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ANALYSIS OF HYDRAULIC RAM PUMP PERFORMANCE ON THE EFFECT OF VARIATIONS IN THE DIAMETER OF THE WASTE VALVE HOLE

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Hydram pump, waste valve hole, Head, Output discharge, Efficiency.

ABSTRACT

The hydraulic ram pump is a tool used to raise water from a low place to a higher place using the water hammer principle. The hydraulic ram pump has several advantages, namely it does not require electrical energy or fuel, does not require lubrication, is relatively inexpensive to manufacture and maintain, and is easy to construct. In its application, the efficiency of the hydraulic ram pump still needs to be improved because more water is wasted than the air produced. Therefore, it is necessary to do research to design an effective and efficient hydraulic ram pump. In this study, experiments were carried out to test by varying the length of the input pipe and the diameter of the valve hole on the performance of the hydraulic ram pump. In this research the height of the sink (H) from the water source to the position of the pump holder is 2 meters while the output height (h) 5 meters. The size of a 1 ½-inch hydramm pump designed by the researcher. Diameter input pipe 1 ½ inch, and output ½ inch, while for air tube diameter 3 inch with height 60 cm. As for the length of the input pipe varies from 2 meters, 4 meters, 6 meters, and 8 meters. In this research also used variation of the diameter of the valve sewage hole, ie from ½ inch, ¾ inch, and 1 inch with a step step valve waste 1.5 centimeters. 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.

INTRODUCTION

Water is one of the basic needs that are very important in human life and all living things on this earth. The need for water that is quite a lot often creates new problems, especially for people who live in areas that are far from water sources or springs that are lower than where they live, so to get it requires more severe effort because they have to be lifted from the road that descends to the bottom. uphill road.

[1]. Hydraulic ram is a tool used to raise water from a low place to a higher place automatically with energy that comes from the water itself. Various studies have been conducted to examine the performance of this pump.

[2]. Research on hydraulic ram pumps is to determine the effect of variations in plunge angle on hydraulic ram pump performance. The compressor tube used is a compressor tube with a diameter of 3 inches with a tube height of 60 cm. The height of the waterfall used is 1 m with variations in angles of 350, 400, 450, 500 and 550. The water lift height is varied, namely 3 meters, 3.5 meters, 4 meters, 4.5 meters and 5 meters. The results of this study indicate that the best output water discharge at a plunge angle of 350 is 0.079 lt/s with a water lift of 3 meters, while the lowest output discharge at a plunge angle of 550 is 0.01 lt/s at a water lift

of 5 meters. The best efficiency is at an angle of 350 with a water lift of 3 meters, which is 6.103%, while the lowest efficiency is at an angle of 550 with a water lift of 5 meters, which is 1.2%.

[3]. The study was to determine the effect of the height of the plunge, the volume of the air tube and the height of the discharge on the performance of the hydraulic ram pump. The hydraulic ram pump used is a hydraulic ram pump which has a 1 inch inlet pipe diameter and a 0.5 inch withdrawal pipe diameter. The height of the waterfall was varied, namely 1.5 meters, 1.75 meters, and 2 meters. While the variations in the volume of air used are 0.00024 m3, 0.0028 m3 and 0.0032 m3 and the variations in discharge height are 2.5 meters, 3 meters and 3.5 meters. The results showed that the most optimal results were at a height of 2 meters with a volume variation of 0.0028 m3 of air tube and a discharge height of 2.5 meters, with a discharge capacity of 10.2 lt/minute, volumetric efficiency of 49%, and pump efficiency of 57. %. The results of the analysis in this study indicate that the higher the plunge, the higher the incoming energy, the balance between the incoming pressure and the pressure in the tube causes the delivery valve to open faster so that the discharge capacity also increases.

[4]. Research on the analysis of the effect of the length of the galvanized pipe and the diameter of the valve opening on the pump head on the hydraulic ram pump. By using a variable valve opening diameter and a variable length of the inlet pipe (input) on the hydraulic ram pump, it greatly affects the pump head on the hydram pump. This can be proven by experiments carried out by using valve opening diameters of 0.065 meters, 0.08 meters and 0.1 meters and the length of the input pipe is 18 meters, 24 meters, and 30. The results obtained from the first experiment that is by using a valve opening diameter of 0.065 meters with three variables, namely pipe lengths of 18 meters, 24 m and 30 m, producing the largest water discharge of 6.44 lt/minute and a pump head as high as 156 m, then by experimenting with the diameter of the valve opening. 0.08 m on the three variables produced a discharge of 6.59 lt/minute with a pump head of 166 m, then with the third test using a valve opening diameter of 0.1 m with the three variables producing a water flow of 6.68 lt/minute with a head pump 173 m.

