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# Scope for using underutilized Hydraulic sources a Re-emphasis on the role ofHydram

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**ABSTRACT**
The aim of the project was to construct and design a pump that practically no running cost and needs minimum maintenance, was simple in construction and fulfilled the required specifications. This was to provide isolation village with water and as a replacement to generator driven pumps that are used by farmers to water their lands. So, primary objective of Hydraulic ram pump is to pump water with no running cost. This paper represents the analytical calculation of homemade hydraulic ram pump with design calculation. These are based on a study of hydraulic ram pump and testing of on hydraulic ramp pump model. For which we consider literatures reviews & some of them are used for the analytical calculations. After elaborating the design, dimensioning and calculations were done and the final design was constructed. The model was tested and checked thoroughly for its working. All aspects were kept in view, efficiencies plotted and optimization was done, & analysis of this result to conclude the relation between efficiency, head & discharge which is modify this hydraulic ram pump. It is observed that with the increase of delivery head, delivery discharge is decreases and the efficiency of the pump is decreases. It is also found that when the delivery pipe diameter is decreased compare to supply pipe diameter, the supply head is increases and the efficiency of the Hydram is increases. It is also observed that with the increase of supply head the delivery head is increased and the performance of the pump is increased.Keywords:Hydraulic ram pump, delivery head, supply head, delivery valve and impulsevalve.

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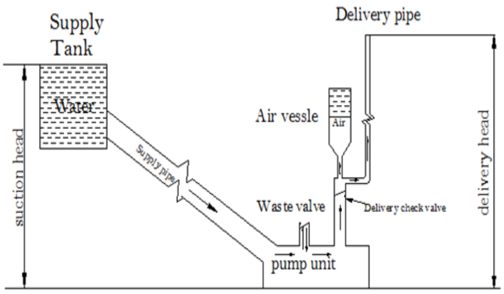
## I. INTRODUCTION

A simplified hydraulic ram the waste valve is open, and the delivery valve is closed. The water in the drive pipe starts to flow under the force of gravity and picks up speed and kinetic energy until it forces the waste valve closed. The momentum of the water flow in the supply pipe against the closed waste valve causes a water hammer that raises the pressure in the pump, opens the delivery valve, and forces some water to flow into the delivery pipe .Because this water is forced uphill through the delivery pipe father than it is falling downhill from the source, the flow slows; when the flow reverses ,the delivery cheek valve closed .If all water flow has stopped ,the loaded waste valve reopens against the now static head , which allows them to begin again.

A pressure vessel containing air cushions the hydraulic pressure shock when the waste valve closed, and it also improves the pumping efficiency by allowing a more constant flow through the delivery pipe. Although, in theory, the pump could work without it, the efficiency would drop drastically and the pump would be subject to extraordinary stresses that could shorten its life considerably. One problem is that the pressurized air will gradually dissolve into the water until none remains .One solution to this problem is to have the air separated from the water by an elastic diagram, however, this solution can be problematic in developing countries where replacement are difficult to procedure. Another solution is to have a mechanism such as shifting valve that automatically inserts a small bubble of air with each pump cycle. Another solution is to insert an inner tube of a car or a bicycle tire into the pressure vessel with some air in it and the valve closed. This tube is in effect the same as diaphragm, but it is implemented with more widely available materials. The air in the tube cushions the shock of the water the same as in the air in other configuration does.

The optimum length of the drive pipe is 5-12 times the vertical distance between the source and the pump, or 500-1000 times the diameter of the delivery pipe, whichever is less. This length of drive pipe typically results in a period of between 1 – 2 pulses. A typical efficiency id 60% but up to 80%is possible the drive pipe is ordinal straight but can be curved or even wound in a spiral. The main requirement is that it be inelastic, strong, and rigid; otherwise, it would greatly diminish the efficiency.




Schematic diagram

## II. XPERIMENTAL SETUP

Components of Hydraulic Ram Pump System are Header Tank, Drive pipe, pump Basement, delivery pipe, pump unit.Pump unit consist of pump body, impulse valve, delivery valve, Air vassal and Sniffer valve.

### 2.1 Header Tank

The header tank has five objectives: To prevent solid elements and air to enter in the Hydram. To continuous flow in the Hydraulic Ram Pump. To allow the water to enter with a high velocity in the Hydram. To resist to external aggressionsand to allow the self-maintenance of the RPS

Picture -1 Header Tank

### 2.2 Drive Pipe

A drive pipe has two objectives, to allow the water entering in the pump body from the headertank with high velocityand to resist to the shocksofthe water hammer effect.

