OPTIMUM DELIVERY HEAD FOR THE NEWLY DEVELOPED HYDRAULIC RAM PUMP

Philip Jun S. Celerinos[1]* and Kristine D. Sanchez[2]

[1,2] Mindanao State University - Iligan Institute of Technology, Iligan City, 9200, Philippines

[a]*philipjun.celerinos@g.msuiit.edu.ph*, [b]*kristine.sanchez@g.msuiit.edu.ph*

ABSTRACT

The newly developed hydraulic ram pump was installed in the river source to determine the optimum delivery head in supplying water for small-scale agricultural farming and was monitored twenty-four (24) hours to investigate its actual performance. Results showed that the optimum delivery head could reach up to eight times from the drive head and could continuously provide water up to 600 liters a day. Moreover, the efficiency outputs of the newly developed hydraulic ram pump were also determined. It was found that the average discharge efficiency was 7.49% and the energy efficiency was 66.11%.

INTRODUCTION

In the 2015 report of the World Bank's Water Supply and Sanitation in the Philippines, around 7.5 million out of 94 million Filipinos have no access to water supply facilities, especially the residents living in the highlands with small-scale agricultural farming [1]. Hence, providing water pumping technology that does not require electricity or diesel fuel to the residents in these areas can be helpful in their living conditions. These community residents may use an alternative water pumping technology called the Hydraulic Ram Pump. It is a technology that utilized the potential energy of water received from the elevated source [2]. The energy creates a water hammer effect that pushes a certain amount of water to higher elevations in a periodic operating cycle [3]. It is also continually used in areas with limited electricity, which works as long as the water source is available [4,5]. This research developed a hydraulic ram pump using recycled materials with locally available pipe fittings for small-scale farming.

METHODOLOGY

1. The hydraulic ram pump was developed in SOLIDWORKS Software and was simulated in ANSYS CFX Software to determine the pressure and velocity behavior inside the body. The design has 25mm diameter inflow and 12.5mm diameter outflow as illustrated in Figure 1.

2. The product had 730 mm width and 610 mm high. The materials were composed of 12.5 mm to 25 mm diameters GI and stainless pipe fittings, 25 mm diameter brass-swing and spring check valve, and 20 Liters disposable polycarbonate bottle, as shown in Figure 2.

3. The newly developed hydraulic ram pump was placed in a river source in Brgy. Binasbas, San Isidro, Compostela Valley. It has been observed for 24 hours to determine the total pumped water volume produced in its optimum delivery head and an hourly monitoring whether there were inconsistencies in its behavior.

Figure 1. Product Design in SOLIDWORKS

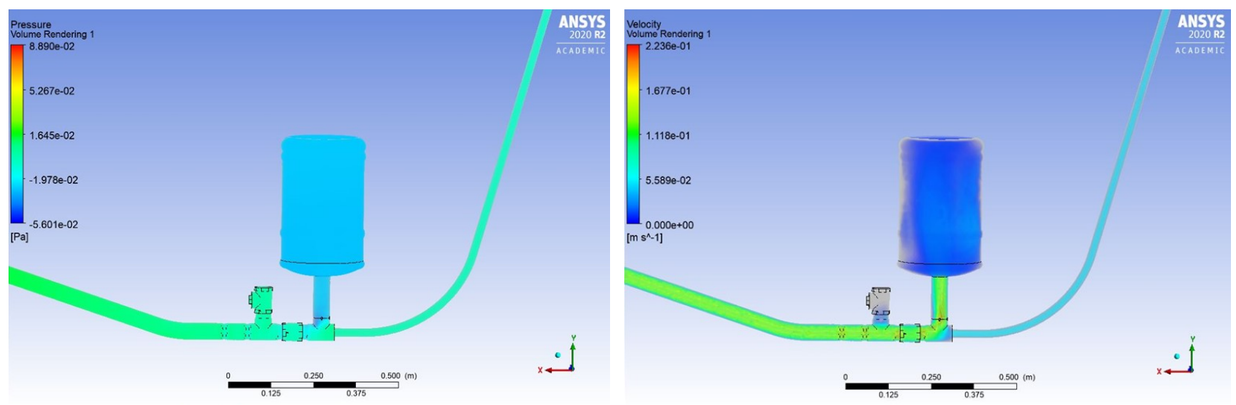
Figure 2. Product Prototype Installed in River-source

4. The performance of ram pump was determined by its obtained efficiencies. These efficiencies were classified by the discharge and energy outputs. The discharge efficiency was measured by its discharged output divided by the discharged input.

5. Lastly, Rankine's equation was used to evaluate the energy efficiency of the newly developed hydraulic ram pump. The energy efficiency was measured by the discharged output times the delivery head, divided by the discharged input times the drive head.

RESULTS AND DISCUSSIONS

In Figure 3, the high pressure and velocity that enters the ram pump body started to drop when the water began to fall down to the moving parts, causing one of the moving parts to close and the other moving parts to open; thus, the water hammer phenomenon occurred, which pushes an amount of water to a certain delivery head. The simulated behavior inferred that the newly developed hydraulic ram pump product was designed effectively.



(a) **(b)**

Figure 3. ANSYS Simulation Result for **(a)** Pressure diagram **(b)** Velocity Diagram

The product was placed in the river source shown in Figure 2. It can deliver water up to 6.18m elevations with 1:8.829 drive pipe head to its delivery pipe head ratio. The calculated average discharge efficiency was 7.49%, and 66.11% for the energy efficiency. It was also observed that there were no fluctuation of pressure occurs, and the ram pump's inlet and outlet provides constant reading during an open and close movement of the swing check valve. In addition, the discharge of water (i.e., input, output and waste) and swing check valve beating counts varies every monitoring because of some unmanageable scenario in site location. It can provide water up to 600 liters a day and was capable to supplying water in small-scale irrigation because according to Infonet-Biovision [6], around 40 to 80 liters of water a day was needed to supply 100 to 200 plants for small-scale agricultural farming.

CONCLUSIONS

This pump is a good alternative for pumps powered by electricity, diesel, or gasoline. It is useful for the community residents living in mountainous areas with small-scale agricultural farming since it can distribute water from the ram body placement up to 6 meters elevation using a 700mm drive head from the river source. The newly developed hydraulic ram pump used cheaper materials that were accessible and mostly available in any hardware, having almost 600 liters of water of its daily output. Therefore, it has less maintenance cost because it can pump an amount of water uninterruptedly.

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