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Mechanical Water Pump Using Double Manifold Tank Hydram

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Abstract:This paper presents a design of Mechanical Water Pump bu using Manifold Tank Hydram. This design had invented after found out of difficulty for farmers to get enough water in the sunny climater. It is a prototype that is used from ground water to dry soil, as a mechanical water pump. The problem statement generates ample pressure for the water to flow from underground to upper ground. The water flow from a spring or a trench into a pipe to create a pressure structure of the hydram principle. There is no additional energy required and the pump works indefinitely, as long as the flow of water decreases constantly. The material chosen for the pump depends on the application, the use of steel pipes is likely to result in the use of virgin polypropylene (PP) or polyvinylidene fluoride (PVDF), as a result of their low cost, strength and heat-resistance, pure water systems. The main aim of this study is to produce mechanical water pump components for a adequate supply of pressure for farmers. The supporting of pump systems requires a significant engineering, design, fabrication and erection effort.

Keywords: Water, Mechanical Water Pump, Hydram, Irrigation.

1. Introduction

Plant farmers are now using rain as a source of water to grow their plants day by day. In dry season, however, the farmers can't get the rainwater because the rainfall in the dry season is very poor and can not supply the plant enough water. During the dry season, farmers would find it difficult to profit from the plantation. But some farmers use electrical water pumps to ensure that their plants receive enough water during the dry season by using electrical water supply pumps. But a high-cost pump was an electric water pump that uses a lot of electric energy. Still today, this is a practice. The problem is the planting of saplings which must always watered, not cover by sprinkling on the regular schedule [1]. The difficulty faced causes delays in dry season crop yields.

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A hydraulic ram (also called hydram) is a pump that uses energy from a falling quantity of water to pump some of it to an elevation much higher than the original level at the source. No other energy is required and as long as there is a continuous flow of falling water, the pump will work continuously and automatically. This makes it a highly useful mechanism for pumping water where there is a large source of available water, such as a river, channel, dam or any other form of reservoir, even if there is no available electricity[2]. Thus, the hydram is completely self sustaining and green in nature. The waste water from the hydram can easily be made to flow back into the reservoir, thus effectively creating zero wastage of water.

The operational efficiency of the hydram is a key factor which needs attention and improvement. Strive to build parameters and relationships which will increase the hydraulic efficiency and promote its implementation. The waste valve is a key component of a hydram, particularly because it creates the pressure surge necessary to carry the water to higher levels [3]. In order to achieve the greatest performance and minimum water wastage, concentrate on designing and optimising the waste valve selected.

Table 1: Ram performance data for a supply of 1 liter/minute liters delivered over 24 hours [4]

Working Fall (m)	Lift - Vertical Height to which Water is Raised Above the Ram (m)											
	5	**7.5**	**10**	**15**	**20**	**30**	**40**	**50**	**60**	**80**	**100**	**125**
1.0	144	77	65	33	29	19.5	12.5					
1.5		135	96.5	70	54	36	19	15				
2.0		220	156	105	79	53	33	25	19.5	12.5		
2.5		280	200	125	100	66	40.5	32.5	24	15.5	12	
3.0			260	180	130	87	65	51	40	27	17.5	12
3.5				215	150	100	75	60	46	31.5	20	14
4.0				255	173	115	86	69	53	36	23	16
5.0				310	236	155	118	94	71.5	50	36	23
6.0					282	185	140	112	93.5	64.5	47.5	34.5
7.0						216	163	130	109	82	60	48
8.0							187	149	125	94	69	55
9.0							212	168	140	105	84	62
10.0							245	187	156	117	93	69
12.0							295	225	187	140	113	83
14.0								265	218	167	132	97
16.0									250	187	150	110
18.0									280	210	169	124
20.0										237	188	140

Components of Hydraulic Ram

One of the main parts of a hydram is the waste valve, primarily because it is responsible for creating the pressure surge which is required to deliver the water to a higher level. Focus upon the design and optimization of the waste valve, in order to obtain maximum efficiency and minimal wastage of supply water. An important factor demanding focus and improvement is the operating efficiency of the hydram. Endeavour to establish parameters and relations that will increase the efficiency of the hydram, which will make it more feasible to be implemented (as mention in **Table 1**).

2. Materials and Methods

The hydraulic ram pump is a simple, motor-less system for pumping water at low flow rates. It uses the flowing water energy to lift water from an elevated storage tank, a pond or trench, or to a discharge point. It is suitable when small amounts of water are needed and electricity supply limited, for example households, gardens or livestock [5].

