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Analysis of Hydram Pump Performance on Variation of Installation on Various High Waterfalls

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Abstract**—** *Water is one of the factors which very important and necessary in the life of living creatures. Therefore, water must be available whenever and wherever in the quantity, timing, and sufficient quality. Hydraulic Ram Pump (Hydram) is a pump which does not require external energy as the power source. In this study, a hydram pump with an input diameter of 1.5 inches, an output diameter of 0.5 inches and a diameter of a compressor tube 3 inches with a height of 60 cm. The height variations in the waterfall used were 2.1 m, 2.6 m, 3.1 m, 3.6 m, and 4.1 m. As for variations in the position of the hydram pump arrangement with the installation position of input-waste-compressor (ILK) and input-compressor-waste (IKL). This study results that the highest output discharge is generated at a height of 4.1 meters with an ILK arrangement of 0.121 L/s. The highest maximum head is obtained at a height of 4.1 meters in the ILK arrangement of 16 meters. The greatest efficiency was obtained at a height of 3.1 meters with an ILK arrangement of 2.618%, while with the same height in the IKL arrangement an efficiency of 2.357% was obtained.*

Keywords**—** *Hydram pump, output, input, head, efficiency.*

I. INTRODUCTION

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

Analyze the effect of variations in input discharge and variation in compressor cylinder output height on the resulting efficiency. The results showed that the variation in output height that produced the largest output discharge was at 10 cm high output ie 102.24 mL/s for input discharge variations of 12.42 L/s, while the lowest output discharge was generated by a 50 cm high output ie 42.08 mL/s for variations in input discharge of 1.73 L/s. The highest efficiency of 5.084% was obtained from an output height of 10 cm with an input discharge of 1.73 L/s and the lowest efficiency of 1.023% was obtained from an output height of 50 cm with a debit input of 12.42 L/s [1].

Along with the development of technology, the thought arose to create appropriate technology to overcome the problem of meeting water needs. This is fulfilled by the hydram pump as the right choice, given that the hydram pump can work 24 hours non-stop and does not require high costs for maintenance [2].

In accordance with natural law, water always flows from a higher area to a lower area. This phenomenon will greatly complicate the distribution of water supplies in the highlands. The use of water pumps is an effort that can be taken to meet water needs. The types of pumps commonly used today are motor powered pumps that use fuel, namely diesel and gasoline [3].

The results of the study on the effect of variations in the ratio d/h of the compressor tube gives an influence on the output discharge of the hydram pump. In various variations of the ratio d/h of the compressor tube obtained the largest discharge output and efficiency of the hydram pump on the ratio d/h of the compressor tube 0.198 for various variations in the height of the waterfall, but did not give effect to the maximum head. This happens because although the size of the compressor tube varies, the volume of the cylinder is the same, this shows that the air chamber with different variations of the compressor tube has the same size. This situation indirectly gives an impact on the voltage (pressure pulse) that occurs the same, which is equal to 0.3 kg/cm2. The maximum head of the hydram pump will change or get bigger as the height of the construction increases. For every 1 meter increase in height, the output of ouput will increase by an average of 36.6% while the maximum head will increase by an average of 5 ÷ 6 meters [4].

Research on hydram pumps with variations in the height of waterfall and waterfall angle. The greatest efficiency was obtained at a 2 m height (5 m high water level) and a 31^o waterfall angle of 14.23% and 19.14%. Whereas the highest pumping occurs at a height of 4 m (height of 5 m) with an angle of 40^o [5].

This research will try to further develop the hydram pump by varying the position of the hydram pump arrangement at various heights. The purpose of this study is to obtain a better efficiency of the hydram pump.

