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Modification of Additional Check Valves and Tube Pressure to Enhance Hydram Pump Capacity and Performance for Agricultural Applications

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Abstract: Pump that operates automatically by relying on natural power from water without using great cost and trouble by pumping hydram. Hydram pumps are one of the types of pumps that are driven by kinetic power, it was discovered by a 1796 Montgolfier in Italy. The purpose is to determine the most optimal water speed of the hydram pump by using different numbers of pressure tubes and several check valves. This research uses a factorial Randomised Group Design (RGD) method. The first treatment is valve variation and the second is variation in the number of tubes. The results showed that the average river water flow velocity was 0.154 meters/second with an average water discharge of 2.61 m3/second under normal flow conditions. The average water flow in the intake pipe is 0.717 meters / second and the volume of water in the pipe is 15.19 liters with an average water discharge entering the intake pipe is 10.804 m3 / second. A combination of three valves and three tube treatments consistently produces greater water discharge than other combinations. The highest efficiency of the hydram pump is found in the combination of three checks.

Keywords: Efficiency; Hydram pump; Tube; Water flow

Introduction

Technology for water supply generally uses a hand pump or is driven by an electric motor. A pump is a mechanical device to convert mechanical energy from the engine driving the pump into fluid pressure energy which can help move fluid to a higher place. Currently, technology has been developed that utilizes renewable energy, namely energy that comes from sustainable natural processes. Research on a non-electric hydram pump that is modified by using a smaller diameter with the addition of three valves to raise water from a low place to a higher place automatically with pressure energy originating from the water itself. The addition of three pressure tubes can press the valve which results in the effect Increased water pressure with lower noise levels. Other technologies such as smart farming prototype design aim to monitor data in rice fields by adding pest protection features, and historical data can be captured well and can provide a strong basis for more effective and sustainable development in the field of agricultural cultivation (Hayati, 2022; Lathifah et al., 2024; Nazarudin et al., 2018; Parti et al., 2023; Sanny et al., 2023; Setiawan et al., 2023; Widanti et al., 2024).

Water is natural resources and regulators universal functions is important for life living things

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(Abdulwahid, 2023; Qadri et al., 2019, 2022; Verma et al., 2016). Air is a main element for all forms of life on earth until now (Fairchild et al., 2024; Francl, 2019; Marshall, 2020; Wimmer et al., 2021). Nearly 71 % the surface of the earth is covered by water. Water is a chemical compound the most abundant in nature, however in line with the level of human life, also increased the demand for water (Igwe et al., 2017). Indonesian geographical conditions especially on land have diverse topography covering the plains, hill, the valley, the river, the lake is forming an unity. Regions like this other than being used as settlement lands are also used as farm land. It is difficult to obtain water that is constrained by the distance of water sources, where conditions like these cause people to have to get water by bringing water over and over again with human power for a great need will face the limitations of human ability (Adi & Kamilia, 2023). To address the problem of providing water both for life and for agricultural activities, farms and fisheries especially in rural areas. It can be overcome with the use of mechanical power like pumps. But the use of mechanical power like this pump will face cost issues. Large costs would be very difficult especially for people in rural areas who generally have relatively low income (Khanal et al., 2021).

Pump that operates automatically by relying on natural power from water without using great cost and trouble by pumping hydrams. Hydram pumps are one of the types of pumps that are driven by kinetic power, It was discovered by a 1796 montgolfier in Italy. Hydram pumps are a tool to pump or raise water from low to higher ground in a simple, effective way to work according to technical and operational requirements (Abi Kusuma, 2022; Mahmud & Rahman, 2020; Mbiu et al., 2022; Nurfauzan, 2019; Ockari, 2019). Hydram pumps work without using fuel or energy from the outside. This pump harnesses the power flow that falls from some where and part of it is pumped to higher ground. At various situations, The hydram pumps have advantages compared to the use of other types of pumps, which requires no fuel or extra power from any other source, don't need lubricant, It's a simple form, The cost of making and maintenance is cheap and does not require high engineering skills to make it. This pump works in twenty four hours a day. The effectiveness of the performance of pump hydram influenced several factors, among other high falls water outlet, diameter pipe, a kind of pipe, characteristic of valve waste, a length of pipe inlet and a length of pipe on valve disposal. At the pumps hydram valve divided into valve suction and valve waste. Valve is very important roles in working mechanism hydram pump.

