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Experimental study on the effect of variations in the mass of the waste exhaust valve ballast and the distance of the waste exhaust valve on the performance of the ram …

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Pengarang Angky Puspawan, Agus Suandi, Yovan Witanto, Agus Nuramal, Nurul Iman Supardi, Emilio Oktori, Ariska Afriansah

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Experimental study on the effect of variations in the mass of the waste exhaust valve ballast and the distance of the waste exhaust valve on the performance of the ram hydraulic pump

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Abstract

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Keywords

Ram hydraulic; mass; distance; performance

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References

Tyler G, Hicks, and Edward, 1996. Pump Usage Technology. Erlangga Publisher, Jakarta.

Orianto, M, and W.A., Pratikto, 1989. Fluid Mechanic 1. BPFE Publisher, Yogyakarta.

Munson, Bruce R., Young, Donald F. and Okiishi, Theodore H., 1994. Fundamental of Fluid Mechanics. John Wiley & Sons Inc., Canada.

Subramnya, K., 1993. Theory and Applications of Fluid Mechanics. Tata McGraw-Hill Publishing Company Limited, New Delhi.

Gerhart, Philip M., and Gross, Richard J., 1985. Fundamental of Fluid Mechanics. Addision-Wesley Publishing Company, USA.

Jehja, Hanafie and De Long, Hans, 1979. Ram Hydraulic Pump Technology. Manual Book for Manufacturing and Installation. Bandung Institute of Tecnology, Bandung.

Panjaitan, Daniel Ortega, and Sitepu, Tekad, 2012. Design of Ram Hydraulic Pump and Testing the Effect of High Variation on Air Tubes and Length of Intake Pipes on Ram Hydraulic Pump Performance. Scientific Journal of the Department of Mechanical Engineering, University of North Sumatra.

Suarda, M., and Wirawan, IKG., 2008. Experimental Study of the Effect of Air Tubes on the Press Head of Hydraulic Pump Ram. Mechanical Engineering Scientific Journal, University of Udayana, Bali.

Mara, Made I, Susanto, Rudi, and S, Fane Didin, 2012. Effect of Compressor Tube Configuration on Ram Hydraulic Pump Performance. Mechanical Engineering Scientific Journal, University of Mataram, Mataram.

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Experimental study on the effect of variations in the mass of the waste exhaust valve ballast and the distance of the waste exhaust valve on the performance of the ram hydraulic pump

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Abstract. One of the most appropriate technologies needed to supply and distribute water is a ram hydraulic pump. The ram hydraulic pump is one type of pump where the driving energy comes from the pressure or impact of the water itself which enters the pump through the conduit pipe. The movement of water coming from the water source in the delivery pipe to the pump must continue to run continuously. The ram hydraulic pump has advantages over other types of water pumps: no lubrication, simple construction, simple manufacture and maintenance. In addition, the pump is able to work 24 hours per day. Two things can affect the efficiency of the ram hydraulic pump, namely the mass of the waste exhaust valve ballast and the distance of the waste exhaust valve. In this study the weight of the waste exhaust valve ballast used varied 61 grams, 71 grams, and 81 grams, at variations in the waste exhaust valve distance of 50 mm, 75 mm, and 100 mm, where the height of the fluid input was constant 1 m, the height of the fluid output was constant 4 m., 1 piece of waste exhaust valve, and 0.0027 m^3 constant air tube volume. From the results of the test, the results of the calculation and the results of the discussion, the highest flow rate value of the hydraulic ram pump is 1.72 liters/minute and the highest efficiency value is 89.11% at the heaviest waste exhaust valve ballast mass 81 grams and at the shortest waste exhaust valve distance 50 mm.

Keywords: Ram hydraulic; mass; distance; performance

1. Introduction

Appropriate Technology is a technology that is used appropriately and efficiently or according to needs. One example of an appropriate technology is the hydraulic ram pump. A hydraulic ram pump is an equipment used to raise and drain water from a lower place to a higher place. The nature of this

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pump works continuously for 24 hours a day by using the water itself as a driving energy without any external energy.

Ram hydraulic pump during operation has an advantage in energy consumption because ram hydraulic pump does not use fuel or electrical energy. This ram hydraulic pump uses water itself as the driving force, of course there are several conditions that must be met so that this ram hydraulic pump is able to work, namely the water source through the input side delivery pipe must be higher than the ram hydraulic pump, this is shown so that water falls so that it can drive the pump. Another condition is that the water discharge at the water source must be constant. This condition is intended so that the exhaust valve can operate continuously. Another requirement is the pipe that conducts the output side of the pump air tube and is higher than the waste exhaust valve.

