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ANALYSIS OF HYDRAM PUMP PERFORMANCE ON INPUT DISCHARGE VARIATIONS

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KeyWords

Hydram pump, discharge, input, output, head, efficiency

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ABSTRACT

A hydram pump is a pump whose energy or driving force comes from pressure or impact of water. The use of hydram pumps is not limited to providing water for household needs, but can also be used for agriculture, animal husbandry and land fisheries. The aim of this research is to improve the performance of the hydram pump. This research was carried out by varying the input discharge entering the hydram pump. The hydram pump used has an input diameter of 3.81 cm, an output diameter of 1.27 cm and a compressor tube diameter of 7.62 cm with a compressor tube height of 60 cm. The input discharge variations used are 3 lt/s, 3.5 lt/s, 4 lt/s, 4.5 lt/s and 5 lt/s. In this research, a waterfall height of 3 m and an output height of 10 m were used. The results of the research show that for every 0.5 lt/s increase in input discharge, the output discharge experiences an average increase of 35.2%, while D'Aubuission efficiency experiences an average increase of 18.8%, as well as the maximum head experiences an average increase of 19%. . The output discharge, D'Aubuission efficiency and maximum head of the hydraulic pump increase along with increasing input discharge.

Introduction

Human need for water is very high, without water humans cannot carry out their activities. Humans use water in daily life for several things, including drinking, cooking, bathing, washing, irrigating rice fields and so on. Therefore, water must remain available wherever and whenever in adequate quantities.

Some areas that are far from water sources or are above water sources will certainly have difficulty getting water. Therefore, we need a technology that is able to lift water from low places to higher places. One effort to meet water needs, especially in locations that are higher than springs, is to use water pumps. The types of pumps commonly used today are water pumps powered by electric motors and pumps that use fuel oil. For urban areas the need for fuel oil is not too much of a problem. Meanwhile, from the data that has been collected, fuel oil is very rare in rural or remote areas, and if it does exist, the price is very expensive. To overcome this problem, the idea emerged to use a water pump without an electric motor and a pump that does not require fuel oil.

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. In various situations, the use of a hydram pump has advantages compared to other types of pumps, namely that it does not use fuel or additional power from other sources, does not require lubrication, is simple in shape, cheap to manufacture and maintain and does not require high skills to manufacture. This pump can work twenty-four hours.

Research on a hydram pump with a size of 3.75 cm and an input-waste-compressor arrangement has the best efficiency at a plunge height of 2.5 m with an input discharge of 2,458 lt/s while the output discharge that can be lifted by the pump is 0.087 lt/s while the lifting height or vertical height of the pump namely 30 m and the efficiency of the hydram pump is 13.6%. Meanwhile, the input-compressor-waste arrangement has the best efficiency at a plunge height of 2 meters with an input discharge of 2,302 lt/s while the output discharge that can be lifted by the pump is 0.068 lt/s while the lifting height or vertical height of the pump is 25 m and the efficiency hydram pump which is 14.2% [1].

The aim of the hydram pump with variations in waste valve load is to determine the performance of the hydram pump with variations in waste valve weight and input head. The ram hydraulic pump used has an inlet pipe diameter of 1.5 inch and an outlet pipe diameter of 0.5 inch. The variations in waste valve weight used are 410 gr, 450 gr, 490 gr, 540 gr, 580 gr and 630 gr. The research results show that the maximum flow capacity, maximum head discharge and maximum efficiency are achieved at a waste valve weight of 410 gr. The maximum flow capacity is 11.15 x 10-5 m^3/s, the maximum head is 7,378 m and the maximum efficiency is 16.3 % [2].

The longer the size of the inlet pipe, the greater the resulting hydraulic pump discharge will be. This is also directly proportional to the efficiency value of the hydraulic pump, the longer the inlet pipe used, the greater the discharge value produced. The maximum hydraulic pump discharge value is at an inlet pipe length of 2.5 m, with a ballast of 0.46 kg, with a value of 142.13 cm^3/s. The maximum pump efficiency value is efficiency using 0.46 kg ballast on an inlet pipe length of 2.5 m and a conducting pipe head of 200 cm, with a discharge efficiency of 24.4% and a D'Aubuisson efficiency of 35.87% [3].