Previous research conducted by Al Qubeissi & Beard (2023); Jain & Patel (2014); Yoga (2023). with the title of the water sources height effect on the efficiency of this research hydrate pump is done to know the efficiency of hydram pumps with a high variation of water resources entering unloaded on the waste valve. Research method through design of hydram pump installation with observation effect of height variation (2 meters, 3 meters and 4 meters). Studies show that the highest efficiency of hydram pumps is 34.05% efficiency at 4 meters and 8 meters in length. The altitude factor of incoming water sources has a profound effect on pumping discharges, discharge the waste, and the efficiency of hydram pumps. Evangelista et al. (2023); Harith et al. (2017); Susana & Sutanto (2016), with the title of a hydram pump efficiency test with variations in the volume of air tubes. It works on the principle of the water hammer on the balance of the exhaust valves and the sink valves so that it can move the water to higher ground. This research was done by experimental methods based on literature studies by doing a variation of the volume of air tubes. The variation of the volume used is volume 330 millimetres, 600 millimetres, 1000 millimetres, 1500 millimetres, and 2000 millimetres. Based on the results of research, it can be concluded that variations in the volume of air tubes have no significant effect on the efficiency of hydram pumps. The design of a hydram pump that produces the best efficiency is a hydram pump with 6 volume air tubes 1500 millimetres with an efficiency of 17.21%. Burhanuddin et al. (2018); Pastirčák & Martinec (2020); Ucok & Mukhtar (2020) entitled designed woke up and the experimental influence variation long driven pipe and diameter of water chamber to pump hydram efficiency.

This study was conducted to obtain influence variation long driven pipe and diameter of hydram pump water chamber of efficiency. Pump hydram used in this study having the diameter pipe driven 1.5 inch pipe 0.5 delivery and diameter of an inch. Variation long driven pipe executed is 8 meters, 10 meters and 12 meters. while variation diameter water chamber executed is 3 inch, and 4 inch. The result showed that maximum efficiency obtained upon variations long driven pipe 8 meters and diameter of 3 inch, water chamber is as much as 37%.

In increasing the pump hydram investigation to find out the water from the most optimal hydram using the number of the pressure and the number of different check valves, the optimal speed water from the pump hydram, discharge and the highest, and capacity hydram pump work.

Method

This study using random design group factorials. The first treatment is a variant valve that consists of three

standard experiment that is one valve, two valves and three valves. The treatment is a variant of the pressure consists of three is a standard experiment, two tubes and three tube, thus there were nine combination treatment by three tests, so acquired twenty-kripseven in a plot trial. Testing the effects of any factor and interactions among the parameter for analysis was conducted using analysis of variant. When a variety of analysis shows the obvious influence between treatment, then analysis passed with the smallest real different test at 5% (Kritikos et al., 2019; Kusnandar et al., 2024; Lin & Hsieh, 2023; Usman et al., 2022). The flow diagram of this research is seen in Figure 1.

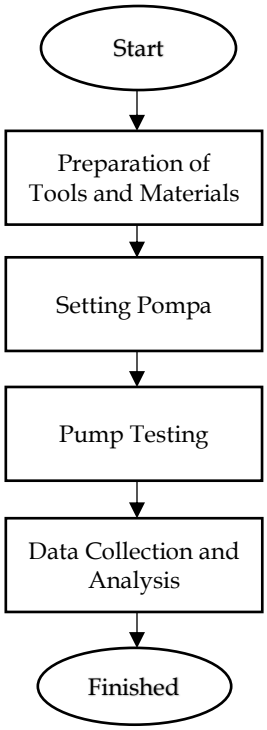

Figure 1. Diagram of This Research

Experimental Design
Parameters of Observation

The measurement of speed and discharge of water intake pipes on the river flow and done to understand the extent to which the system in early performance hydram flow to pump. The measurement of water flow in rivers and the intake conducted to determine the speed of water flow in a pipe hydram pump input. The measurement of the velocity water do by using the method a buoy. The duration of valve beats each treatment performs duration measurements by using stopwatch. Water debit measurements on output pipes are made at a certain altitude and held in buckets for five minutes to know the best working capacity of all treatment and determine hydram pump efficiency (Abduraimova & Ismoilova, 2020; Flórez Otero, 2016; Gamez-Montero et al., 2016; Ji et al., 2020).

