p-ISSN 2622-2027
e-ISSN 2622-2035

Experimental Test of Hydram Pump Model in Utilization of Artesian Well Water Flow

Bahrul Ulum[1], Syamsul Arifin[2], M. Fathuddin Nur[3]
[1]Gending 1 Probolinggo State Vocational High School
[2] Faculty of Engineering, Billfath University
[3] Faculty of Engineering, PancaMarga University Probolinggo
syamsarifin3@gmail.com

Abstrac- **A hydraulic ram is a device for moving fluid from a lower place to a higher place. Hydram pumps have the same function as pumps in general. The driving energy of the hydraulic ram pump comes from the pressure of the water entering through the suction pipe into the pump. By using the energy of a large enough flow of water at a low place, the water will flow to a higher place with less water flow capacity. The capacity of water flowing to a higher place depends on the difference in pressure between the suction pipe and the pump discharge pipe. The design of the hydraulic ram pump in the form of a model is used to distribute water sourced from artesian wells. The calculation results show that the maximum pump capacity of 2.11 x 10^{-4} m^3/s occurs at the suction valve opening 90° and the discharge valve opening 90°, and the minimum capacity 0.51x10^{-4} m^3/s occurs at the suction valve opening 90° and the discharge valve opening 20 °. The maximum pump head of 4.34 m occurs at 90° suction valve opening and 90° discharge valve opening, and the minimum 1.33 m pump head occurs at 90° suction valve opening and 20° discharge valve opening. The maximum water power of 0.0119 Hp occurs at 90° suction valve opening and 90° discharge valve opening, and the minimum water power occurs at 90° suction valve opening and 20° discharge valve opening.**

Keywords: hydraulic ram pump, capacity, head, and water power.

I. INTRODUCTION

Water is a basic need that is very important for human survival and water is a basic need. Water can be obtained easily in areas adjacent to water sources or located under springs. What if the occupied area is mountainous where it is difficult to get water, although there will be difficulties moving water from the source because the source location is lower than residential areas and agricultural land. If you use an electric pump, you will have to pay a lot of costs such as electricity bills, piping installation and maintenance costs.

The technology of water resources, which are mostly in the form of pumps, is not something new. However, in its use it can minimize costs or can take advantage of the potential of the surrounding nature. The development of the world of technology that utilizes natural potential (especially water and earth's gravity) is commonly called a ram pump. [Muhammad HeriZulfiar, faculty of civil engineering and planning, Muhammadiyah University of Yogyakarta , Feb. 2020, Application of Hydram Pump Technology for the Community].

From the above background, the author wishes to utilize the flow of wasted artesian well water at Gending 1 Probolinggo State Vocational High Schoolin order to test the water pump model without using electricity based on the development of renewable energy known as the hydraulic ram pump. This requires technical expertise in the field of mechanical engineering. Therefore, the Mechanical Engineering Study Program at Billfath University - Lamongan, Panca MargaUniversity - Probolinggo, and Gending 1 Probolinggo State Vocational High School which consists of lecturers and teachers intends to carry out research.

p-ISSN 2622-2027
e-ISSN 2622-2035

Drilling Well (Artesian)

An artesian aquifer is a confined aquifer containing groundwater that will flow upward through a well called an artesian well without needing to be pumped. Water can reach the ground if the natural pressure is high enough, in this case the well is called a flowing artesian well.

2. FLOW CAPACITY

To analyze the amount of water flow capacity that comes out of the discharge pipe and waste valve using V – Notch and Bernoulli equation.

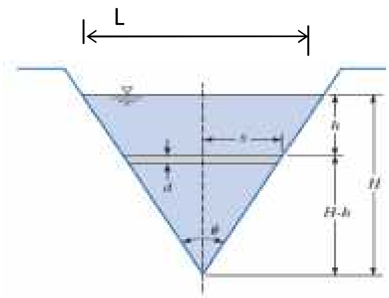

Figure 1: V-Notch Weir

Referring to Figure 1, the rate of discharge through the area element, dA, where H = the height of the liquid above the top of the notch, θ= the angle of the notch, L = the width of the notch, x = the area of the notch, h = the depth is [5].