The ram hydraulic pump is very suitable for use in areas that have abundant water sources and have discharge such as rivers. Not all of the water entering the pump can be raised by the ram hydraulic pump because some of the water will be wasted. A comparison of the amount of water that rises and is wasted concludes the efficiency of the ram hydraulic pump. This has led to a lot of research to improve the efficiency of the ram hydraulic pump. This research is also expected to know the efficiency level of the ram hydraulic pump by varying the mass of the exhaust valve ballast and the distance of the exhaust valve.

2. The pump

The pump is a mechanical device used to move and flow the fluid from one place to another [1]. Pumps are not only used to move fluids but can also be used to increase speed, increase the pressure and height of the fluid [2]-[5].

The pump operates using the principle of creating a pressure difference between the fluid inlet side and the fluid outlet side. This pump functions to convert the mechanical energy from an activator into kinetic energy, in this case, the flow velocity used to flow the fluid. In processes that require very large hydraulic pressure, pumps can also be used, usually this is often found in heavy equipment. The pump has the pump class and type.

In the applications of everyday life, there are many types of pumps, including water pumps, diesel pumps, fuel pumps, ram hydraulic pumps, oil pumps and others. From some of the examples above, the pumps that are very often used by the community are the centrifugal water pumps that people use to raise water from wells or rivers to their homes.

2.1. The ram hydraulic pump

The ram hydraulic pump is an equipment used to raise water from a low place to a higher place automatically with power coming from the water itself [6]. This ram hydraulic pump can work effectively if it matches the criteria that must be met for this pump to work. This pump works based on the water hammer principle where when the water is suddenly stopped, the change in mass momentum of the fluid immediately increases the pressure suddenly, this pressure is used to lift the water to the desired place.

The ram hydraulic pump has several advantages over other pumps including this pump that does not require other external power sources, relatively cheap operating costs, does not require lubrication because the wear rate of these pumps tends to be low, the manufacturing and maintenance costs are easy and cheap are also advantages this pump.

The ram hydraulic pump is able to work a full 24 hours without stopping if all the criteria or conditions are met, including the water discharge condition which must be constant, if the water flow is not constant then it will affect the performance of the water hammer and the pump cannot operate.

2.2. The ram hydraulic pump components

The main components of the ram hydraulic pump are shown in figure 1. The pump house is a place for the pumping process to occur, this section is equipped with a stand so that the pump can stand upright and firmly. While the delivery valve is a valve that delivers water from the pump body to the air tube, this valve serves to hold water that has entered the air tube so it doesn't return to the pump body [7].

One of the core of this ram hydraulic pump is the waste exhaust valve because this is where the water pressure starts to increase until it can flow to a higher place. This valve is also used to remove residual water (waste) that does not enter through the delivery valve. The air tube continues and multiplies the pumping power, so that water entering the air tube can be pumped up as shown in figure 2. Information: a. Head in b. Head output c. Waste of Discharge d. Result of Discharge e. Tube Pressure.