Figure 2. Hydram pump data collection

Result and Discussion

The speed and discharge of the river water

Provide a concise and precise description of the experimental results, their interpretation as well as the experimental conclusions that can be drawn. Speed and discharge on pipe intake hydram pumps. The measurements indicate an average rate of river flow of 0.154 meters/second with an average debit of water about 2.61 m^3/second in normal flow conditions.

Speed and discharge on pipe intake hydram pumps

The measurements indicate that the average rate of water flow in the intake pipe is approximately 0.717 meters/second. The water discharge on the intake pipe is calculated by utilizing a measured speed data and a wide viewer of the pipeline. According to calculations, the volume of water in the pipe is 15.19 liters with the average water discharge that goes into the intake is about 10.804 m^3/second.

A time beats check valve in the morning

Research shows a very real impact on the combination of valves and the number of tubes to the duration of the valvet beats produced by hydram pumps at various periods of time: morning, during the day, and afternoon. To test the treatment on a time check valves beats hydram valve at the pumps, researchers conducted statistical analysis using the smallest real difference. The results of the shows that there are considerable very real that occurred in the morning and afternoon.

Figure 3 shows that the treatment of one valve has the fastest knock that in the morning has the duration of 1.85 seconds per beat and at noon has the duration of 1.87 seconds per beat, the treatment of two valves has a slower knock that in the morning has a duration of 3.50 seconds each day and at noon has a duration of 3.26 seconds every beat and treatment of three valves has the

slowest knock that in the morning has the duration of 4.66 seconds per beat and at noon has a duration of 4.62 seconds per beat. Morning and afternoon between the beats does not have the great but beats a in the morning a little more rapidly than during the day, a tube and beats at two and three tube day a little faster. This is in accordance with the statement by (Nur et al., 2021), which states that pump performance increases with increasing cylinders volume. As the exhaust valve load increases, the volume of the fixed tube decreases significantly.

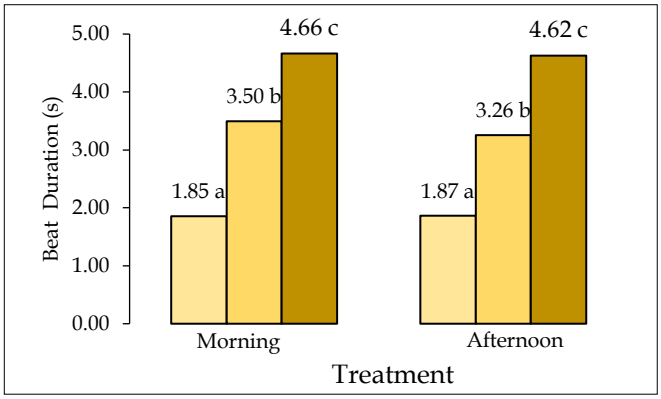

Figure 3. Chart of impact of the number of check valve in the morning and day against the duration of the valve.

A time beats check valve in the afternoon

The results of the shows that there are considerable very real that occurred in the morning and afternoon. To test the effects of the valve and the treatment of the tube against the time span of the check valve on the hydram pump, Researchers do statistical analysis using the smallest real different test. The results of the shows that there are considerable very real treatment occurring in a tube and treatment valve is presented in Figure 4.