The velocity at depth h is, and the theoretical discharge is

$$Q_{t} \quad = \int v \quad = \int_0^H v \quad h \text{ ....} (1)$$

With similar triangles x can be connected with h.

$$\frac{x}{H-h} = \frac{L}{H} \text{ ....} (2)$$

After the velocity v is substituted into equation (2), equation (1) becomes:

$$Q_{the} \quad = \frac{4}{1}\sqrt{2g}\,\frac{L}{H}\,H^{5/2} \text{ ....} (3)$$

By expressing L/H as a function of the notch angle θof the V-Notch we get L/2H=tan θ/2 . So that equation (3) becomes:

$$Q_{the} \quad = \frac{8}{1}\sqrt{2g}\,\frac{L}{H}\,H^{5/2} \text{ ....} (4)$$

From equation (4) can be obtained the total actual discharge:

$$Q_{a} \quad = \frac{8}{1}\,C_d\sqrt{2g}\,\frac{L}{H}\,H^{5/2} \text{ ....} (5)$$

Where C_d is the V-Notch Weir coefficient.

Equation (5) can then be used to measure the amount of water flow capacity out of the discharge pipe and waste pipe.

p-ISSN 2622-2027
e-ISSN 2622-2035

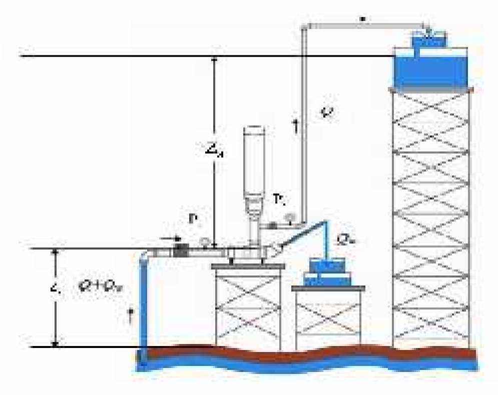

Figure 2: Hydraulic Pump Installation

3. PUMP HEAD

The pump head is the energy per unit weight of the fluid provided by the pump so that the fluid can flow from suction to discharge.
In general, the pump head can be determined using the equation:

$$H_P = \left[\frac{P_d}{\rho} + \frac{v^2}{2g} + z_d\right] + \left[\frac{P_s}{\rho} + \frac{v^2}{2g} + z_s\right] \text{ .... } (6)$$

Where: P_d = discharge pipe pressure (psi); P_s = suction pipe pressure (psi); = density of water (kg/m^3) ; g = acceleration due to gravity (m/s^2) ; z = height (m)

4. WATER POWER

Water power is the energy effectively received by the water from the pump per unit time. The equation for water power is:

$$\dot{W}_h = \rho \quad H_p = Q\,(p_2 - P_1) \text{ .... } (7)$$

where $\dot{W}_h$= Water power (kW) ; Q = Water capacity (m^3/s) ; = density of water (kg/m^3); g = acceleration due to gravity (m/s^2) ; Hp = pump head (m) ; p_1 and p_2 = pump static pressure (Psi)

5. MATERIALS AND METHODS

Research Object

The object of this research is to clarify the hydraulic ram pump model used in the study. The model used is a hydraulic ram pump design and piping installation.

p-ISSN 2622-2027
e-ISSN 2622-2035

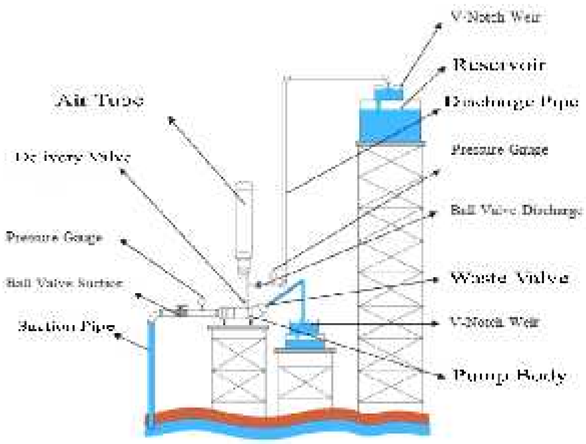

Figure 3: Hydraulic Pump Installation Parts

The equipment used in designing the hydraulic ram pump model are:

1. Pump body diameter 3 in.
2. Dimensions of the sewage pipe with a diameter of in and a length of 0.75 m.
3. Air tube dimensions with a diameter of 4 in and a tube height of 0.985 m
4. Discharge pipe diameter at: 0.5 in hydram pump, 2 in artesian well, and 2 in suction pipe.
5. The length of the discharge pipe from the hydraulic ram pump is 2.03 m, and the length of the suction pipe to the artesian well is 1 m.
6. Pressure gauge is installed on the suction pipe and discharge pipe.
7. The dimensions of the V-notch consist of a notch angle of 60°; notch length 0.45 m ; notch width 0.25 m ; corner distance with a base of 0.05 m.
8. Ruler.
9. Ball valves.
10. Elbow 90°.
11. Water moors.
12. Over shock.

Testing Process

In accordance with the research objectives, namely knowing the work process and calculations on the hydraulic ram pump model. This research was conducted atGending 1 Probolinggo State Vocational High School, and carried out direct observations by carrying out tests.

The test equipment used in designing the hydraulic ram pump model consists of a pump body, waste pipe, air tube, smooth pipe, pressure gage, V – Notch Weir, ruler, ball valve, elbow, water moor, and over shock.

Before carrying out the test, the things that need to be done are:

1. Check the sewage valve and the hydraulic ram pump delivery valve with the aim of whether the valves can work properly.
2. Check the pressure gauge and V-Notch Weir on the discharge side, take the average of the water level measurements on the V-Notch Weir.
3. Inspection of suction pipe and discharge pipe to prevent leakage.
4. Check the pump installation thoroughly whether the installation has any leaks or not.

In this study, it was done by adjusting the valve opening on the suction pipe with a full opening of 90^0 and the waste valve being opened $20^0 \sim 90^0$.

While the steps taken by researchers in order to collect test data are:

p-ISSN 2622-2027
e-ISSN 2622-2035

1. Measure the pressure on the suction pipe and the hydraulic ram pump discharge pipe using a pressure gauge.
2. Measurement of water level at V – Notch Weir in the discharge pipe reservoir and V – Notch Weir in the waste water reservoir.
1. This test was carried out repeatedly with variations in discharge valve openings until data collection for each experiment was carried out.

6. RESULT

Table 1: Calculation Result Data on Ball Valve Suction Opening 90° and variations of discharge valve opening 20° ~ 90°.

Table Result

Discharge valve opening	Exhaust valve capacity . 10^4 [m^3/s]	Discharge capacity.10^4 [m^3/s]	Total capacity.10^4 [m^3/s]	Pump Head [m]	*Water power*.10^4[Hp]
20^0	4.70	0.51	5.21	1.33	9
30^0	4.93	0.64	5.57	1.44	12
40^0	4.93	0.79	5.72	1.60	17
50^0	5.17	0.96	6.13	1.81	23
60^0	5.17	1.15	6.32	2.06	31
70^0	5.17	1.47	6.64	2.59	50
80^0	5.42	1.83	7.25	3.57	86
90^0	5.42	2.11	7.53	4.34	120