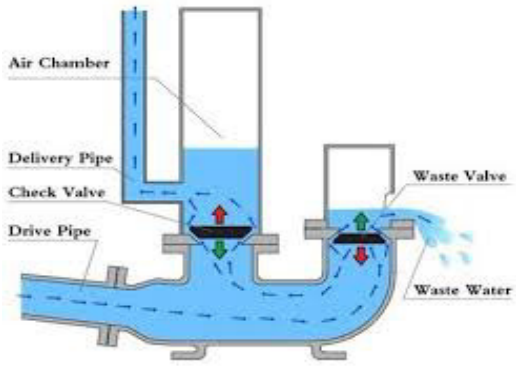

Figure 1. The ram hydraulic pump

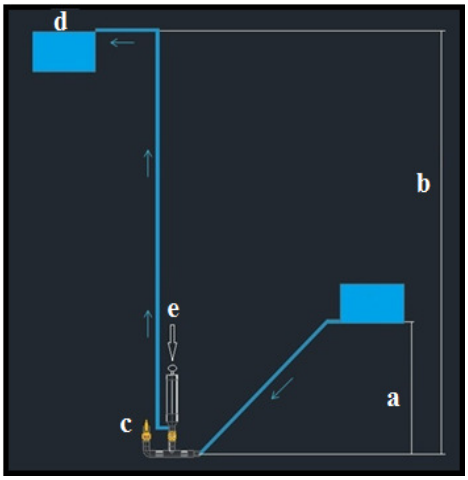

Figure 2. The ram hydraulic components

2.3. Working principle of the ram hydraulic pump

The working principle of the ram hydraulic pump is a process of changing the kinetic energy of water flow into dynamic pressure, this pressure causes a water hammer, causing high pressure in the pipe. In this pump, the waste valve and delivery valve are designed to be able to open and close alternately so that pressure occurs which causes water to rise into the air tube before being passed on to the delivery pipe [8].

The air tube presses the incoming water so that the water can rise at a higher head, before the water enters the air tube the water passes through the one-way valve, the function of this valve is to keep water from returning to the pump body.

2.4. The mechanism of water hammer

The mechanism of the water hammering is when water which has velocity enters through the pipe and pushes the waste valve so that it causes the waste valve to lift, directly if the waste valve is lifted, the valve will close. Closing the waste valve will make the water stop suddenly and cause a pressure head on the water in all directions, at high pressure the delivery valve will open and drain the water from the pump body to the air tube [9].

The pressure on the pump body decreases when water flows in the air tube, causing the waste valve to open again and simultaneously the conveying valve is closed due to the back pressure of the air in the air tube. And on continuously the mechanism of the water hammering.

2.5. The efficiency of the ram hydraulic pump

The efficiency of the ram hydraulic pump can be calculated by the *D'Aubuisson* equation and the *Rankine* equation:

According to *D'Aubuisson*:

$$\eta_A = \frac{q \cdot h}{(q+Q) \cdot H} \; x100\%$$

According to *Rankine*:

$$\eta_R = \frac{q \cdot (h-H)}{(q+Q) \cdot H} \; x\; 100\%$$

Information:

η_A = Efficiency of *D'Aubuisson* (%)

η_R = Efficiency of *Rankine* (%)

q = Yield discharge (m^3/s)

Q = Waste discharge (m^3/s)

h = Output of Head (m)

H = Input of Head (m)

3. Research method

The steps of the flowchart procedure as shown in figure 3.

3.1. Determination of Inlet Pipe Length

Pipe length 4 m and diameter 0.0254 m so: $L/D = \frac{4\,m}{0{,}0245\,m} = 157{,}480$

3.2. Determination of The Diameter of The Conductive Pipe

The output diameter is 0.0127 m, and the inlet pipe diameter is 0.0254 m. Output pipe diameter qualifies:

$$D_{out.} = ½\ D_{in}.$$

3.3. Determination of The Waste Exhaust Valve Ballast Mass

The waste exhaust valve ballast mass variations are 61 grams. 71 grams and 81 grams.

3.4. Determination of The Distance of The Exhaust Valve

The distance of the waste exhaust valve variations are 50 mm, 75 mm and 100 mm.

3.5. Measurement Points

Measurement points are shown in figure 4.