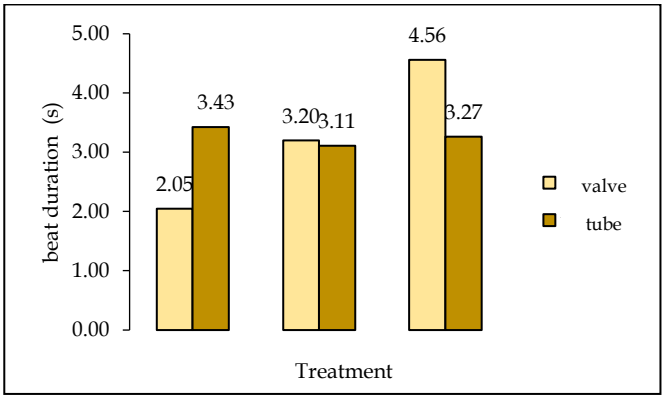

Figure 4. Effect of the check valve and tube to the duration of the check valve beats in the afternoon

Figure 4 shows that in treatment the valve has the fastest knock that has the duration of 2.05 seconds per knock and the treatment of two valves has a slower knock with the duration of 3.20 seconds of each knock, The treatment of three valves has the slowest knock by 4.56 seconds per knock, While at the treatment of one tube slower than two tubes is the duration of 3.26 seconds per beat and treatment of two has the slowest knock of 3.11 seconds per beat and on three tubes have a slower knock of one tube and is faster than three tubes with a duration of 4.62 seconds per beat. This is in accordance with the statement of Mulyadi (2017) which states that the performance of the hydram pump on the difference in distance between the waste valve and the delivery valve has an influence on the pumping discharge so that it affects the efficiency of the hydram pump.

Place height to water speed

Test results show that treatment in the mornings and during the day as a single person has a profound effect on a single person., describes the speed of water between these two periods of time by considering the variety of valves and the size of the pressure tube can be seen in Figure 5.

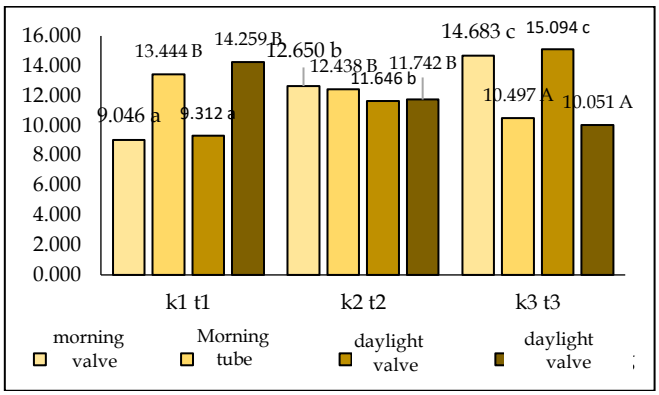

Figure 5. Influence the number of check valves and tubes in the morning and during the day to the speed of water

The Figure 5 shows that of 10 to two that period has the same result as the highest speed rata-rata water occurs in a valve with triplets, while the lowest is rata-rata in combination one valve with three tubes. It appears that the number of valves has a significant effect on the speed of water generated by hydram pumps. This is in accordance with research by Amanda & Fitria (2023), which states that the angle of the inlet pipe and the diameter of the delivery valve influence the amount of wasted water flow and the water flow resulting from pumping, which directly influences the efficiency value of the hydram pump.

The speed of water pumps hydram in the afternoon

The testing shows that treatment in the afternoon had have real impact in combination treatment valve with tubes can be seen in the Figure 6.