[5]. The greater the plunge angle, the smaller the suction and thrust forces of the hydraulic ram pump. From the results of research on hydraulic ram pumps at a plunge height of 2 m, the largest suction force value is 194.1 N at a plunge angle of 35° and the smallest is 164.6 N at an angle of 55^{o}. While the largest thrust is 19.9 N at a plunge angle of 35^{o} and the smallest thrust is 17.2 N at an angle of 55^{o}.

[6]. Research on hydraulic ram pumps which shows that for every 1 m increase in plunge height, the output discharge will increase on average by 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 hydraulic ram pump. While the highest efficiency is obtained at a height of 2 m and a compressor tube d/h ratio of 0.198, which is 33.98%.

Hydram pump or an abbreviation of the word hydraulic ram which comes from the words hydro (water) and ram (blow/blow) so that it can be interpreted as water pressure. Pump is one type of tool that is able to move liquids from one place to the desired place. One example of these liquids is water, oil and other incompressible liquids. Based on this definition, the hydraulic ram pump can be interpreted as a pump whose energy or driving force comes from the pressure or blow of water entering the pump through the input pipe. Therefore, the entry of water from the water source into the pump must run continuously so that the pump can continue to work. This tool is simple and effective to use in conditions that match the conditions necessary for its operation.

RESEARCH METHODS

The tools used in this research are: Flow meter, Pressure gauge, Measuring cup, Pipe wrench, Wrench 10, 12, 14, 15, and 17., Hammer, Drilling machine, Grinding machine, Welding machine, File, Scissors , Vise, Pliers, Thermometer, Meter, Tank, Weterpass, Laptop, Handpone, Screwdriver, Cutter, Water pump, Match, Grinder, Wrench, Ruler.

The materials used in this study include: Bolts, nuts, rings, seal tape, PVC pipe diameter 1 inch with a length of 8 m, PVC pipe diameter inch with a length of 5 m, pipe connection 1 inch, pipe connection inch, Watermur 1 inch, Pipe glue, 1 inch elastic hose, inch elastic hose, Silicon glue, Iron glue, Water tank with a capacity of 1100 m^3 (diameter 1080 mm with an overall height of 1470 mm), Bucket, Iron plate with a thickness 5 mm, Welding wire, Isamu, Sandpaper, Galvanized pipe t joints with diameters of inch, inch, and 1 inch.

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

a. Independent Variable, The independent variables in this study were the height of the waterfall from the source to the hydraulic ram (H_1) in meters, the input water flowrate (Q_1) in lt/minute or m^3/s and the pump dimensions in mm.
b. Dependent variable, The dependent variable in this study is the suction force and the discharge force

The following is the arrangement of the hydraulic ram pump research test equipment.

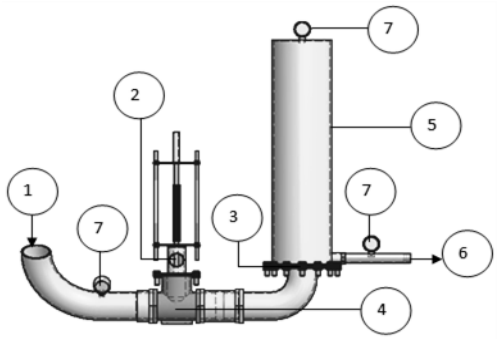

Figure 1. Hydraulic ram pump parts, 1. Input pipe, 2. Waste valve, 3. Delivery valve, 4. Pump body, 5. Air tube, 6. Output pipe, 7.pressure gauge.