2.1 Material of Products

Material assemble to create pressure starting using brass swing check valve which function as collector for air mix water pressure. This pressure channeled from pvc pipe to two bottle-shaped collectors as accumulator tank. From here water pressure is sent for watering planting of saplings. Drip irrigation tube can deliver irrigation throughout the main saplings site.

2.2 Methods

The research includes about how to design the product and what material needed to fabricate this research. Finding the most suitable design for the "Mechanical Water Pump". Several sketches have been done and the decision to choose the most suitable design had been decided based on opinion. Full design of the product is sketched including the dimensions. Main body and part component are drawn using Solidwork software. Run Finite Element Analysis (FEA) to predict how the product reacts to fluid flow. All components and equipment needed are listed out. Finding all component for the product and started the measuring process with provided specification according to the main sketches. Assembling process are made by combining every component according to the sketch that were chosen. Testing process is carried out for the product analyzing to ensure that the "Mechanical Water Pump" is functional. Achieving the finding results and making calculation based on analyzing process. The main objective is fabricate an efficient mechanical water pump using double manifold tank hydram.

2.3 Component Design

The research studies the hydraulic ram pump concept which raises water for operation without any external power. The availability of a large volume of water with a reasonable positive head or height is required in order to ensure a satisfactory operation of the hydraulic ram. Large amounts of water are important for raising small amounts of water to higher altitudes. This works concept of the hydraulic ramp principle illustrated step by step in Figure 1. Rubber pipes from the pipeline or reservoir in low altitudes are connected to the supply of water. Rubber pipes from a supply tank or reservoir at low altitudes are connected to the water supply. The water then flows into the drip of the rubber pores. When the water flow reaches its full level, the swing check valve as in Figure 1. Inertia fluid water creates much pressure inside the pump. A second valve is opened by the pressure forces. The high pressure water will flow through the second valve to an air-space pipe that normally allows the transmission pipe to capture as much high-pressure water as possible during the reaction. This reduces the pressure inside the pump and re-opens the first valve so that water can circulate and restore dynamics. Then other valve is shut down and cycle repeated. Comprehensive set-up design prototype shown in **Figure 2**.

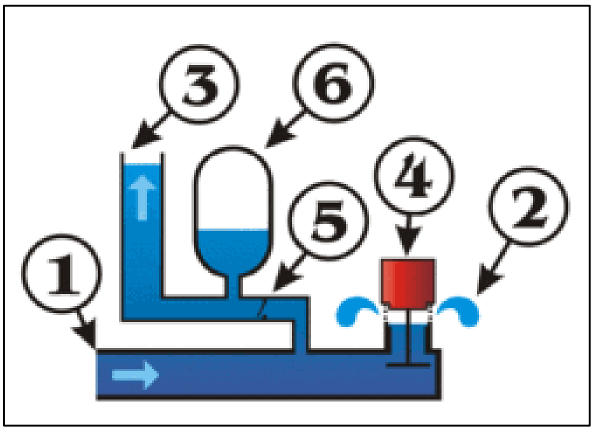

Figure 1: Hydraulic ramp principle

Figure 2: Mechanical water pump prototype

Banana trees need 8-12 litres daily. For at least 500 trees to be grown, a minimum of 4000 to 6000 litres will be needed for large-scale planting. The entire farm, 40 metres from the ground of the water supply, can be fed by a DN32: 1-1/4 Inch (31.75mm) swing check valve (as ilustrated **Figure 3**) to a flow of 6000 litres. Hydraulic ram must be produced at 5 metres in height to form a potential energy linked to gravity. In 24 hours, 118 litres can be watered, which is at least 10 to 15 banana trees in one time. The case study data as indicated by **Table 1** has been taken.