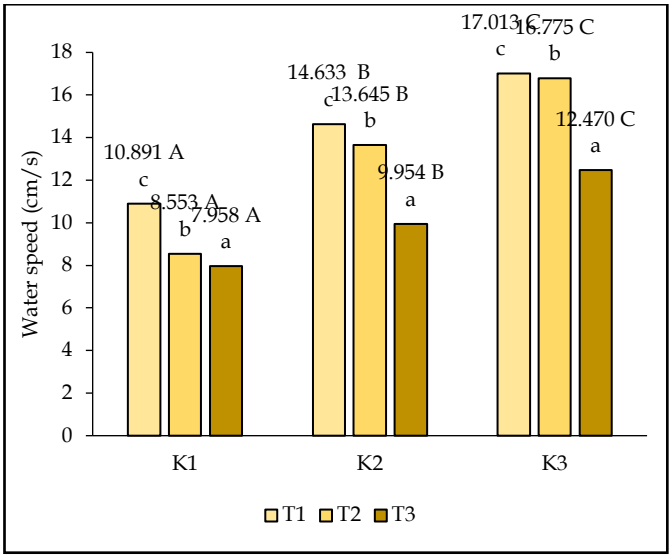

Figure 6. influence the check valves and tubes to speed water in the afternoon

Figure 6 shows that in that period it had the same result that the highest average speed of water occurred in a combination of three valves with one tube, where as the lowest average occurs in a combination of one valve with three tubes. This shows that the number of valves and tube having influence significantly to speed water produced by pumps hydram. This is in accordance with the research results of Koswara et al. (2020) which states that there is an influence of the position of the exhaust valve on the discharge capacity produced by the hydraulic pump and the position of the exhaust valve on the efficiency of the hydraulic pump.

Discharge hydram water pumps in the morning and afternoon

The results of water discharge measurements during periods of the morning and noon show that variations in the number of valve checks and tubes have a significant effect on the performance of hydram pumps in producing water discharges. The results showed that treatment rata-rata discharge of the check valves and tubes more efficient, in those-three-valve with three tubes capable of producing the water debit far higher than other combination. This significant influence can be explained through the operating mechanism of hydram pumps. The number of valve checks and tubes that actually harmonize with the principle of working hydram pumps would create an effective difference in pressure, which in turn generates stronger and more consistent streams of water. Improper combinations can reduce the water flow efficiency and performance of the entire hydram pump. Therefore, the selection of check valve and proper tubes is essential in designing and operating hydram pumps.

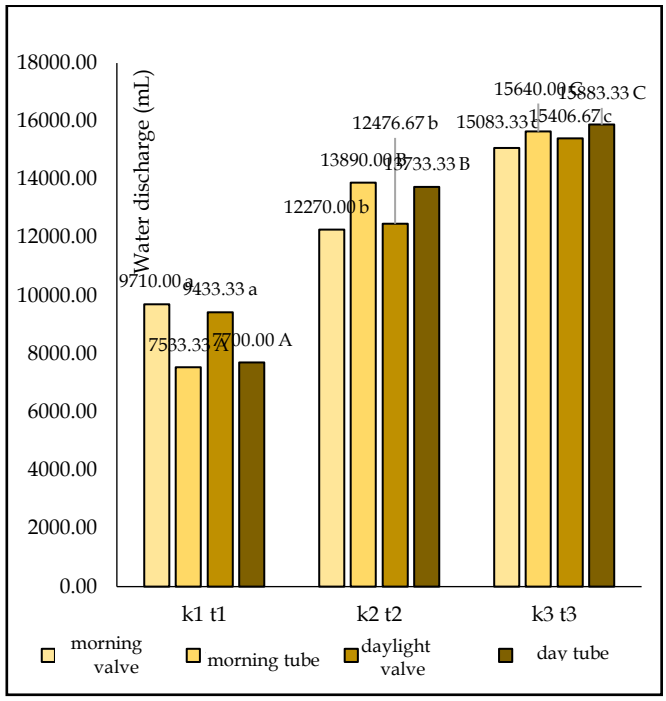

Figure 7. The effect of check valves and tubes on water discharges in the mornings and during the day

Figure 7 shows that the discharge in the morning and afternoon treatments varied, the highest being recorded in the average discharge in the three-valve water treatment with three tubes while the lowest average water discharge results are found in the treatment of one valve with one tube. The results of high-water discharge in the treatment of three valves with three tubes show that it is influenced by the large pressure factor of the valve so that it can produce maximum performance in the morning and afternoon Conversely, the decrease in water discharge in the treatment of one valve with one tube can be caused by low pressure, causing the performance of the hydram pump to decrease (Alrawashdeh et al., 2021; Asli, 2024; Pandey et al., 2022; Wang et al., 2024). Hydram pump work capacity. The working capacity of this pump is found in combination at three valve checks with three tubes is 75.48 liters an hour or equal to 1811.52 liters a day.

This shows that the number of variations valve having influence on essential characteristics flow in hydram pump in the morning and afternoon. This very real influence can be contributed to the main role of the valve check in managing water flow and pressure differences in hydram pump systems. Variations of the number of valves affect flow mechanisms and form

valve beats patterns, which in turn affects the beat range. From this discussion it gives strong confirmation that the treatment of the valve has a significant impact on the time span of the check valve on the hydram pump. Therefore, in designing and operating hydram pump systems, the combination of the number of valve needs careful attention to ensure optimal performance (Januddi et al., 2018; Johanis et al., 2021; Rahman et al., 2023; Tsegaw, 2021).

