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Hydraulic Ram Pump as a Water Management System

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Abstract: : *The hydraulic ram pump is an application of the vast branch of engineering known as fluid mechanics one can say that it is a sub study of hydraulics and pneumatics. It uses the principle of compression of air using mechanical systems using the primary component as a non-return valve. It uses a rich source of water like a lake or river which can be located at a long distance to provide water at places of higher altitude and utilize the loss of water to our benefit by the means of irrigation. It is the practical study of an existential problem in our own state hence should get the leverage of industrial production and manufacturing provide as an alternative to the conventional methods of fluid management system and use it as a low-cost mechanism.*

Key Word*: Hydraulic ram pump, irrigation, utilization of water, managing water loss, fluid mechanics*

1. Introduction

The hydraulic ram pump is an application of the vast branch of engineering known as fluid mechanics or applied fluid mechanics systems or to be exact it can be described as a sub study of hydraulics and pneumatics, It uses the principle of compression of air using the main component as a non- return valve It uses a rich source of water like a lake or river which can be situated far away to provide water at places of higher altitude and utilize the loss of water to our benefit by the means of irrigation system. It is the practical study of an existential problem in our own state hence should get the leverage of industrial production and manufacturing provide as an alternative to the conventional methods of fluid management system and use it as a low- cost mechanism. Most importantly it is a component which can be easily adapted to the Indian terrain as many regions face the problems of excessive rainfalls and water management problems. The parts used are standard and the use is not just to lift water efficiently to a particular height but also to manage waste water or excessive water

1.1) Material and Method

Since this project wishes to be cost effective, low maintenance and accessible it uses parts which are standard and are easily available in any hardware or plumbing stores, all dimensions of the assembly are in inches

1.1.1 Tools required:

1. Flat head screw driver
2. Pipe wrench
3. Tool kit for screw fastening
4. Nylon tape
5. Cutting tools for pipe adjustment

1.1.2 Material required:

A. Drive pipe

1. 1-1/4" Pipe of the required length (pvc or steel or Upvc)
2. Screen cloth or hardware cloth

B. Delivery pipe

1. 3/4" Pipe of required length for showing the water lift (flex,steel,PVC or Upvc)

1.1.3 Material required:

C. Hydram

1. 1-1/4" ball valve
2. 1-1/4" * 3/4 " bushing
3. 3/4" PVC union
4. 1-1/4" FTA threaded
5. 1-1/4" metal or PVC T *2
6. 4" * 2ft PVC pipe
7. 1-1/4" PVC union
8. 4" PVC cap
9. 1-1/4" threaded brass check valve
10. PVC cement and primer
11. 3/4" ball valve
12. 3/4" pressure gauge (optional)

1.1.4 Material required:

D. Irrigation system

1. 1-1/4" water sprayer of required length (pvc or steel)
2. Screen or hardware cloth
3 Bucket for collecting water loss
4. Movable nozzle for determining spray efficiency

2) Procedure methodology

The hydraulic ram pump is also easy to construct and assemble as it has very few components and all parts are standard and available in the nearest hardware shops. It was made suitable to rural conditions so that farmers or villagers can avail the components in the simplest manner. The hydraulic Ram pump has very easy assembly and this assembly and it only takes 2 to 3 hours to assemble and only 1 to 1 1/2 hours to disassemble, The whole component and the area of application of the Hydraulic Ram pump should always be near a rich or abundant source of water it can be a primary source or a secondary source but the best source is rivers or Ponds which are continuously flowing it can add to the working pressure in which the delivery pipe is situated so that maximum lift can be achieved.

Step 1: Buy all the material forementioned in the writeup in materials list

Installation Materials

- Clamps,Bricks,Blocks to hold material steady
- Long 1 by $1/4^{th}$ pvc pipe for connecting hydram with water supply
- Hose
- Shower drain for attaching pipe and water supply

Step 2: Buy the all the Required tools for assembly
Build Materials and Tools

- Gloves for safety
- Nylon tape for threaded parts and connections
- Hacksaw for pipe cutting
- Swiss knife for pipe adjustments
- Holding device or Clamps to hold material while working
- Solvent
- Primer

Step 3: Lay Out the assembly structure to know component placement

Step 4: Cut conecting pieces according the assembly structure, the more compact the better ie with a compact assembly higher energy efficiency can be achieved

Step 5 : Apply solvent or adhesive to required parts and join all materials piece by piece

Step 6: Mount a pressure gauge which is an optional assembly only required for calculations

Step 7: Install the Non Return valve as a primary component and Install the pump

Fig. Completed assembly of the Ram Pump

3) Design considerations

Before a hydram can be selected, several design considerations are made ,Which are:

1. The Supply head i.e. the change in head between hydram and water source.
2. The Delivery head i.e. the change in head between hydram and delivery position.
3. The discharge (Qs) from the source of water.
4. The quantity of water supplied in a limited period of time (Qs).
5. The length of Drive pipe.

6. The length of Delivery pipe.

By considering these factors , It is possible to calculate the exact amount of water which can be supplied by the hydram. Which is given by the formula : Ws= (Qs x Fa x Ef)/L Where:

Ws = Amount of water supplied in a day.
Qs = Quantity of water supplied in lit/min.
Fa = The fall or height of the source above the ram in meters.
Ef = Efficiency of the ram pump.
L = Lift in meter of hydram.