Design of a hydram pump and test the effect of variations in air tube height and intake pipe length on the performance of the hydram pump. The research was carried out using variations in air tube heights of 40 cm and 60 cm with a diameter of 6.35 cm and variations in intake pipe lengths of 8 m, 10 m and 12 m. The supply channel height is 2.3 m and the pressure channel height is 8 m. The research results show that the maximum pump capacity is 0.0346 lt/s. The maximum efficiency of the hydram pump is 29.55% at a tube height of 60 cm and an inlet pipe length of 10 m [4].

Research on the effect of the diameter of the air tube and the distance between the pressure pipe hole and the delivery valve on the efficiency of a 2 inch hydram pump. The research results show that the use of variations in air tube diameter and pressure pipe hole distance greatly influences the efficiency of the hydram pump. It can be seen that the use of air tubes and the pressure pipe hole distance have the highest and lowest efficiency values respectively in each condition, but overall the highest efficiency occurs at an air tube diameter of 2 inches with a pressure pipe hole distance of 22.5 cm at 35.3% while the lowest efficiency is 19.57% when using a 2.5 inch air tube at a pipe hole distance of 25 cm [5].

The results of the research showed the largest output discharge at the length of the input pipe 6 meters and 8 meters with the diameter of the 1-inch waste valve hole, while the output discharge was mined to the length of the 2 meter input pipe with the diameter of the ½ inch waste valve. The best efficiency is 57.3% on the length of the 8 meter input pipe with the diameter of the 1-inch waste valve hole, while for the worst efficiency of 17.27% on the length of the 2 meter input pipe with the diameter of the ½ inch waste valve [6].

Research on a hydram pump which has an input–waste–compressor arrangement has the best efficiency at a plunge height of 2.5 meters with an input discharge of 2,458 lt/s while the output discharge that can be lifted by the pump is 0.087 lt/s while the lifting height or vertical height of the pump is 30 meters and the efficiency of the hydram pump is 13.6%. Meanwhile, the input-compressor-waste arrangement has the best efficiency at a plunge height of 2 meters with an input discharge of 2,302 lt/s while the output discharge that can be lifted by the pump is 0.068 lt/s while the lifting height or vertical height of the pump is 25 meters and the efficiency hydram pump which is 14.2% [7].

Research on hydram pumps shows that for every 1 m increase in plunge height, the output discharge will increase by an average of 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 hydram pump. Meanwhile, the highest efficiency was obtained at a plunge height of 2 m and a compressor tube d/h ratio of 0.198, namely 33.98% [8].

The greater the plunge angle, the smaller the suction force and thrust force of the hydram pump. From the results of research on hydram pumps at a plunge height of 2 m, it was found that the largest suction force value was 194.1 N at a plunge angle of 35° and the smallest was 164.6 N at an angle of 55°. Meanwhile, the largest thrust force was 19.9 N at a plunge angle of 35° and the smallest thrust force was 17.2 N at an angle of 55° [9]. The pump with a size of 1.5 inch had the best efficiency at a plunge height of 2 m which was 18.4 % with an input discharge of 1.44 lt/s while the output discharge produced was 0.11 lt/s while the lift height of pump which was 26.1 m [10].

To determine the efficiency of the hydram pump, in this study D'Aubuissondan efficiency was used. 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, where in Rankine efficiency head loss is ignored. So the D'Aubuission efficiency value can be calculated as follows [11]:

$$\eta = \frac{Q_2}{Q_1} x \frac{H_2}{H_1} x\, 100\ \% \quad \text{(1)}$$

where,
η = D'Aubuission efficiency of the hydram pump (%)
Q_1 = Waterfall discharge or input (lt/s)
Q_2 = Increased water discharge or output (lt/s)
H_1 = Height of the waterfall or input (m)
H_2 = Height of water lift or output (m)
The equation used to measure water discharge

$$Q = \frac{V}{t} \quad \text{(2)}$$

where,

Q = discharge (lt/sec)
V = volume (lt)
t = time interval (seconds)

Research Methods

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, with an input – waste – compressor hydram pump arrangement, and a compressor tube size of 3 inch in diameter and height tube compresor is 24 cm. The height of the water fall is 3 m and the lifting height is 10 m, with five variations of the hydram pump input discharge, namely 3, 3.5, 4, 4.5, and 5 lt/s.

