**DESIGN AND MODELING OF HYDRAULIC RAM PUMP**

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**ABSTRACT:**

The removal of water from well, rivers and lakes by the use of an electric motor and pipes for domestic purpose and agricultural use is an common scenario in day to day life. Considering the fact following investigation was done and advantages of using hydraulic ram pump for drawing water from rivers and wells was examined. Many drawbacks where seen in the traditional method of drawing water, some of them includes non-availability of power, requires human efforts, money required for the maintenance, etc. Above drawbacks can be successfully overcome by using hydraulic ram pump which have an advantage like no consumption of any energy (electricity) for carrying out work, requires less maintenance, continuous work output, pollution free, etc. Keeping this in minddifferent aspect of designing a hydraulic-ram pump system is discussed to get results for varying conditions.

**INTRODUCTION:**

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. Noother energy is required and as long as there is a continuous flow of falling water, the pump will work continuously and automatically. Provision of adequate domestic water supply for scattered rural populations is a major problem in many developing countries. Fuel and maintenance costs to operate conventional pumping systems are becoming prohibitive. The hydraulic ram pump (Hydram) is an alternative pumping device that is relatively simple technology that uses renewable energy, and is durable. The hydram has only to moving parts and can be easily maintained.

**AIM AND OBJECTIVES:**

* To make study of design and working of existing hydram installations.
* Detail study of principle working of hydram.
* To study effect of various parameters with respect to behaviour of ram pump.
* Detailed design to check the performance parameters related with hydram.

**PRACTICAL ASPECT OF DESIGN FACTORS:**

The ram pump consists essentially of two moving parts, the impulse and delivery valves. The construction, basically consist of pipe fittings of suitable designed size. The main parameters to be considered in designing a hydraulic ram include:

* Drive pipe length (L)
* Drive pipe diameter (D)
* Quantity (Q) of flow available.
* Supply head (H);
* Delivery head (h);
* Friction head loss in the drive pipe;
* Friction head loss through the waste valve;
* Size of the air chamber.

**OPERATION PRINCIPLE:**

The energy required to make a Ram lift water to a higher elevation comes from water falling downhill due to gravity. As in all other water powered devices, but unlike a water wheel or turbine, the ram uses the inertia of moving part rather than water pressure and operates in a cycle based on the following sequences.

**SEQUENCE 1:**

Water from the source flows through the drive pipe (A) into the ram pump body, fillsit and begins to exit through the waste or “impetus” valve (B). The Check Valve (C) remains in its normally closed position by both the attached (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

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**sequence 1**

**SEQUENCE 2:**

Water is entering the pump through the Drive Pipe (A). The velocity and pressure of this column of water is being directed out the Waste Valve (B) which is overcome, causing it to close suddenly. This creates a momentary high pressure “water hammer” that in turn forces the Check Valve (C) to open allowing a high pressure “pulse” of water to enter the Pressure Tank (D). The air volume in the pressure tank is compressed causing water to begin flowing out of the Delivery Pipe (E) and at the same time closing the Check Valve (C) not allowing the water a path back into the pump body. As the air volume in the Pressure Tank (D) continues to re-expand, wateris forced out of the Delivery Pipe (E) to the holding tank.



**sequence 2**

**SEQUENCE 3:**

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 (depicted earlier). 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 the Delivery Pipe (E).



**sequence 3**

**SEQUENCE 4:**

The “shock wave” reaches the holding tank causing a “gasp” for water in the Drive Pipe (A). The Waste Valve (B) falls open and the water in the Drive Pipe (A) begins to flow into the pump and out the Waste Valve (B). The Check Valve (C) remains closed. The air volume in the Pressure Tank (D) has stabilized and water has stopped flowing out the Delivery Pipe (E). At this point Sequence 1 begins all over again.

**sequence 4**

**DETERMINATION OF DESIGN PARAMETERS FOR THE HYDRAM**

Since a hydram makes use of sudden stoppage of flow in a pipe to create a high pressure surge, the volumetric discharge from the drive pipe is given by:

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| --- | --- |
| http://lejpt.academicdirect.org/A11/059_070_files/image001.gif | (1) |

where, Q = volumetric flow rate through the pipe, r = pipe radius, L = pipe length and n = speed of revolution.

Also the velocity of fluid flow in the driven pipe is given by

|  |  |
| --- | --- |
| http://lejpt.academicdirect.org/A11/059_070_files/image002.gif | (2) |

where,Vd = velocity of fluid flow and Ad = area of pipe.

