Engineering and Technology Journal e-ISSN: 2456-3358

Volume 08 Issue 08 August -2023, Page No.- 2609-2612

DOI: 10.47191/etj/v8i8.17, I.F. – 7.136

Performance of Pressure Divider Valves in Hydram Pumps with Variation of Divider Tube Length

Rudy Sutanto[1], Sujita[2]

[1,2]Departmen of Mechanical Engineering, Faculty of Engineering, Mataram University, Mataram, Indonesia.

ABSTRACT: Air is the source of life for humans, plants and animals. One of the efforts to meet water needs is to use a hydram pump. A hydram pump is a pump that works without requiring external power to activate it, but this work is done by utilizing power from a water source. This study aims to determine the effect of using a pressure divider valve on the discharge of waste water and the discharge of water released by the hydram pump. This study used a hydram pump with the specifications of an air tube with a height of 60 cm and a diameter of 3 inches. The height of the waterfall from the pump body is 2 meters and the output height is 4 meters. The height of the air tube on the pressure divider is 20, 25, 30, 35, 40, 45 and 50 cm. The method used in this research is the experimental method. Quantitative data is made in tabular form and displayed graphically. The results showed that the highest wastewater discharge was 0.238 lt/s when using a tube length of 20 cm at an installation height of 2 meters from the pump body and the highest wastewater discharge was 0.232 lt/s when using a tube length of 50 cm. The highest water discharge that can be pumped is 0.0477 lt/s when a tube length of 20 cm is used. While the lowest water discharge pumped was 0.0398 lt/s occurred when using a tube length of 50 cm.

KEYWORDS: Hydram pump, Pressure divider valve, discharge, waste water

I. INTRODUCTION

The hydram pump is an environmentally friendly water pump which is an appropriate technology in the field of pumping using a water hammer to raise water. A hydram pump is a water pump that does not use fuel and electricity and can work twenty-four hours. The efficiency and effectiveness of the performance of the hydram pump is influenced by many factors including the height of the plunge, the diameter and length of the air tube, the diameter of the pipe, the length of the pipe, and the length of the piston at the waste valve. The existing hydraulic ram pumps have low efficiency, on average, below 20%. Due to the low efficiency of hydram pumps, further research is needed to increase the efficiency of hydram pumps.

Hydram pump with added threaded waste valve to control valve opening and closing. At the same time it reduces the time it takes to build momentum and hammer effect. The results showed that with the improved design, the water loss in the waste valve was reduced by around 20-30% compared to the existing design at a mass flow rate of 0.10 kg/s. The speed and min/max pressure along the pipe have also been increased for open and closed conditions [1]. The valve frequency impulse has a large impact on the hydram pump discharge. When the impulse valve frequency increased from 65 beats/min to 76 beats/minute, it was found that the quantity of wastewater increased by 47.2% but the quantity of useful water decreased by 74.5% [2].

Research on the effect of changes in diameter (1/2, 3/4 and 1 in) on the inlet pipe and three levels of waterfall height (1.9, 1.8 and 1.65 m) was carried out experimentally. The results showed that there was an inverse relationship between the height and outflow rate and the pressure in the vessel had no effect on the outflowing height and rate. In addition, the maximum efficiency is 29% at a tank height of 1.9 m and a diameter of 0.5 [3]. The waste valve mass and lift height affect the efficiency of the hydram pump. The highest hydram pump efficiency in this study was at a lift height of 5 m and a waste valve mass of 1.5 kg of 60.6%. While the lowest hydram pump efficiency occurs at a lift height of 7 m and a waste valve mass of 3.0 kg of 27.1% [4].

The diameter of the waste and delivery valve greatly affects the efficiency of the hydram pump. The highest D'Aubuisson efficiency is 67.66% with a waste valve diameter of 2.75 inches and a delivery valve diameter of 2 inches. The lowest efficiency is 36.14% with a waste valve diameter of 2.25 inches and a delivery valve diameter of 0.6 inches [5]. The spherical delivery valve model has the best efficiency, followed by the membrane, hemispherical and flat delivery valve models [6].

Research on the effect of various installation arrangements on the performance of hydram pumps shows that the higher the plunge, the greater the output discharge produced by the hydram pump. The highest output discharge is at a height of 4.1 meters with the position of the ILK (Input-Waste Valve-

Compressor) arrangement of 0.121 lt/s while the position of the IKL (Input-compressor-waste valve) arrangement is 0.112 lt/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 of the IKL arrangement, the maximum head produced is 12 meters. The greatest efficiency was at a drop height of 3.1 meters with an ILK arrangement of 2.618%, while with an IKL arrangement an efficiency of 2.357% was obtained [7]. The effect of the inlet pipe angle on the performance of the hydram pump is that the highest suction force is 194.1 N at a drop angle of 35° and the smallest is 164.6 N at an angle of 55°. While the biggest thrust is 19.9 N at a drop angle of 35° and the smallest thrust is 17.2 N at an angle of 55° [8].