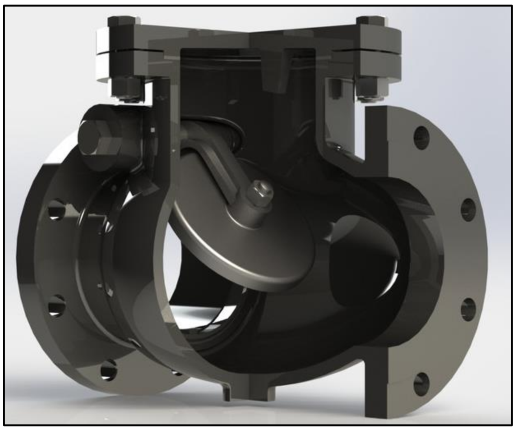

Figure 3: Swing check valve in Solid Work

2.4 Design Analyses

The ram pump basically consists of two moving elements: the momentum and the supply pipes. The structure consists essentially of tube attachments of the correct built dimension. For the construction of a hydraulic ram the key parameter must be taken into account:

- The height difference between the pumping site and water supply (known as vertical fall).
- Big disparity between the pump site and the storage or application paint (life).
- The flow volume (Q) from the source.
- The pipe length from the source to the pumping site is known as the drains pipe.
- The water quantity required.
- Length of a tube called the distribution tube from the storage spot [6].

Since a hydram uses the sudden flux stop in a tube to create a large one. Pressing surge, the drive pipe's volumetric discharge is given by:

$$Q = \pi r^2 l \frac{n}{60} \quad \textbf{Eq. 1}$$

Where, Q = pipe flow rate, r = pipe radius, l = pipe length and n = revolution speed [7].
The flow rate in the driven pipe is also specified as:

$$V_d = \frac{Q}{A_d} \quad \textbf{Eq. 2}$$

Where, V_d = fluid flow velocity and A_d = pipe area [8].

It was intended to assess (whether turbulent or laminar) the nature of the flow. Number of Reynolds required to be determined by:

$$R_e = \frac{V_d}{\upsilon} \quad \textbf{Eq. 3}$$

Where, V = fluid flow rate, d = pipe diameter and υ = film viscosity.

Mathematically the friction factor f can be calculated for laminar flow, but no mathematical relationship is possible with turbulent flow to vary f with Reynolds number. In addition the relative ruggedness (ratio of surface imperfection size to the inside diameter of the pipe) has been found by Nikuradse [10] to affect the value f also.

Blasius [11] proposed this for turbulent flows for smooth pipes.

$$f = \frac{0.316}{R_{e^{0.25}}} \quad \textbf{Eq. 4}$$

Where, f = the pipe friction and R_e is the number of Reynolds.

The Darcy-Wersbach [12] formulation for fluid flow is the basis for determining head loss in drains and pipes and is supplied by:

$$Heat\ loss = f\ \frac{l}{d}\left(\frac{V^2}{2g}\right) \quad \textbf{Eq. 5}$$

where, g = acceleration due to gravity, L = length of the pipe, V= fluid velocity and d = pipe diameter.

The velocity of fluid flow in the T-joint is determined by:

$$V_T = \frac{Q}{A_T} \quad \textbf{Eq. 6}$$

Where Q is the fluid discharge volumetric and A_T equal the T-juncture pipe x sectional area [9]. Loss caused by a sudden expansion of the T-junction as:

$$H_{LT} = \frac{(V_d - V_T)^2}{2g} \quad \textbf{Eq. 7}$$

Other head losses, as is usually expressed in pipe fittings as:

$$H_L = K_T\left(\frac{V^2}{2g}\right) \quad \textbf{Eq. 8}$$

Since head (H) has been used to accelerate water in the driven pipe, this acceleration is achieved as:

$$H = F\left(\frac{l}{D}\right)\left(\frac{V^2}{2g}\right) - \sum\left(K\left(\frac{V^2}{2g}\right)\right) = \left(\frac{l}{D}\right)\left(\frac{dv}{dt}\right) \quad \textbf{Eq. 9}$$

Finally, this flow accelerates enough to start closing the waste valve if the drag and pressure in the water exceeds the mass of the waste volume. Equation of the drag force as:

$$f_d = C_d A_v \rho \frac{V_T}{2g} \quad \textbf{Eq. 10}$$

3. Results and Discussion

The design of the mechanical water pump has two input of water for the system. For the analysis, estimated of velocity is *50 m/s* for each of the input. The velocity of input is depending on the height of the slope. The pressure vessel calculations and fluid flow FEA results as shown in **Figure 4**. Converting the results of a visual medium like FEA to a printed report is always challenging. It is important not to underestimate the challenge involved in writing a report to meet these varying requirements and to meet various reviewers views on what these requirements really mean. It is not unusual for writing the report to take half of the total research time. The pressure of the mechanical water pump is depending on the velocity of input. The higher velocity of the water, the higher pressure in the mechanical water pump. After the fluid flow simulation is done, **Figure 5** shows that the average value of velocity on the output is *89.36 m/s*. It shows that the velocity of water will increase on the output as the water from the system is come from the two-independent system in the mechanical water pump.