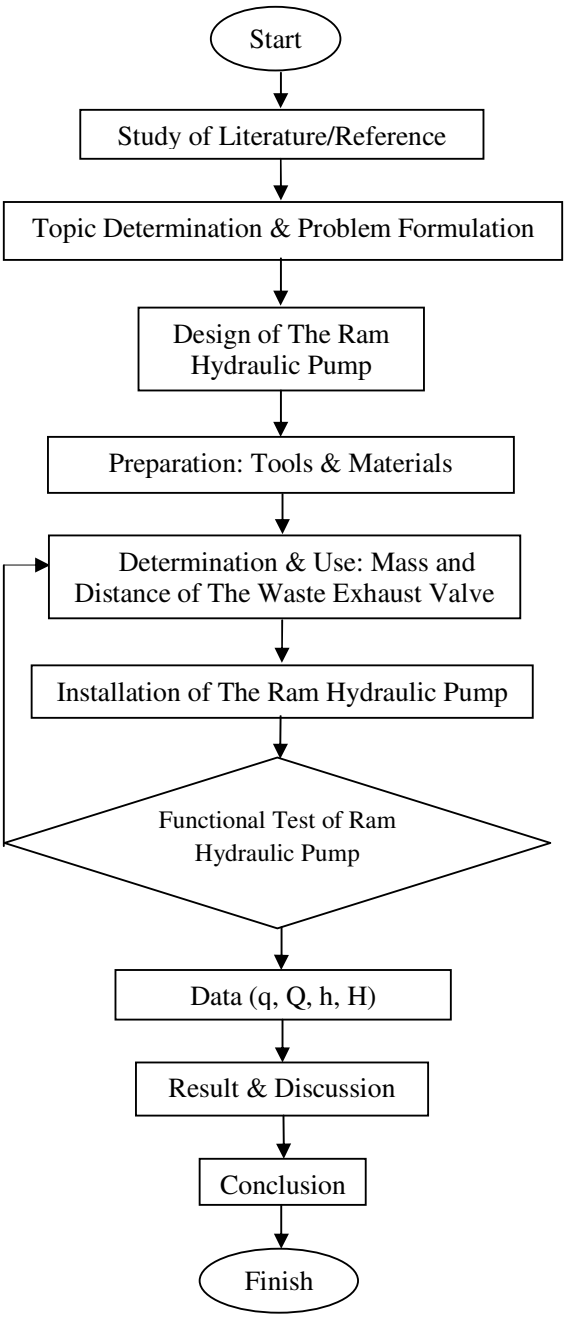

Figure 3. Research Flowchart

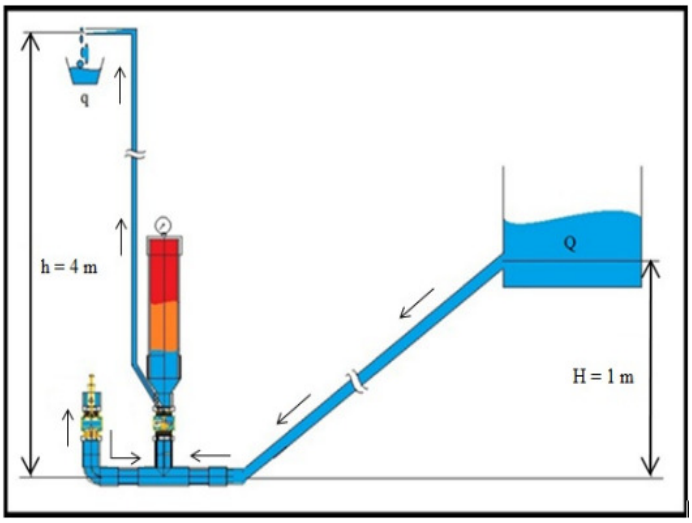

Figure 4. The measurement points

3.6. Research Procedure

In the research procedure, there are several stages that must be carried out, these stages must be in accordance with the sequence, as follows:

1. Prepare the ram hydraulic pump and the entire installation according to predetermined variables.
2. Installing the ram hydraulic pump installation including the inlet pipe, outlet pipe and reservoir.
3. Installing the air tube with the tube volume that has been determined.
4. Installing the waste valve pipe at a predetermined distance.
5. Ensure all installations are installed properly and there are no leaks.
6. Test the ram hydraulic pump by opening the ball valve to allow water to flow, ensuring that the ram hydraulic pump can work properly.
7. Conducting tests to determine the efficiency of the ram hydraulic pump by measuring the waste discharge (Q) and the result discharge (q), the discharge measurement is done using a measuring cup and a stopwatch.
8. Repeating the research procedure by changing the mass of the waste exhaust valve ballast and the distance of the waste exhaust valve according to the provisions.

4. Discussion

The pump that has been flowed with water works as it should, the next process is to wait for the water to reach a head of 4 meters and the resulting discharge is constant, after that data collection is done by measuring the resulting discharge using a measuring cup and the time is calculated using a stopwatch until it reaches 1 minute, the resulting discharge measurement is carried out at the top of the head (4 meters), apart from the yield discharge, the pressure in the air tube is also recorded.

Efficiency is obtained from the average data collection in one variable by getting the yield and waste discharge. Data collection was carried out five times in a variable, this is shown to reduce errors due to fluid flow which changes in fluid density due to the hot sun environment in the ram hydraulic pump testing. Then always ensure the condition of the pump installation at every connection and variable replacement of the pump is installed properly.

After processing the data and the efficiency is obtained from all the hydraulic ram pump variables, the hydraulic pump data is displayed in graphical form to make it easier to analyze and find out the best ram hydraulic pump variables.