1. The source of water can have a steady or laminar flow or it can also be turbulent or unsteady, Therefore in order to find the type of flow we use Reynolds number which is denoted by Re and given by the following formula

$$R_e = \frac{v \times d}{u}$$

Where, V = velocity of the fluid flow, d = Diameter of the pipe and u = kinematic viscosity of the fluid Reynolds number is critical to understand the type of flow inside the pump as if Reynolds no is more than 4001 the flow becomes turbulent which can be the case for a primary source of water like river but for household tank or a small pond it can be below 2001 i.e., a steady or laminar flow can be observed

2. The volumetric discharge which is denoted by Q from the water supply i.e. drive pipe is given by

$$Q = \frac{\pi^2 Ln}{60}$$

Where, Q = volume flow rate through the pipe,
r = Radius of delivery/inlet pipe, L = length of delivery/inlet pipe And n = speed of revolution of device.

3. Velocity of fluid denoted by vd in drive pipe is given by

$$v_d = \frac{Q}{A_d}$$

Where, V_d = Velocity of the flow and A_d = area of the pipe.

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4. The heat loss in pipes is denoted by Hl and given by the following formula

$$Hl = \frac{fL}{D}\left[\frac{v^2}{2g}\right]$$

Where, L = length of Delivery/Supply pipe g = acceleration due to gravity, V= Velocity of the water and d = Diameter of the pipe

There are two types of losses in fluid or water governed systems, They are major losses and minor losses The major loss is due to friction and loss of water but minor losses are considered as other losses which are due to lose connections or other factors and are often neglected

5. The velocity of flow in T shaped pipes or T junction is denoted by Vt and given by the formula

$$v_T = \frac{Q_t}{Ad}$$

Where Qt is discharge at T junction and Ad area at T junction

6. The power required for the water is denoted by P can be calculated by formula

$$p = \rho g Q h$$

Where p is the density of the given fluid or water in our case, h is head achieved, Q is the discharge of water and g is acceleration due to gravity

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2. Result

- From the empirical formulae which are used in the hydram we can calculate the theoretical or expected efficiency
- The efficiency of the hydram can be denoted by Q and found by the following formula

$$E = \frac{Q \times h}{[Q + Qw] \times h}$$

- In the case of hydram unlike the generic fluid systems where efficiency calculated is volumetric efficiency in the ram pump, we calculate energy efficiency which is proportional to the head achieved by the pump.
- For example let us consider the flow rate as 3 lit per min and tank capacity to be 500 liters we get a calculated head of almost 9.1 meters which a is an energy efficiency of almost 60 percent
- The actual efficiency of the hydram is almost up to 50- 58 percent
- Here are certain calculations done with respect to change in efficiency of ram pump with change in parameters
- Like head and capacity of water which are shown below in tabulated manner from which we can conclude that the capacity of water does not have considerable effect on the energy efficiency but the supply head plays a very important role in increasing the efficiency of the hydram

Sr.No	Capacity in liters	Head in meter	Flow of water in meter/min	Efficiency in percentage
1	100	1.5	3	58
2	500	1.5	3	61
3	1000	1.5	3	63
4	2000	1.5	3	64

Table 1. Effect of capacity of water on efficiency of hydram

Sr.No	Capacity in liters	Head in meter	Flow of water in meter/min	Efficiency in percentage
1	500	0.5	3	51
2	500	1	3	57
3	500	1.5	3	61
4	500	2	3	67

Table 2 . Effect of change in head on efficiency of hydram

3. Water management system

Though the ram pump is Installed near a rich and abundant source of water , it faces the problem of water loss through the nonreturn valve. this is a major issue in regard to water management since the management of water in areas with excessive rainfall or water abundant areas is not done with care that's why we need to integrate the water management system into the hydraulic rain pump for a more efficient component which can be practical and pragmatic at the same time to save water or store it.

The water loss in ram pump is almost 40% which seeps into ground and it is stored as natural ground water
But this is not practical in the urban concrete jungle as water seepage doesn't happen or due to plastic and or other debris which stops ground water seepage
This creates floods rains and droughts in different regions of the state
Some other problems arise due to water not percolating to the ground
These other issues include the lowering of water table which is a direct measure for the amount of potable water available for people and also the quality of water which can be considered fit for use .

3.1) Objectives

- Creating waste water suitable for domestic use
- The assembly should be simple and easy to maintain
- Cost of construction should be low
- Material should be standard and available in market at all times
- The project should be affordable to people in rural and rain prone areas

3.2) Procedure for assembly

- Buy all the components forementioned in the thesis
- Buy the necessary tools required for the project
- Cut the container with a hacksaw in a 40;60 ratio
- 40% on the opening and 60% on the closure
- Invert the open side and place it on closed side
- Put the necessary material inside according to specific order
- Insert a plastic tap or valve to regulate flow

4. Conclusion

The following study proves that the hydram is a compact device which is very cheap and easy to assemble which consists of standard components which can be availed from the market. The hydram is a very efficient and capable device which can lift water up to 6 times the supply head. The device can be installed at remote locations and apart from being a pump it can also be used as a water management device. The hydram is most suitable for remote locations where problems of load shedding and cost of electricity supply can be avoided.

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