### 2.3 Pump Basement

The functions of the pump basement are:
To hold the Hydram against the shocks of the water hammer effect; and to collect the waste water and to direct it to a targeted location to avoid having a muddy area around the pump and cavitations.

Picture-3 Pump Basement

### 2.4 Delivery Pipe

It needs to be buried to avoid external aggression; the delivery height minimizes the internal diameter of the pipe (i.e. the small diameter creates more head losses) the delivery height also designs the pressure that the pipecan hold and as a consequence, the material of the pipe, andthe route of the pipe must avoid going alternatively upand down and should stay straight as much as possible.

Picture-4 Delivery Pipe

### 2.5 Pump Body

The pump body of a Hydram needs to be robust: it is the centre of the water hammer effect. The ACF design uses a 1-1/4inch GI tee and a 1-1/4inch GI elbow threaded together. It gives three openings:

- One input, the connection to the drive pipe; and
- Two outputs, the connections to the impulse valve and to the delivery valve

Picture- 5 Pump Body

**2.6 Impulse Valve**

The impulse valve is located above the elbow of the pump body. The impulse valve of the ACF design of the Hydram is mainly based on the designfrom the DTU.

It is composed of three components:
The plate;
The plug; and
The locking bolt.

The impulse valve is the part that allows the water to create continuous water hammer effects. The plug needs to be wide enough so that the water pushes it upward. The closure needs to be fast and clear. This is why it is important to guide the plug vertically. Also, it is recommended that the contact surfaces between the plate and the plug are conical: this contact is better than flat surfaces for waterproof purposes. The locking nut is used to stop the plug falling downward. It allows the modification of the length of the stroke of the plug. This option is better than putting simple nuts on the plug. One or two nuts are not enough: they get loose by the continuous hits when the plug goes down. This device makes sure that the length of the stroke staysthe same until further modification during maintenance.

Picture-6 Impulse Valve

**2.7 Delivery Valve**

The delivery valve is located above the tee of the pump body. The delivery valve is a non-return valve: it allows the water to go from the pump body to the air vessel and forbid the water to flow in the opposite direction. When the pressure inside the pump body is higher than the pressure in the air vessel, the valve opens and let the water flows. The delivery valve is made out of three components: The delivery plate; the delivery plug; and the bolt.


Picture-7 Delivery Valve

**2.8 Air Vessel**

The air vessel is located above the delivery valve.The air vessel is a vital component of the Hydram and is visually its main characteristic. Without it, the water coming through the delivery valve would have a great velocity and too much head losses would be created. With the air vessel, the air is slowed down because the air inside the air vessel acts like a spring. The air vessel improves a lot the efficiency of the pump.

Picture-8 Air Vessel

## III. METHODOLOGY

**3.1Sequence of Operation**

**3.11 Sequence I**

Water from the source flow through the drive pipe (A) into the ram pump body, fills it and begins to exit through the waste or "impulse" valve (B). The check valve (C) remains in its normal closed positions by both the attached spring and water pressure in the tank (D) and the delivery pipe (E) (no water in the tank prior to start up). At this starting point there is no pressure in tank (D) and no water is being delivered through exit pipe (E) to the holding tank destination. See Figure 1.

**3.12 Sequence II**

Water entering the pump through the drive pipe (A) has its velocity and pressure being directed out of waste valve (B) as illustrated in Figure 2.

**3.13Sequence III**

Water has stopped flowing through the drive pipe (A) as a "shock wave" created by the "water hammer" travels back up the drive pipe to the settling tank. The waste valve (B) is closed. Air volume in the pressure tank (D) continues expanding to equalize pressure, pushing a small amount of water out of the delivery pipe (E). See the illustration in Figure 3.

**3.14 Sequence IV**

The shock wave reaches the holding tank causing a "gasp" for water in the drive pipe (A). The waste valve (B) opens and the water in the drive pipe (A) flows into the pump and out of the waste valve (B). The check valve (C) remains closed until the air volume in the pressure tank (D) has stabilized and water has stopped flowing out of the delivery pipe (E). At this point sequence 1 begins all over again.