II. RESEARCH METHODS

The method used in this research is a direct experiment in the field. All variables that are determined and searched for are measured directly except for those variables that must be calculated based on the variable being measured. The hydram pump used in this study has the following specifications: input diameter is 1.5 inches, output diameter is 0.5 inches and the piston stroke at the waste valve is 5 mm, and the compressor tube size is 3 inches in diameter and 24 cm high. The height of the waterfall is 2 meters. The installation height of the pressure divider valve is 2 meters from the pump body. Water lifting height 4 meters.

The variables that will be examined in this study are divided into independent variables and dependent variables.

a. Free Variables

The independent variables in this study are the height of the water falling from the source to the hydram pump in meters (m), the input water discharge in lt/s units and the pump dimensions in mm.

b. Dependent variable

The dependent variable in this study is the discharge of wastewater and pumped water in units of l/s.

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

- High input pressure (H1; drop height) is measured the vertical distance from the water level in the reservoir to the hydram pump. In this study, variations in the length of the pressure divider tube were used, 20, 25, 30, 35, 40, 45 and 50 cm.
- High output pressure 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.

Series of testing equipment

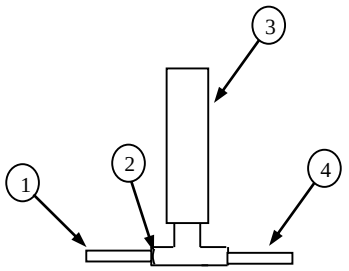

Figure 1. Pressure divider valve. 1. input, 2. check valve, 3. divider tube, 4. output.

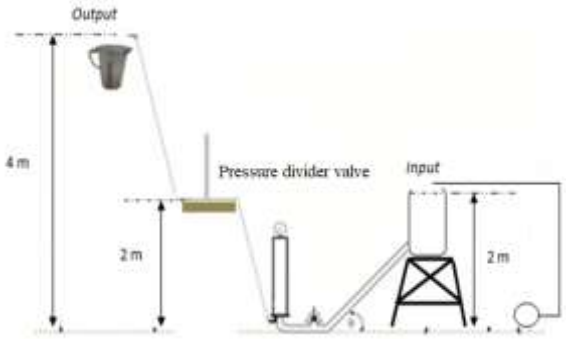

Figure 2. Research scheme for a hydram pump using a pressure divider valve

III. RESULTS AND DISCUSSION

Table 1. Waste water discharge data at various lengths of tube at pressure divider valve

Pressure divider valve tube length (cm)	Wastewater flowrate (lt/s)
No Valve	0.252
20	0.238
25	0.236
30	0.235
35	0.234
40	0.233
45	0.232
50	0.232

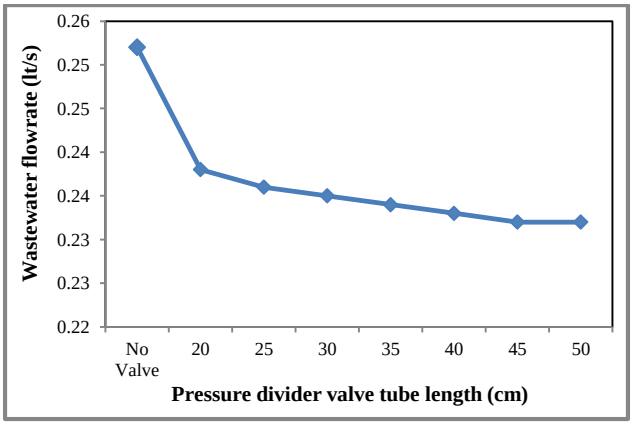

Figure 3. Graph of the relationship between the length of tube at pressure divider valve and the discharge of wastewater.

Fig 3 shows that the tube length at the pressure divider valve is inversely proportional to the achieved waste discharge. The waste discharge is very high in hydram pumps that do not use pressure divider valves. Meanwhile, for hydraulic ram pumps that use a pressure divider valve, the highest waste discharge is 0.238 lt/s when using a tube length of 20 cm at an installation height of 2 meters from the pump body and the lowest waste water discharge is 0.232 lt/s when using a tube length of 50 cm. This happened because in the same treatment where the water discharge entering the pressure divider was the same, the water compressive force was the same and the diameter of the pressure divider tube was the same, the volume of air trapped in the pressure divider air tube was different because the height of the air tube was different as a result the air tube was 20 cm at This study has a higher compression ratio than other air cylinders.