In order to ascertain the nature of the flow (that is whether laminar or turbulent), it was necessary to determine the Reynolds number given by

|  |  |
| --- | --- |
| http://lejpt.academicdirect.org/A11/059_070_files/image003.gif | (3) |

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

The friction factor *f* can be derived mathematically foFor smooth pipes Blasius suggested that for turbulent flow

|  |  |
| --- | --- |
| http://lejpt.academicdirect.org/A11/059_070_files/image005.gif | (4) |

The Darcy–Wersbach formula is the basis of evaluating the loss in head for fluid flow in pipes and conduits and is given by

|  |  |
| --- | --- |
| http://lejpt.academicdirect.org/A11/059_070_files/image006.gif | (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–junction is given by

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| --- | --- |
| http://lejpt.academicdirect.org/A11/059_070_files/image007.gif | (6) |

where Q = is the volumetric fluid discharge and AT = pipe x-sectional area at T-junction.

Loss due to sudden enlargement at the T-junction is expressed as

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| --- | --- |
| http://lejpt.academicdirect.org/A11/059_070_files/image008.gif | (7) |

Other losses of head, as in pipe fittings are generally expressed as

|  |  |
| --- | --- |
| http://lejpt.academicdirect.org/A11/059_070_files/image009.gif | (8) |

Since the head (H) contributed to water acceleration in the driven pipe, this acceleration is given by

|  |  |
| --- | --- |
| http://lejpt.academicdirect.org/A11/059_070_files/image010.gif | (9) |

 The value of K and *f* can be found from standard reference handbooks/textbooks. Eventually this flow will accelerates enough to begin to close the waste valve this occurs when the drag and pressure in the water equal the weight of the waste value. The drag force given by equation

|  |  |
| --- | --- |
| http://lejpt.academicdirect.org/A11/059_070_files/image011.gif | (10) |

The force that accelerates the fluid is given by

|  |  |
| --- | --- |
| http://lejpt.academicdirect.org/A11/059_070_files/image012.gif | (11) |

The pressure at point is obtained by divided the force F in Equation (11) by the area A.

|  |  |
| --- | --- |
| http://lejpt.academicdirect.org/A11/059_070_files/image013.gif | (12) |

The power required can k calculated using this expression

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| --- | --- |
| http://lejpt.academicdirect.org/A11/059_070_files/image014.gif | (13) |

The efficiency of the hydram is given by

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| --- | --- |
| http://lejpt.academicdirect.org/A11/059_070_files/image015.gif | (14) |

**RESULTS:**

Design Specifications:

 Supply Head = 1.5m

 Delivery Head = 2.87m

Table1. Results of calculated parameters

|  |  |
| --- | --- |
| Parameters | Values |
| Drive pipe diameterDrive pipe lengthSpeed of diaphragmFlow discharge in drive pipeTotal head losses in the systemForce on waste valvePressure at waste valvePower developed by the hydramHydraulic pump efficiency | 25 mm90 mm96 beats/min2.3 l/min11.71 ×10-4m7.2 N3668 kN/m21.273 kW57.3 % |

**MATHEMATICAL CALCULATIONS:**

|  |  |  |
| --- | --- | --- |
| Sr no. | Input Parameters | Output Parameters |
|  | Supply Head (m) | Drive pipe diameter (mm) | Waste valve diameter (mm) | SupplyRate(m^3/sec) (\*10^-3) | VelocityOf Supply (m/sec) | Delivery Flow Rate (m^3/sec) |  Efficiency (%) |
| 1. | 1 | 30 | 30 | 3 | 4.24 | 0.375\*10^-3 | 25.00% |
| 1 | 30 | 40 | 3 | 4.24 | 0.376\*10^-3 | 25.08% |
| 1 | 30 | 50 | 3 | 4.24 | 0.376\*10^-3 | 25.08% |
|  |  |  |  |  |  |  |
| 2. | 2 | 25 | 70 | 2.95 | 6 | 0.413\*10^-3 | 25.00% |
| 2 | 25 | 75 | 2.95 | 6 | 0.3709\*10^-3 | 25.15% |
| 2 | 25 | 60 | 2.95 | 6 | 0.368\*10^-3 | 25.04% |
|  |  |  |  |  |  |  |
| 3. | 3 | 30 | 42 | 5.206 | 7.364 | 6.5075\*10^-4 | 25.00% |
| 3 | 30 | 75 | 5.20 | 7.07 | 0.652\*10^-3 | 25.09% |
| 4 | 25 | 42 | 4.17 | 8.49 | 0.522\*10^-3 | 25.06% |
| 4 | 30 | 42 | 6.0115 | 8.5045 | 7.5144\*10^-4 | 25.00% |
| 4. | 3 | 25 | 50 | 3.61 | 7.35 | 0.452\*10^-3 | 25.07% |
| 3 | 25 | 60 | 3.61 | 7.35 | 0.451\*10^-3 | 25.00% |
| 3 | 25 | 42 | 3.61 | 7.35 | 0.45\*10^-3 | 25.03% |
|  |  |  |  |  |  |  |

**2-D SKETCH OF HYDRAM IN PRO-E:**

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**MAIN BODY OF HYDRAM:**

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**CONCLUSION:**

Presently we have study all the design parameters of the hydram and the mathematical calculations has been carried out as shown in the above table. Modelling of hydram should be taken in catia software.

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