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THE WATER HAMMER PUMP

Atharva S Dhanwat[*1]

[*1]Student, Department Of Mechanical Engineering, NBNSSOE, Pune, Maharashtra, India.

ABSTRACT

The Hydraulic ram pump or the hydram is a device which is capable of lifting water without electricity which dominates over two major issues in the Indian rural sector of electricity consumption and water management ,The pump also avoids the problem of load shedding which is frequent in the Indian terrain, The pump works on The Water Hammer Principle and the primary component is the non-return valve which creates enough back pressure to produce a gulp effect and lift water up to 60 % efficiency , Making it cheap, efficient and reliable

Keywords: Hydraulic Ram Pump, Water Hammer ,Cheap, Efficient, Electricity Saving, Reliable.

I. INTRODUCTION

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 means using the primary component as a non- return valve The majority of the Indian terrain is not a stranger to frequent rainfalls and floods due to rains at times it can be very dangerous and lethal to human life as well as flora and fauna ,Which if can be managed properly can be beneficial to people for various purposes like potable use ,domestic use and electricity generation. It uses a rich source of water like a lake or river which can be located at a long distance to provide water to places of higher altitude and utilize the water loss to our benefit by the means of irrigation. It is the practical study of an existential problem in any country with water management issues and excessive rainfalls, 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.

II. METHODOLOGY

The assembly of the ram pump is very easy as it is an assembly of standard components which can purchased from the hardware store nearest to you. The entire assembly takes only one to one and a half hours to assemble and only half hour to disassemble. If the pump is structured properly then it can be also used as a water storage device or a separate water storage arrangement can be made by keeping a container below the non-return valve to collect the waste water's more compact is the assembly of the ram pump the more efficient is the performance.

2.1 Material And Method

Since this project aspires to be cost effective and accessible it uses minimalistic parts which are standard and readily available in the local stores

2.1.1 Tools required:

1. Pipe wrenches * 2
2. Flat head screw driver *1
3. Standard tool kit for screw fastening
4. Cutting tools for pipe adjustment
5. White pipe tape

2.1.2 Material required:

A. Drive pipe

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

B. Delivery pipe

1. 3/4" Pipe of required length for completion of hydraulic structure(flex,steel,PVC)

2.1.3 Material required:

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C. Ram pump

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

2.2 Assembly Procedure

Step 1: Buy all the material required for the assembly of hydram

Step 2: Buy the neccessary tools for assembly

Step 3: Lay Out the plan of assembly

Step 4: Cut Your Connecting Pipe Pieces

Step 5 : Apply solvent to neccesary parts

Step 6 : Join material Piece by Piece

Step 7: Optional Pressure Gauge Assembly

Step 8: The Last Piece and most important component should be installed ie Non Return valve

Step 9: Pump Installation

Fig: Completed assembly of Ram pump

III. MODELING AND ANALYSIS

The mathematical modelling of the Hydram can be done by the empirical formulae listed below :

1. The volumetric discharge from the drive pipe is given by

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

Where, Q = volumetric flow rate through the pipe,

r = Radius of drive pipe, L = length of drive pipe And n = speed of revolution.

2. Velocity of fluid in drive pipe

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

Where, V_d = Flow velocity and A_d = area of pipe.

3. The source of water can have a steady or laminar flow or it can also be turbulent or zig zag in order to find the nature of flow we use Reynolds number

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

Where, V = velocity of fluid flow, d = pipe diameter and u = kinematic viscosity.

The type of flow can be found out after calculating the Reynold number because if re is anything less than 100 the flow is laminar i.e.; it is steady but above that it starts to become turbulent and above 4100 it Becomes critical.

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

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

Where, L = length of Delivery pipe g = acceleration due to gravity, V= Velocity of water and d = pipe diameter.

There are two major types of losses in fluid systems those are major losses and minor losses The major loss is due to friction but minor losses are considered as other losses

5. The other or minor losses are given by

For example, loss in joints, connections or fittings

$$Hl = Kt[\frac{v^2}{2g}]$$

6. Pressure at any point is given by

$$P = \frac{F}{A}$$

7. The power required can be calculated by

$$P = pgQh$$

8. The efficiency of the hydram can be found by

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

This is the formula for energy efficiency which is a direct measure for the water lifted by the hydram proportional to the delivery head

IV. RESULTS AND DISCUSSION

1. For theoretical design calculations let us consider a household tank as a water reservoir with capacity = 500 liters per day or 0.3472 liters per minute
2. Let us consider the ram pump situated 1.5 meters below the reservoir
3. Let us assume the flow of water to be 3 liters per minute
4. Efficiency of ram pump is given by

$$E = \frac{Qxh}{(Q+Qw)xH}$$

5. And Fall and Elevation is given by vol(h/H) * efficiency
6. A typical energy efficiency is 60%, but up to 80% is possible. This should not be confused with the volumetric efficiency, which relates the volume of water delivered to total water taken from the source

7. From the above data we know that the theoretical efficiency of the ram pump with and ideal design is 80%
8. So, we can expect the height of water lifted to be 12 meters
9. But in actual it is only 9.3 meters i.e., having 60% efficiency

Table 1. Difference between theoretical and actual calculations

Parameters	Calculated	Actual
Supply head	1.5 meters	2.5 meters
Delivery head	9.3 meters	9.0 meters
Capacity of water	500 liters	2000 liters
Flow rate	3 liter per min	2.3 liter per min
Difference in head	7.8	6.5
Efficiency	61%	57.3 %

From the above displayed table we can conclude that the actual efficiency of the Ram pump is almost equal to the theoretical calculations mentioned in the text.

V. CONCLUSION

After the practical and theoretical conclusions of the above-mentioned report we have come to the following conclusions about the hydram

1. The device is simple to assemble and eliminates the use of electricity to lift water to the required level
2. The device is protected against issues like load shedding or electrical hazards
3. The ram pump has very low maintenance and upkeep
4. The hydram not only acts as a pump but also as a water storage device
5. A separate water management system can be included in the assemble to contain water for domestic or industrial use
6. The efficiency of the assembly is quite high and the cost of assembly is quite low.

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