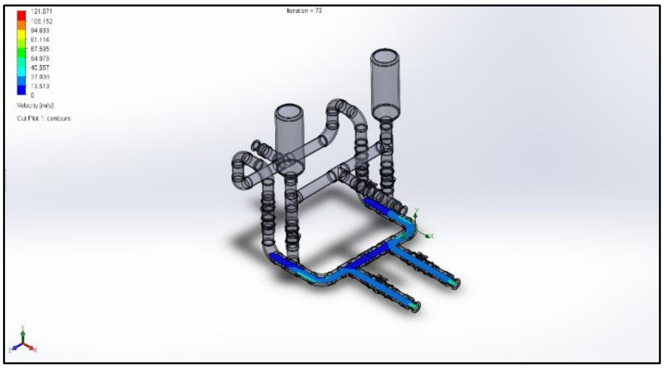

Figure 4: Setup analysis

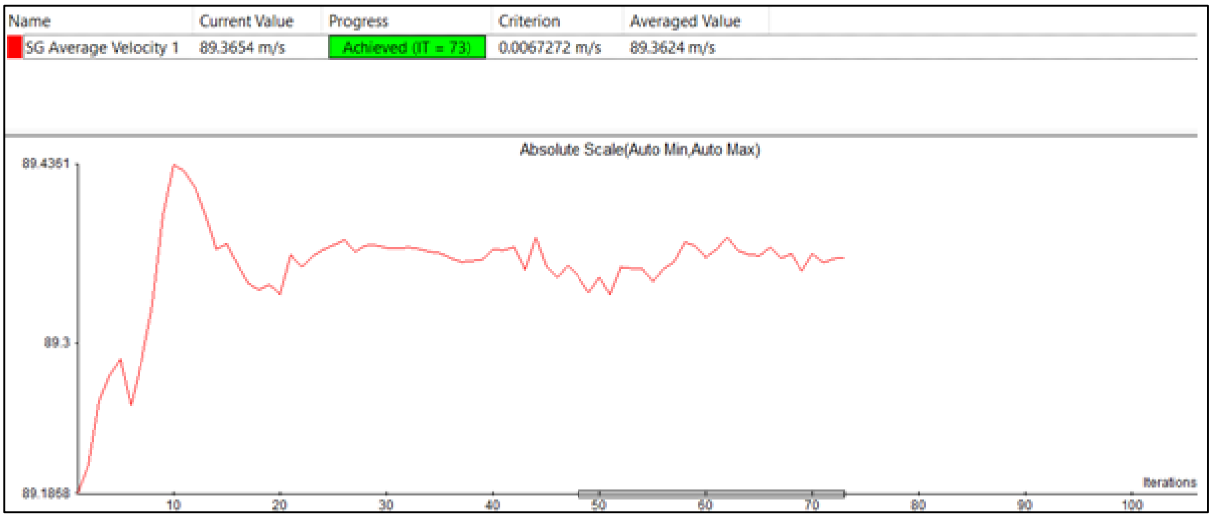

Figure 5: Graph of velocity (m/s) for the output

The velocity of water for the output will increase from the input, it shows that the system can increase the velocity of water even the water on the input is low in velocity. It is useful for a certain situation that does not have enough height of slope for the water entering the system to have a greater velocity of water on the output.

4. Conclusion

In conclusion fabricate an efficient mechanical water pump using double manifold tank hydram achieve. The design process is the main process in this research to make the mechanical water pump succeed. In the other hand, with this design process design that want to be a commercial product that can be use for the farmer for their plantation. However, the design process also can be an introduction to the desired product. Adding more, by this process make the choice for the component and of course the low cost component and the quality component will be the priority for this research to make this water pump can function well and long lasting usage. Next, this water pump system use two independent system output that has greater velocity compare to one output system that give a low result for the velocity for the output flow.

After that, the fabricate process is the process to apply what has been design to produce the desired product and also can show that the product that has been design can function well or else. Beside, the component use also at a minimal cost to make a low cost mechanical water pump for the farmer beside can save energy usage by using free energy. The free energy come from the river flow that can run the system of the water pump and does not use other energy like existed water pump in the market that use electric energy for their engine motor to generate power for their water pump.

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