Pump efficiency is the ratio between the energy carried by the pump to lift water with potential energy when water enters the pump. The method used in determining the efficiency of a hydram pump installation is the D'AAubuisso method with the equation

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

Where :

- η = hydram pump efficiency (%)
- Q_1 = water flow or input (L/min)
- Q_2 = increased water discharge or output (L/min)
- H_1 = input height (m)
- H_2 = output height (m)

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II. Materials and Methods

The research method that will be used to achieve the research objectives is to test the performance of hydram pumps in various variations in the height of 2.1 m, 2.6 m, 3.1 m, 3.1 m, 3.6 m, and 4.1 m. As for variations in the position of the hydram pump arrangement with the installation position of input-waste-compressor (ILK) and input-compressor-waste (IKL). Testing performance of the hydram pump which includes: discharge output, waste discharge, maximum head and efficiency generated by the hydram pump.

2.1. Research Variable

In this research the dependent variables are input pressure, output pressure, input discharge and output discharge. While the independent variable is the height variation and the variation in the position of the hydram pump arrangement.

Fig. 1. Hydram pump with ILK pump arrangement

Fig. 2. Hydram pump with IKL pump arrangement

2.2. Tools and Materials

Equipment used in the study: wrench, pipe wrench, wrench, pressure gauge, scissors, grinding machine, stop watch, measuring cup, 8 MP camera, welding machine. material: galvanized pipe, 1.5-inch knee, 1.5-inch tee, 1.5-inch and 0.5-inch elbow, 1.5-inch water nut, 0.5-inch socket, plate, seal tape, 0.5-tap faucet inches, 1.5 inch pvc pipe and 1.5 inch lid.

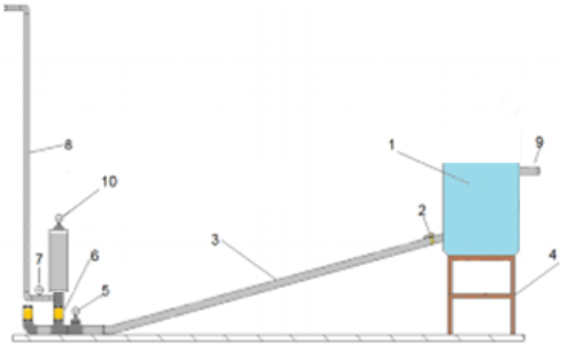

Fig. 3. Series of test equipment

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.

2.3. Research Procedure

Prototype of hydram pump that will be made using galvanized pipe material combined with iron plate material because it has good strength and durability. In this study, in general the hydram pump made has the following specifications: Material for the manufacture of the pump body using galvanized pipes and iron plate material, the dimensions of the pump is 1.5 inches, the height of the pump is 2.1 m, 2.6 m, 3, 1 m, 3.6 m and 4.1 m. As for variations in the position of the hydram pump arrangement with the installation position of input-waste-compressor (ILK) and input-compressor-waste (IKL). In this study the variables studied were the influence of the hydram pump arrangement position and the variation in the height of the waterfall on the output discharge, waste discharge, maximum head and efficiency generated by the hydram pump.

III. Results and Discussion

The increase in the output discharge along with the higher waterfall at the hydram pump is caused by the water inlet pressure and the greater the input discharge at the pump as shown in Figure 4. The greater the input discharge, the greater the volume of water entering the compressor tube. The large volume of water that enters the compressor tube is forwarded to the output channel and causes greater output discharge.

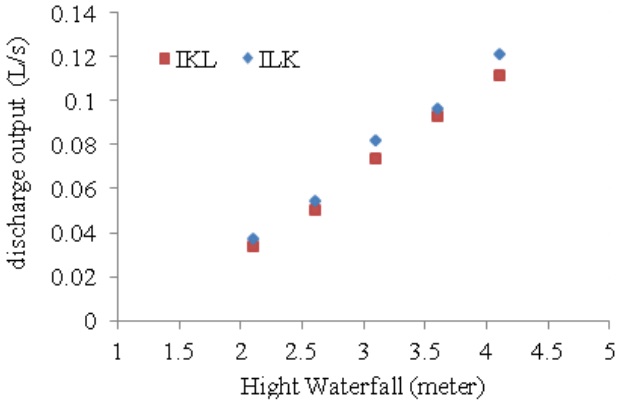

Fig. 4. Graph of the relationship between the height variations that occur in the discharge of output in the ILK and IKL arrangement