4.1. Analysis of mass of waste exhaust valve ballast vs result of discharge (volume flow rate)

Figure 5 shows a graph of the relationship between the mass variation of the exhaust valve ballast and the volume flow rate of the ram hydraulic pump at the variation of the exhaust valve distance. Here it can be explained that the greater the mass of the waste exhaust valve ballast used, the greater the volume flow rate of the ram hydraulic pump produced for all variations of the exhaust valve distance used. This means that the greater the increase in the weight of the exhaust valve ballast in the ram hydraulic pump system, the greater the impact on the volume flow rate obtained in the ram hydraulic pump system.

Broadly speaking, it shows a straight line. From the picture shows a trend line or an upward straight trendline. In this case, what greatly affects the volume of water fluid that can be flowed or better known as the discharge from the ram hydraulic pump is the shortest (closest) waste exhaust valve distance to the pump body with a mass variation of the exhaust valve ballast used, namely with a mass of 61 grams, 71 grams, and 81 grams. Of the three variations of the mass of the exhaust valve ballast used, the highest mass is 81 grams at the closest exhaust valve distance of 50 mm is the best result of the ram hydraulic pump discharge. The greater the rate of increase and decrease in the mass of the exhaust valve ballast for a period of 1 (one) minute, the greater the volume of water fluid discharged (better known as waste discharge) into the environment, the greater the ability of the ram hydraulic pump through the body ram hydraulic pump to drain or distribute fluid volume of water to the reservoir. This is stated to be directly proportional. As well with the use of variations in the mass of the waste exhaust valve ballast, that the greater the mass of the exhaust valve ballast, the greater (enlarge) the ability of the waste exhaust valve frequency, namely the movement of the valve up and down during an interval of 1 (one) minute, so that the greater the discharge. yield or volume of water fluid produced to the container. The best volume flow rate is 1.72 liters/minute when the mass of the exhaust valve ballast is 81 grams and the exhaust valve distance is 50 mm. Broadly speaking, the best flow rate for the exhaust valve ballast variation is at a waste exhaust valve distance of 50 mm.

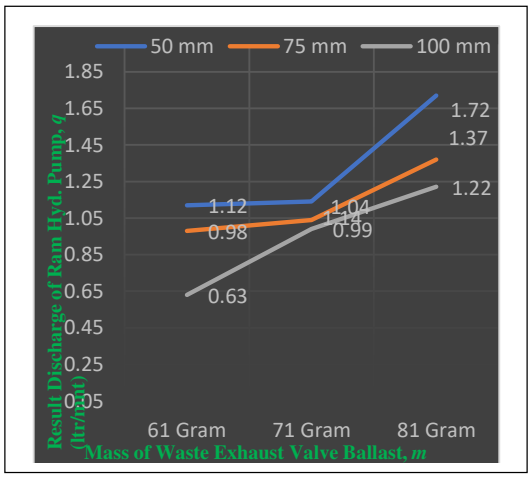

Figure 5. Relationship graph of mass of waste exhaust valve ballast, *m* (grams) vs result discharge (volume flow rate) of ram hydraulic pump, *q* (liters/minute)

4.2. Analysis of mass of waste exhaust valve ballast vs efficiency of ram hydraulic pump

Figure 6 shows a graph of the relationship between the mass variation of the exhaust valve ballast and the efficiency of the ram hydraulic pump under conditions of variations in the exhaust valve distance. Here it can be explained that the greater the mass of the exhaust valve ballast used, the greater the performance (efficiency) of the ram hydraulic pump produced for all variations of the exhaust valve distance used. This means that the greater the mass of the exhaust valve ballast in the ram hydraulic pump system, the greater the impact on the amount of efficiency obtained in the ram hydraulic pump system. This is influenced by that the greater the resulting discharge, it affects the performance (efficiency) of the ram hydraulic pump.

Broadly speaking, it shows a line that is directly proportional. From the picture shows a trend line or an upward straight trendline. In this case, what greatly affects the performance (efficiency) of the hydraulic ram pump is the shortest (closest) distance of the exhaust valve to the pump body with variations in the weight of the exhaust valve ballast used, namely with a mass of 61 grams, 71 grams, and 81 grams. Of the three variations of the weight of the exhaust valve ballast used, the highest mass of 81 grams at the closest distance of 50 mm is the best performance (efficiency) of the ram hydraulic pump.