The variables to be studied in this research are divided into independent variables and dependent variables

a. Independent variable
The independent variables in this research are the height of the water fall from the source to the hydram pump or input (H_1) in meters, the input water discharge (Q_1) in lt/s units and the pump dimensions in mm units and the output height (H_2) in meters.

b. Dependent variable
The dependent variables in this research are the yield and discharge (Q_2) in units of lt/s, maximum head and hydram pump efficiency.

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

- Input height (H_1; plunge height) is measured by the vertical distance from the water level in the reservoir to the hydram pump. In this study, a waterfall height of 3 m was used.
- Output height (H_2) is measured using a pressure gauge, namely the vertical distance from the pump to the reservoir. In this research, an output height of 10 m was used.
- Output discharge (Q_2) is measured directly.

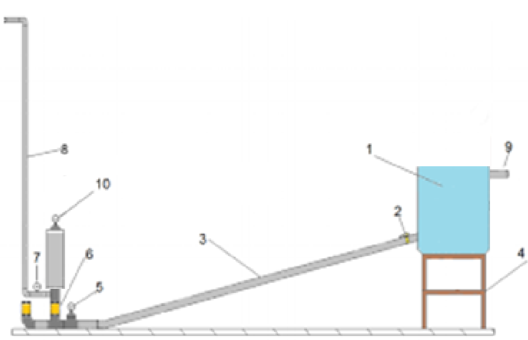

Figure 1. Series of test equipment

Caption: 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 carried out on a hydram pump measuring 1.5 inches with a plunge height of 3 m varying the input water discharge (5 variations), it shows that in Figure 2 it can be seen that the greater the input water discharge entering the hydram pump, the higher it is. also the water that can be pumped, and as the input water discharge becomes greater, the greater the water that can be channeled or the greater the water that can be pumped upwards. This is more because the speed of water entering the hydram pump increases as the input water discharge increases. Every increase in input water discharge of 0.5 lt/s is followed by an average increase in maximum head of 19%. Figure 2 shows that the highest maximum head is produced at an input water discharge of 5 lt/s, namely an average of 16 m at a waterfall height of 3 m.

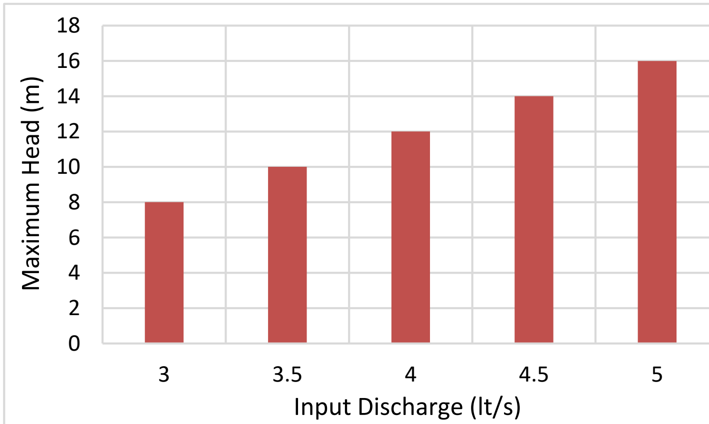

Figure 2. Graph of the relationship between the variation of input discharge and the maximum head