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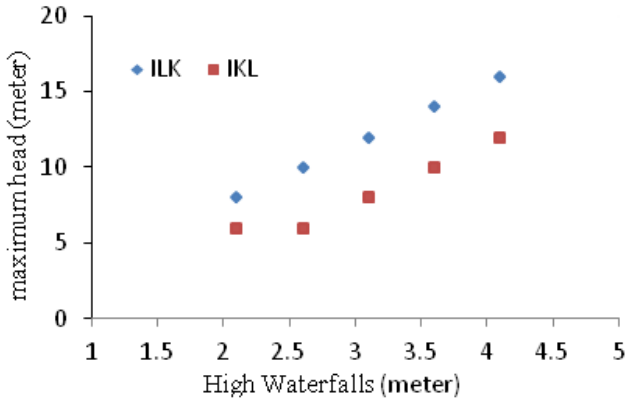

Fig. 5. The graph of the relationship between the height variations that occur in relation to the maximum head in the ILK and IKL arrangement

In Figure 5 it can be seen that the highest maximum head is produced at a height of 4.1 meters with the position of the ILK compressor tube which is 16 meters. At the same height in the position of the IKL compressor tube obtained a maximum head of 12 meters. The smallest maximum head is obtained at a height of 2.1 meters, with ILK compressor tube position of 8 meters and IKL of 6 meters. The two variations of the pump arrangement are ILK and IKL, it is seen that the position of the ILK compressor tube has a maximum head which is better than IKL. This situation occurs due to water entering the pump or thrust energy that occurs due to high waterfall can directly be used or used a compressor tube to move the valve so that energy can be used first directly by the compressor tube to raise the pressure in it and then to push the water up . Not so with the IKL position where the energy is first used directly to move the waste valve in the rest then move the valve on the compressor tube.

The efficiency of the hydram pump is obtained from the ratio of output discharge and input discharge multiplied by the ratio of the output head and the input head then multiplied by 100%. Here is a graph of the results of the calculation of efficiency obtained.

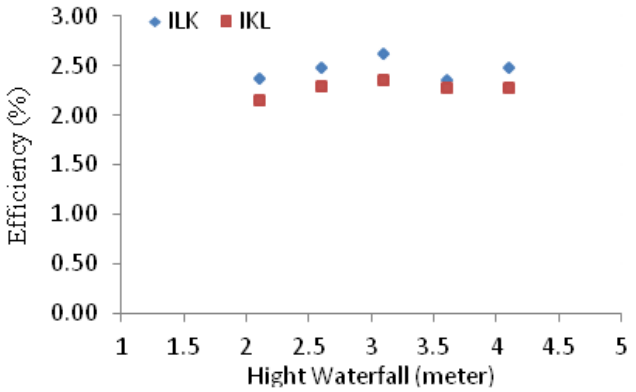

Fig. 6. Graph of the relationship between the height variations that occur with respect to efficiency in the ILK and IKL arrangement

From Figure 6 it can be seen that the highest efficiency is generated at a height of 3.1 meters with the ILK compressor cylinder position of 2.618%. With the same height in the position of the IKL compressor tube obtained an efficiency of 2.357%. From the two variations of the pump arrangement, ILK and IKL, it can be seen that the highest efficiency is obtained at the same height, which is 3.1 meters high. At a height of 3.6 meters the efficiency decreases again. This shows that for a hydram pump with a size like this would be very suitable for use in the height of 3.1 meters.

IV. CONCLUSION

The higher the waterfall, the higher the output discharge of the hydram pump. The highest discharge is at a height of 4.1 meters with an ILK arrangement of 0.121 L/s while the IKL arrangement is 0.112 L/s. The highest maximum head is obtained at a height of 4.1 meters with an ILK arrangement of 16 meters. As for the position position, the maximum IKL head produced is 12 meters. The greatest efficiency at a height of 3.1 meters with the ILK arrangement of 2.618%, while the IKL arrangement obtained efficiency of 2.357%.

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