The conditions of 1 m high fluid input, 4 m high fluid output, 81 grams of waste valve mass, and the shortest exhaust valve distance of 50 mm resulted in the best performance (efficiency) value, namely 89.11%. This means that the best energy from the potential energy of the water fluid at the input height of 1 m and the kinetic energy of the water fluid that enters through the pipe and pushes the waste valve with a distance of 50 mm against the ram hydraulic pump body is lifted, and automatically closes this flow, the water stops. So that it gives rise to optimal water pressure in all directions. With optimal water pressure conditions, the delivery valve opens and water flows from the pump body to the air tube and immediately flows into the reservoir.

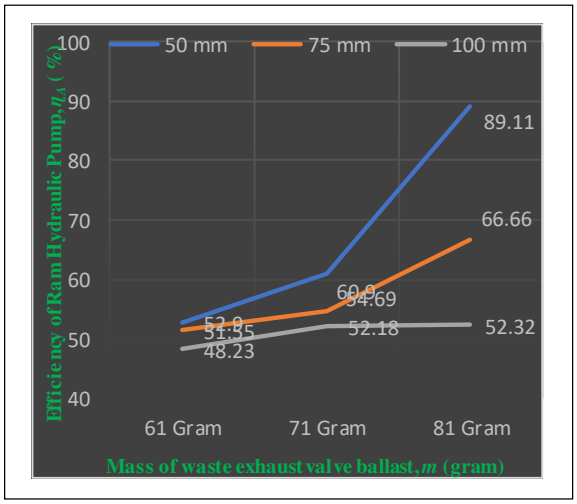

Figure 6. Relationship Graph of Mass of Waste Exhaust Valve Ballast, m (grams) vs Efficiency of Ram Hydraulic Pump, η_A (%)

5. Conclusion

From the results of testing and discussion, it can be concluded that:

1. At a fluid input height of 1 meter, a fluid output height of 4 meters, the number of exhaust valves 1 with a tube volume of 0.0027 m^3 at a pipe diameter of 4 inches, the highest flow rate results

from the ram hydraulic pump are 1.72 liters/minute with the mass of the waste exhaust valve ballast 81 gram and the shortest waste exhaust valve distance of 50 mm.

2. At a fluid input height of 1 meter, a fluid output height of 4 meters, the number of exhaust valves 1 with a tube volume of 0.007 m^3 at a pipe diameter of 4 inches, the highest performance (efficiency) of the ram hydraulic pump is 89.11% with the mass of the waste exhaust valve ballast 81 grams and the shortest waste valve distance of 50 mm.

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References

[1] Tyler G, Hicks, and Edward, 1996. Pump Usage Technology. Erlangga Publisher, Jakarta.

[2] Orianto, M, and W.A., Pratikto, 1989. Fluid Mechanic 1. BPFE Publisher, Yogyakarta.

[3] Munson, Bruce R., Young, Donald F. and Okiishi, Theodore H., 1994. Fundamental of Fluid Mechanics. John Wiley & Sons Inc., Canada.

[4] Subramnya, K., 1993. Theory and Applications of Fluid Mechanics. Tata McGraw-Hill Publishing Company Limited, New Delhi.

[5] Gerhart, Philip M., and Gross, Richard J., 1985. Fundamental of Fluid Mechanics. Addision-Wesley Publishing Company, USA.

[6] Jahja, Hanafie and De Long, Hans, 1979. Ram Hydraulic Pump Technology. Manual Book for Manufacturing and Installation. Bandung Institute of Tecnology, Bandung.

[7] Panjaitan, Daniel Ortega, and Sitepu, Tekad, 2012. Design of Ram Hydraulic Pump and Testing the Effect of High Variation on Air Tubes and Length of Intake Pipes on Ram Hydraulic Pump Performance. Scientific Journal of the Department of Mechanical Engineering, University of North Sumatra.

[8] Suarda, M., and Wirawan, IKG., 2008. Experimental Study of the Effect of Air Tubes on the Press Head of Hydraulic Pump Ram. Mechanical Engineering Scientific Journal, University of Udayana, Bali.

[9] Mara, Made I, Susanto, Rudi, and S, Fane Didin, 2012. Effect of Compressor Tube Configuration on Ram Hydraulic Pump Performance**.** Mechanical Engineering Scientific Journal, University of Mataram, Mataram.