At a certain volume of water filling in the optimal compression tube, the mass of water and air in the compression tube will press the suction valve to close again, at the same time some of the water comes out through the output pipe. With the closing of both valves, the flow of water in the pump house reverses opposite to the flow of incoming water, followed by the lowering of the discharge valve because the direction of water pressure is no longer to the discharge valve but reverses towards the inlet pipe. This is where the water impact occurs, where the water with the gravitational force of the fall hits the reverse flow, 2/3 of the discharge exits the drain hole, while 1/3 of the discharge pushes the suction valve into the pump tube while pushing the water in the pump tube to come out through the output pipe. The repetitive impact energy flows the water to a higher place (Metra & Credo, 2020; Surbakti, 2018; Sutanto & Sujita, 2022; Utomo et al., 2015).

The duration of the knock on the treatment of one valve, two valves and three valves have significant differences, but on the treatment of one tube, Two tubes and three tubes have no significant difference. Even treatment with one tube has the slowest knock time. Thus it is known that the duration of the valve check knocks has a very real effect on the number of valve checks in which the greater the number of valve checks is then the slower the duration of the knock. While the amount of pressure tubes have no significant effect on the duration of the valve check beats. The large water pressure in the ram is partly reduced by the escape of water into the air tube which functions to flatten the drastic pressure changes in the hydraulic ram through the delivery valve and the pressure pulsation in the tube that returns to the pump will cause suction and closure of the delivery valve which is a unidirectional valve that blocks the return of water into the pump, so that the water in the tube will be pressed out through the delivery pipe (outlet) which drains the water upwards with a certain height. Adjusting the length of the inlet pipe from the reservoir to the exhaust column and the weight of the exhaust valve is expected that the hydram pump can pump optimal water (Fatahi-Alkouhi et al., 2015; Jafri et al., 2020; Prihatin et al., 2022).

The average highest water speed occurs in a combination of three valves and one pressure tube. From this discussion shows that adding valves can increase the rate of water flow. However, keep in mind that the effect of adding valves may be reduced after certain boundaries, that can be observed by comparison with a combination of three valves with two tubes. Is also affected by other factors such as environmental conditions, water temperature, wear and tear equipment. For that reason, important to consider this outcome as a guide early and do more experiments and analysis to understand more complex interaction between the number of valves, a measure of the pressure, and speed water in greater depth.

The higher the outlet pipe, the smaller the discharge will be, this is because the angle of the water slide on the outlet pipe is getting higher so that the pump requires more power to transport water, while the potential energy of the pump in this data is fixed. greater power to transport water, while the potential energy of the pump in this data is still comes from a water source with a predetermined height (Kurniawan et al., 2023; Nur et al., 2021; Nurfauzan et al., 2022; Ridwan et al., 2022). A deep understanding of the impact of this combination on water flow is key to enhancing the efficiency and efficiency of the hydraulic pump. In this condition, the pumping capacity produced by the pump is large, the performance of the hydram pump is also maximum, so the pump efficiency is also maximum. This is because if the water pressure entering the pump body is greater, the waste valve will often close alternately with the suction valve during pumping. This results in water continuing to escape through the waste valve and partially exiting through the discharge pipe (Diwan et al., 2016; Hussin et al., 2017; Kahar, 2017; Nurchayati et al., 2017).

Conclusion

Adding a valve can increase the water flow rate. A combination of three check valves and three tubes consistently produces a greater water flow than other combinations. The highest efficiency of the hydram pump is found in the combination of three check valves with three pressure cylinders of 75.48 liters per hour or the same as 1811.52 liters a day.

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Author Contributions

Conceptualization and design of research work (UH. YA); Implementation of field/laboratory experiments and data collection (MA. YA); Data analysis and interpretation (UH, YA, MA); Manuscript preparation (IH, SA, LM, AK, KN).

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Conflicts of Interest
The authors declare no conflict of interest.

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