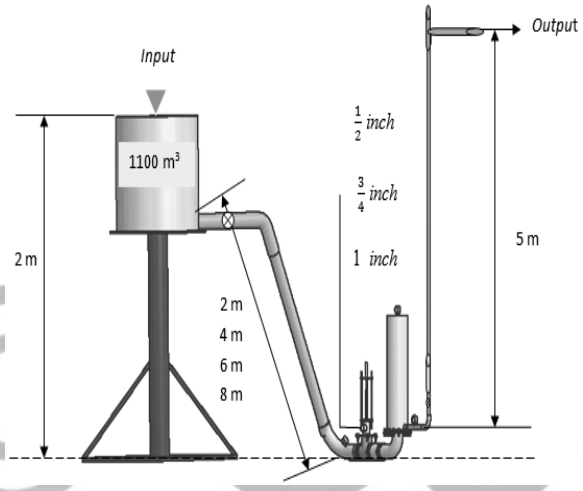

Figure 2. Schematic of research test equipment

RESULTS AND DISCUSSION

In this study, the plunge height (H) from the water source to the pump holder is 2 meters while the output height (h) is 5 meters. The size of the hydraulic ram pump used was 1 inch which was designed by the researcher. The diameter of the input pipe is 1 inch, and the output pipe is inch, while the air tube has a diameter of 3 inches and a height of 60 cm. As for the length of the input pipe, it varies from 2 meters, 4 meters, 6 meters, and 8 meters. In this study also used variations in the diameter of the waste valve hole, namely from inch, inch, and 1 inch with a stroke length of 1.5 centimeters waste valve. The data collection process for output discharge, waste volume, input pressure, tube pressure, output pressure and maximum output pressure was carried out with three repetitions, from the 3 repetitions the average was taken for the results to be used in the calculation. Based on the research that has been done, several data are obtained from calculations such as waste discharge (Qlimbah), input discharge (Qinput), efficiency (η), and maximum pump head (h_{max}).

The performance of the pump that will be analyzed in this research is output discharge (Qoutput), efficiency (η), and maximum head (hmaks) for all variations of the installation of the input pipe length and variations in the diameter of the waste valve hole.

From the results of field research using variations in the length of the input pipe and variations in the diameter of the waste valve hole, the data obtained from the graph above. Figure 3 shows that from each variation of the installation of the input pipe length, the highest output discharge produced is at the input pipe length of 8 meters and 6 meters using a 1 inch waste valve hole diameter, and the smallest output discharge produced occurs in the long installation. 2 meter input pipe using inch waste valve hole diameter. The results of the analysis above can be concluded that the installation of input pipe lengths of 2 meters, 4 meters, 6 meters and 8 meters with a diameter of inch, inch, and 1 inch waste valve holes tends to increase the resulting output discharge.

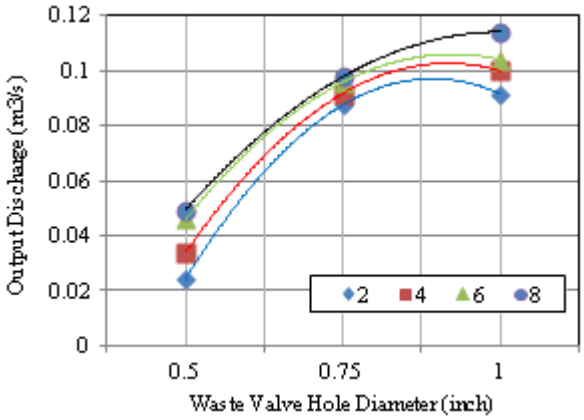

Figure 3. The relationship of variations in the diameter of the waste valve hole to the output discharge at various variations in the length of the input pipe

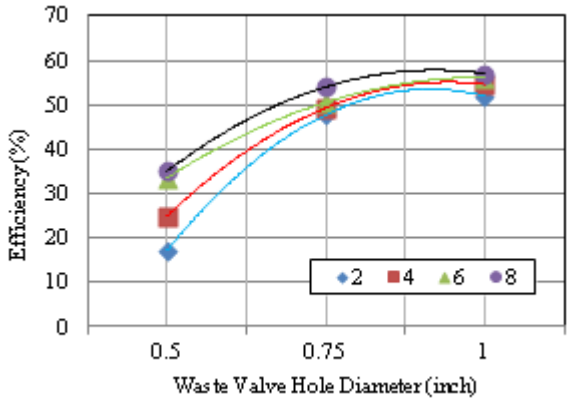

Figure 4. The relationship of variations in the diameter of the waste valve hole to efficiency at various variations in the length of the input pipe

From the results of field research using variations in the length of the input pipe and variations in the diameter of the waste valve hole, the data obtained from the graph above. Figure 4 shows that the greatest efficiency of 57.3% is produced by the input pipe length of 8 meters on the installation of a 1 inch diameter waste valve hole, while the smallest efficiency of 17.2% is obtained from the length of the 2 meter input pipe on the installation of the waste valve hole diameter. inch. However, here it can be seen that the highest and lowest efficiency when viewed from variations in the installation of the diameter of the waste valve hole are shown in the installation of the diameter of the waste valve hole of 1 inch, and inch in each variation of the installation of the length of the input pipe. The amount of efficiency generated at the input pipe length of 8 meters is due to the large output discharge produced. While the smallest efficiency is produced at the input pipe length of 2 meters, this is because the output discharge produced is decreasing. When viewed from the variation of the installation of the waste valve hole diameter, 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. The length of the input pipe and the diameter of the waste valve hole is directly proportional to the output discharge, meaning that the longer and larger the diameter of the waste valve hole in this study, the output discharge tends to increase so that the resulting efficiency will be even greater. In accordance with the efficiency equation of the hydraulic ram pump installation. From the efficiency equation, it can be concluded that an increase in output discharge will result in better hydraulic ram pump efficiency, because the resulting output discharge is directly proportional to the hydram pump efficiency. the greater the output discharge produced, the efficiency of the hydram pump will increase, and vice versa.