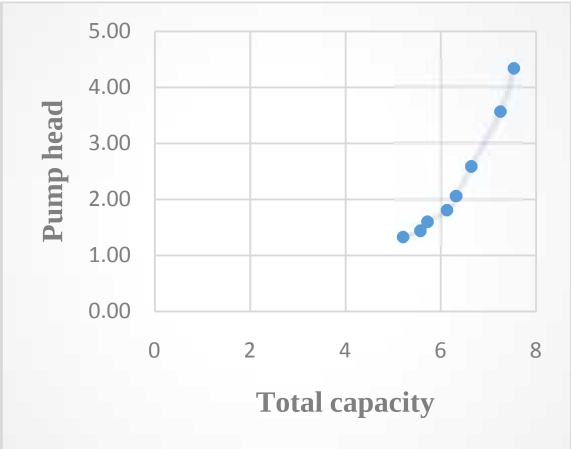

Figure 4: Relationship of pump head and total capacity

p-ISSN 2622-2027
e-ISSN 2622-2035

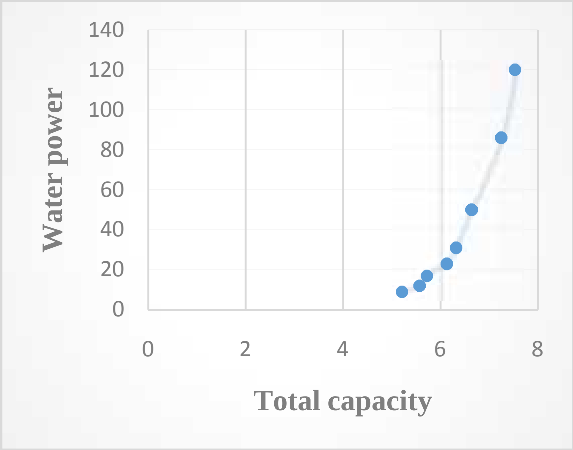

Figure 5: Relationship of water power and total capacity

References

[1]. Asvapoositkul, Wanchai. Dkk. 2019. *Determination of Hydraulic Ram Pump Performance*. Department of Mechanical Engineering. King Mongkut's University of Technnology Thonburi. Bankok. Thailand. Diperoleh 31 Agustus 2021 https://www.researchgate.net/publication/331528770_Determination_of_Hydraulic_Ram_Pump_Performance_Experimental_Results

[2]. Blogspot. (2016, 03 Mei). Kelebihan dan kekurangan pengeboran sumur artesis. Diperoleh 25 April 2018, http://infosumurbormurah.blogspot.co.id/2016/03/kelebihan-dankekurangan-pengeboran.html.

[3]. Edwards Ken, Ph.D., P.E., V Notch Weir discharge ca lculator and equations. Diperoleh 30 Agustus 2021, dari https://www.lmnoeng.com/Weirs/vweir.php

[4]. Facebook. (2012, 1 April). Pompa air tanpa listrik dan tanpa bahan bakar untuk sungai di daerah perbukitan. Diperoleh 22 Februari 2018, dari https://m.fecebook.com/notes/bambang-erbata-kalingga/pompa-airtanpa-listrik-dan-tanpa-bahan-bakar-untuk-sungai-di-daerahperbukitan/101507016040897

[5]. Grygo Dariusz . (2016, 25 Mei). Effect of the height of the delivery water on performance of water ram. Diperoleh 03 April 2018, dari : http://uwm.edu.pl/wnt/technicalsc/tech_19_2/grygo.

[6]. Hussin NSM, etc. 2017. *Design and analysis of hydraulic ram water pumping system.* Diperoleh tanggal 05 September 2021 dari : https://www.researchgate.net/publication/320706730_Design_and_analysis_of_hydraulic_ram_water_pumping_system/citation/download

[7]. Karassik, Igor. J, Messina, Joseph. P, Cooper, Paul, Heald, Charles. C, Pump Handbook, Third edition, Mc Graw-hill, Inc. 2001.

[8]. Matthias Inthachot, Suchard Saehaeng, etc. 2015. *Hydraulic Ram Pumps for Irrigation in Northern Thailand.* Diperoleh tanggal 05 September 2021 dari : https://www.researchgate.net/publication/282363314_Hydraulic_Ram_Pumps_for_Irrigation_in_Northern_Thailad

[9]. Pritchard, Philip. J, Robert W. Fox, Alan T. Mc Donald, Fox and McDonald's Introduction to Fluid Mechanics, 8th Edition, John Wiley & Sons, Inc 2010.

[10]. Streeter, Victor. L, Wylei, E B, Alih bahasa Aryo Priyono M. S. E, Mekanika Fluida, jilid satu, Erlangga. Jakarta, 1988

[11]. Ulum, Bahrul. 2019. " Pengaruh Bukaan Katup pada Pipa Hisap terhadap Kinerja Pompa *Hydram* dengan Memanfaatkan Sumur Artesis" Universitas Panca Marga Probolinggo.

[12]. White, Frank. M. Fluid Mechanics. 5th edition. McGraw-Hill. Inc 2003.