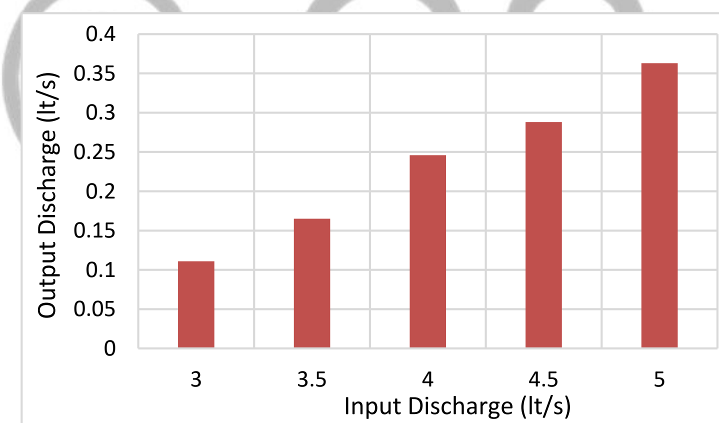

Figure 3. Graph of the relationship between the variation of input discharge and the output discharge

In Figure 3, it can be seen that the greater the input water discharge, the greater the output pressure, this means the higher the water lifting force obtained and indirectly the higher the output water discharge that can be pumped by the hydram pump, for an input water discharge of 5 lt/s, the output water flow that the hydram pump can flow is 0.363 lt/s with a lift height of 10 m in the vertical direction of the pump. For every increase in input water discharge of 0.5 lt/s, this is followed by an increase in output water discharge of 35.2% on average. Figure 3 shows that the highest output water discharge is produced at an input water discharge of 5 lt/s, namely an average of 0.363 lt/s.

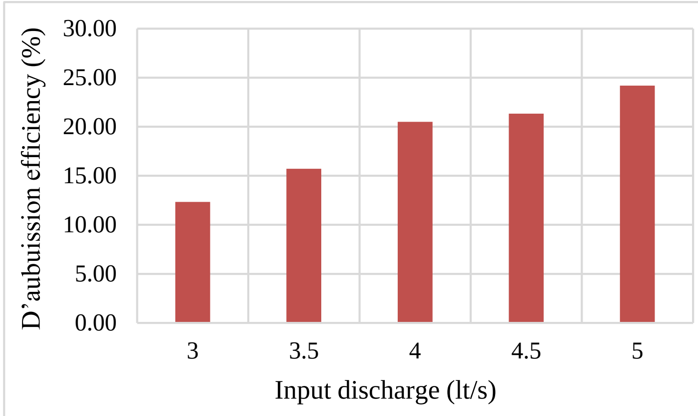

Figure 4. Graph of the relationship between the variation of input discharge and the D’aubuission efficiency

The highest D'Aubuission efficiency was obtained at an input discharge of 5 lt/s, namely 24.2%. The greater the input discharge, the greater the D'Aubuission efficiency obtained, as can be seen in Figure 4. This is mainly because every increase in the input water discharge entering the hydram pump will also be followed by an increase in the pumping water discharge or output water discharge. This results in D'Aubuission efficiency increasing as the input water flow into the hydram pump increases. Besides that, there is a tendency for the comparison between output discharge and input discharge to increase, so this has an impact on increasing the D'Aubuission efficiency of the hydram pump. Figure 4 shows that the highest D'Aubuission efficiency is produced at an input water discharge of 5 lt/s. Every increase in input water discharge of 0.5 lt/s is followed by an increase in industrial efficiency by an average of 18.8%.

Conclusion

The research results show that the best d'aubuission efficiency of the hydram pump is obtained at an input water discharge of 5 lt/s, namely an average of 24.2 lt/s. The best hydraulic pump output water discharge is obtained at an input water discharge of 5 lt/s, namely an average of 0.363 lt/s with a lifting height of 10 m. The highest maximum head is produced at an input water discharge of 5 lt/s, namely an average of 16 m at a waterfall height of 3 m. Every increase in input water discharge of 0.5 lt/s is followed by an average increase in maximum head of 19%, average output water discharge of 0.363 lt/s and average D'Aubuission efficiency of 18.8%.

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