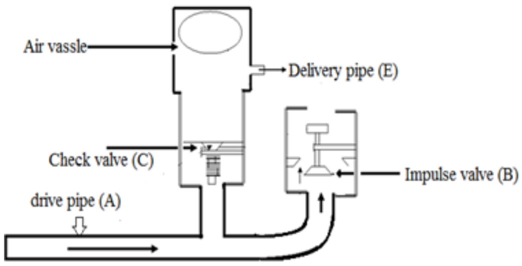



*Figure 1. Hydraulic Ram Sequence I*

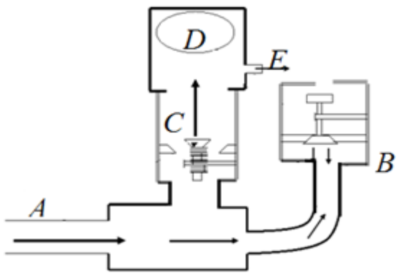



*Fig-2: Hydraulic Ram Sequence II*

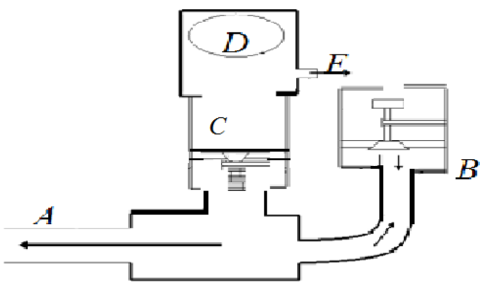



*Fig-3:Hydraulic Ram Sequence III*

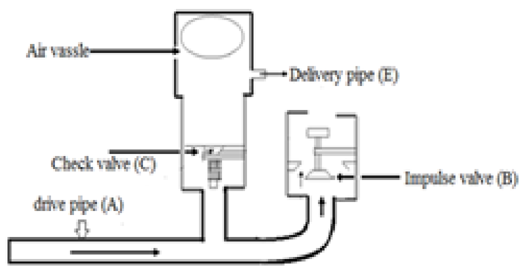



*Fig-4: Hydraulic Ram Sequence IV*

**3.2 Detail Design of present work in Hydraulic Ram Pump**

Table 1`: Design parameters

| SL. No | Drive Pipe Details | Delivery Pipe Details |
|---|---|---|
| 1 | Drive pipe length=19feet | Delivery Pipe length=10feet 8inch |
| 2 | Drive Pipe Diameter=40mm | Delivery Pipe Diameter=15.5mm |
| 3 | Drive Pipe angle =$10^0$ | Delivery Pipe Angle =$90^0$ |

**3.21 Loss of heads in pipe**

The loss of head in the delivery and drive pipe s also a factor in the resistive force of the delivery head. This loss of head is typically in normal pipe selections. This loss can be calculated by various ways. One of which is Darcy formula. The formula for loss of head in the Darcy method is given below;

**Darcy Formula**

$Hf=4flv^2/2gd$ (loss of head in pipe due to fluid friction)

Where,f=0.005[(1+1)/12d] for smooth

f=0.01[(1+1)/12d] for old

Loss due to the entrance=$0.5v^2/2g$

Loss due to exit=$v^2/2g$

**3.22 Flow Rates**

For a circular orifice, the flow rate equation is given by,

$$Q = Cd(1/4\pi D^2)\sqrt{2gh}$$

Where,Q= flow rate

Cd= coefficient of discharge

D=Diameter of the pipe

h=Head acting on the center line

g=Acceleration due to gravity

Typical values for the coefficient of discharge are sharp orifice=0.62

and Tube=0.80

## IV. RESULT & DISCUSSION

### 4.1 Variation of Discharge with Delivery head

A number of experiments were carried out to find out the effect of discharge with the increase of delivery head. The variation of discharge at delivery head are presented in fig.

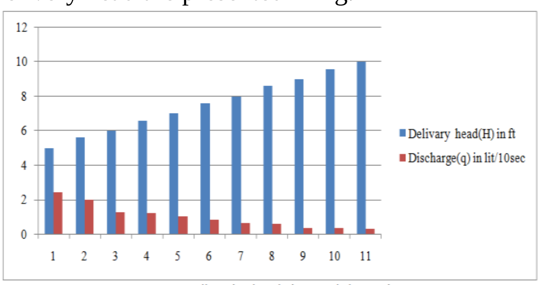



**Figure 5.**Delivery head & Discharge variation graph

### 4.2 Variation of Efficiency of Hydraulic Ram Pump

The Efficiency in term of Discharge is written as,

$$\eta_{D'Aubuisson's} = \frac{qXH}{Qxh} \qquad \eta_{Rankine's} = \frac{q(H-h)}{(Q-q)h}$$

