efficiency was obtained at 6.63% when using a 10 cm output pipe location. The lowest efficiency was obtained at 4.86% when using an output pipe location of 50 cm. The highest Rankine efficiency was obtained when the output pipe was located 10 cm from the bottom of the compressor tube, namely 3.43%. The lowest Rankine efficiency of 2.49% was obtained at the output pipe location 50 cm from the bottom of the compressor tube.

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