Table 2. Data of pumped water at various lengths of tube at pressure divider valve

Pressure divider valve tube length (cm)	Pumped water flowrate (lt/s)
No Valve	0.0387
20	0.0447
25	0.0441
30	0.0433
35	0.0424
40	0.0413
45	0.0400
50	0.0398

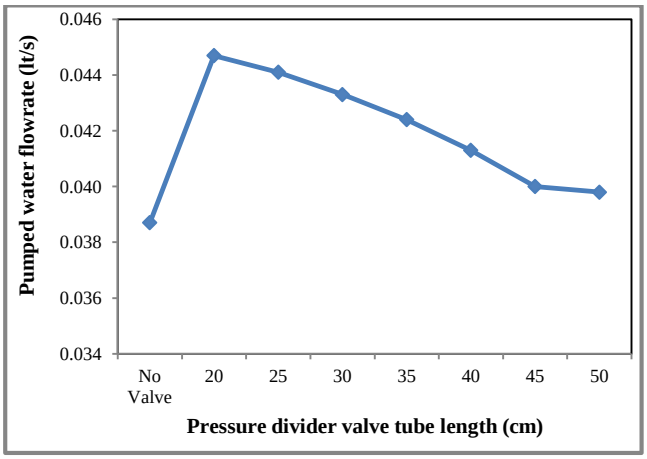

Figure 4. Graph of the relationship between the length of tube at pressure divider valve and the discharge of water being pumped.

Fig 4 shows that the water discharge pumped by the hydram pump is inversely proportional to the length of the pressure divider valve tube. The highest water discharge that can be pumped is 0.0477 lt/s when a tube length of 20 cm is used. While the lowest water discharge pumped was 0.0398 lt/s occurred when using a tube length of 50 cm. This happens because the addition of tube length at the pressure divider valve will actually reduce the pressure at the pressure divider valve at the hydram pump, as a result the resulting discharge will decrease.

Based on Fig 4, it shows the comparison of the discharge of water pumped by a hydram pump without the installation of a pressure divider valve and with the installation of a pressure divider valve. The water discharge pumped by the hydram pump without the installation of a pressure divider is 0.0387 lt/s lower than the hydram pump with the installation of a pressure divider valve. This happens because the hydram pump without the installation of a pressure divider, the water being pumped does not flow continuously. Unlike the case with the installation of a pressure divider on the hydram pump. From observations of hydram pumps with the installation of a pressure divider, the vibrations due to water hammer disappear and the water being pumped flows continuously because of the tube in the pressure divider valve which can stabilize the water discharge so that at the same time the pumped water discharge is greater than the hydram pump without the installation of a divider valve pressure.

CONCLUSIONS

The results of the research it can be concluded that the use of a pressure divider valve has an effect on the water hammer effect. A hydram pump without a pressure divider valve will vibrate quite a bit. While the hydram pump with a pressure divider valve, the vibration of the hydram pump is reduced and the vibration of the vibration pressure divider valve disappears in the output pipe. The use of a pressure divider valve affects the discharge of water being pumped. At the hydram pump without a pressure divider valve, the water discharge pumped is only 0.0387 lt/s. However, with the installation of a pressure divider valve, the pumped water discharge increased, namely the highest, reaching 0.0447 lt/s.

REFERENCES

1. M N Harith, R A Bakar, D Ramasamy, Ma Quanjin. A significant effect on flow analysis & simulation study of improve design hydraulic pump. IOP Conference Series: Materials Science and Engineering, 4th ICMER2017, Swiss Garden Beach Resort, Kuantan, Pahang, Malaysia. 2017; 257. https://iopscience.iop.org/article/10.1088/1757-899X/257/1/012076
2. N. Mishra, Er. Indu Bhusan Bhagat, Yogendra Kumar Jyoti. Effect of water hammering action on performance of hydraulic ram pump. IJSRP. 2018 Dec; 8(12): 396-9. http://dx.doi.org/10.29322/IJSRP.8.12.2018.p8453
3. Hussein T. Dhaiban. Experimental Study The Performance Of Ram Water Pump. EUREKA: Physics and Engineering. 2019; 1: 22-7. doi: https://doi.org/10.21303/2461-4262.2019.00836

4. Muhamad Jafri, Nurhayati, Dominggus G. H. Adoe, Gusnawati. Karakteristik massa katup limbah dan tinggi angkat terhadap efisiensi pompa hidram 3 inci. J Teknik. 2020; 18(2): 91-100. doi : https://doi.org/10.37031/jt.v18i2.131
5. Muhamad Jafri, J. Bale and A. Thei. Experimental study of waste valves and delivery valves diameter effect on the efficiency of 3-inch hydraulic ram pumps. IJFMS. 2020; 13(3): 615-22. doi: https://doi.org/10.5293/IJFMS.2020.13.3.615
6. Made Suarda, I Gusti Bagus Wiajaya Kusuma, Made Sucipta, Ainul Ghurri. Preliminary study on various shaped models of delivery valve in hydraulic ram pump experimental results. IJEET. 2020; 5(1): 43-49. doi: https://doi.org/10.24843/IJEET.2020.v05.i01.p09
7. R. Sutanto, Sujita. Analyses of hydram pump performance on variation of installation on various high waterfalls. IRJAES. 2020; 5(2): 30-2. http://irjaes.com/volume-5-issue-2/
8. R. Sutanto, K. Wardani, M. Wirawan, Salman. Variasi sudut pipa masukan terhadap unjuk kerja pompa hydram. J Dinamika Teknik Mesin. 2019; 9(1): 7-14. doi: https://doi.org/10.29303/dtm.v9i1.250