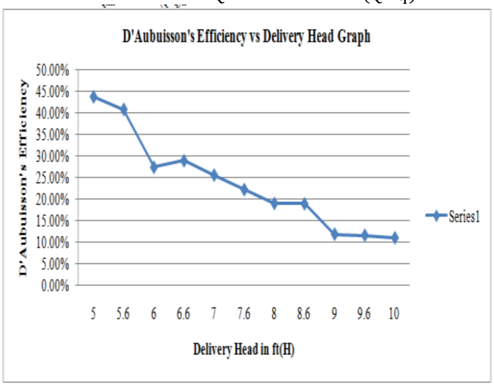



**Figure 6.**Variation of D'Aubusson's Efficiency with respect to Delivery Head

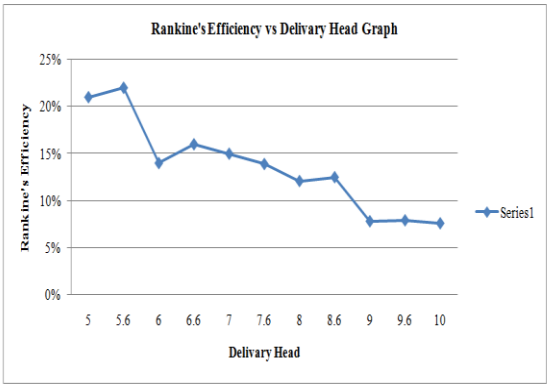



**Figure 7.**Variation of Rankin's Efficiency with respect of Delivery Head

Now, we get the dimensionless quantity in homemade Hydraulic Ram Pump is the ratio of Delivery Head (H) to the Supply Head(h).

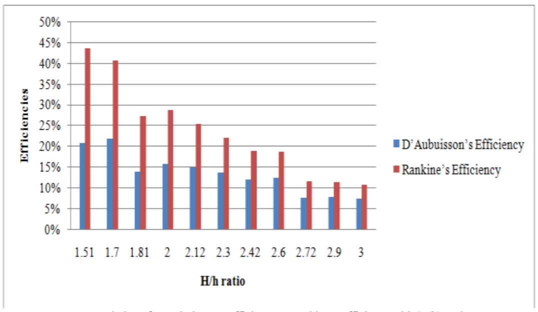



**Figure 8.**Variation of D'Aubuisson's Efficiency & Rankine's Efficiency with (H/h) Ratio.

If we calculate the head loss due to friction (major loss) then effective head $(H_1)=h_f+H$.
So, the various discharge various head loss is occurred and then varies the value of efficiency compare to previous value.
Following table we discussed variation of efficiency with respect to head loss compare to previous efficiency,

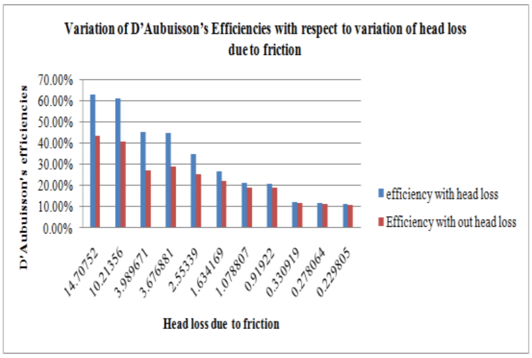



**Figure 9.**Variation of D'Aubuisson's Efficiencies with respect to variation of head loss due to friction Delivery Head

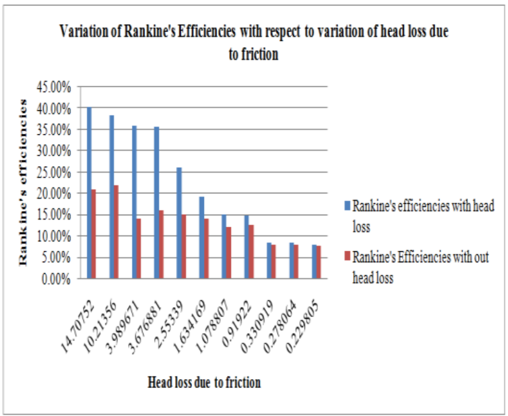



**Figure10.**Variation of Rankin's Efficiency with respect to variation of head loss due to friction

## CONCLUSION

Based on the result is obtain, it can be concluded that

1) With the increase of delivery head the delivery discharge is decreases and the Efficiency of the pump is decreases.
2) When the Head Loss (mainly frictional loss) is considered with the increase of delivery head the efficiency of the Hydram is increased.
3) If the delivery pipe diameter is decreased compare to supply pipe diameter, the supply head is increases and the Efficiency of the Hydram is increases.
4) With the increase of supply head delivery head is increases and the performance of the pump is also increases.

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