In Figure 5 the relationship between the length of the input pipe and the diameter of the waste valve hole to the maximum head of the hydraulic ram pump shows that the maximum head is 19.07 meters at the input pipe length of 6 meters and 8 meters with a diameter of 1 inch waste valve hole, this is because by the output pressure on the 6 meter and 8 meter input pipe is greater than the 2 meter and 4 meter. The amount of pressure on the input pipe causes the pressure on the output pipe to increase as well. While the smallest maximum head is 10.04 meters at the input pipe length of 2 meters with a waste valve hole diameter of inch, this is because the pressure on the output pipe is 2 meters smaller than the length of the other input pipes. The small pressure on the input pipe causes the pressure on the output pipe to also be small. So it can be concluded that the installation of input pipe lengths of

2 meters, 4 meters, 6 meters and 8 meters with a diameter of inch, inch, and 1 inch waste valve holes is directly proportional to the maximum head (hmax). From the equation of the maximum head formula, it shows that the maximum output pressure is directly proportional to the maximum head (hmax). The maximum head (hmax) increases as the maximum output pressure increases.

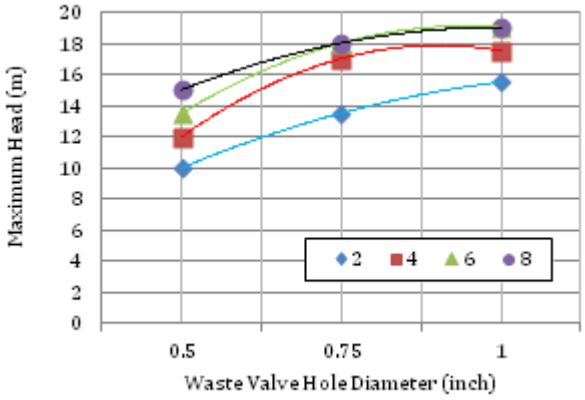

Figure 5. The relationship between variations in the diameter of the waste valve hole to the maximum head at various lengths of the input pipe.

CONCLUSION

The largest output discharge was obtained at the input pipe length of 6 and 8 meters at the 1 inch diameter of the waste valve hole. Thus it can be said that the length of the input pipe and the diameter of the waste valve hole is directly proportional to the resulting output discharge. The longer the input pipe and the larger the diameter of the waste valve hole is directly proportional to the resulting output discharge so that the resulting efficiency increases. The maximum head is the largest at the input pipe length of 6 meters and 8 meters with a diameter of 1 inch waste valve hole, this is because the pressure on the output pipe at the input pipe length of 6 meters and 8 meters by using a waste valve hole diameter of 1 inch is larger if compared to the input pipe lengths of 4 meters and 2 meters. 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.

References

[1]. Hanafie, J., de Longh, H., 1979, Teknologi Pompa Hidraulik Ram, Pusat Teknologi Pembangunan Institut Teknologi Bandung, Bandung.
[2]. Nasution, S. H., 2015, Pengaruh Variasi Sudut Terjunan Terhadap Unjuk Kerja Pompa Hydram (Hydraulic Ram Pump), Universitas Mataram, mataram.
[3]. Sofwan, M., 2015, Pengaruh Ketinggian Terjunan dan Volume Tabung Udara Terhadap Kinerja Pompa Hidram, Universitas Negeri Surabaya, Surabaya.
[4]. Utomo, G. P., Abidin, K., 2015, Analisa Pengaruh Panjang Pipa Galvanis Dan Diameter Bukaan Katup Terhadap Head Pompa Pada Pompa Hidaram, Universitas 17 Agustus 1945 Surabaya, Surabaya.
[5]. Sutanto R., Wardani K., Wirawan M., Salman, 2019, Variasi sudut pipa masukan terhadap unjuk kerja pompa hydram, Jurnal Dinamika Teknik Mesin, 9(1), 7-14.
[6]. Nurchayati, Mulyanto A., Sutanto R., Wardani K., 2017, Pengaruh variasi tinggi terjunan dan dimensi tabung kompresor terhadap unjuk kerja pompa hydram, Jurnal Mesin ITB, 26(2), 91–101.