ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Design of Hydraulic Rampump

D.Satyanarayaana
Final Year Student,
Department of Mechanical Engineering,
VITS College of Engineering,
Sontyam, Visakhapatnam.

P.Syam Kumar
Assistant Professor,
Department of Mechanical Engineering,
VITS College of Engineering,
Sontyam, Visakhapatnam.

G.Siva
Final Year Student,
Department of Mechanical Engineering,
VITS College of Engineering,
Sontyam, Visakhapatnam.

K.Tulasi Kumar
Final Year Student,
Department of Mechanical Engineering,
VITS College of Engineering,
Sontyam, Visakhapatnam.

ABSTRACT:

Hydraulic ram pumps are water-lifting devices that are powered by falling water. These pumps work by using the energy of water falling at small height to lift a small part of that amount of water to a much greater height. In this way, water from a spring or stream in a valley can be pumped to a village or irrigation scheme on the hillside. The main and unique advantage of hydraulic ram pumps is that with a continuous flow of water, a ram pump operates automatically and continuously with no other external energy source –be it electricity or hydrocarbon fuel. It uses a renewable energy source (stream of water) mid hence ensures low running cost.

It imparts absolutely no harm to the environment. Hydraulic ram pumps are simple, reliable and require minimal maintenance. All these advantages make hydraulic ram pumps suitable to rural community water supply mud backyard irrigation in developing countries. 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 two moving parts and can be easily maintained.

I. INTRODUCTION:

In many parts of the world, villages are situated above the spring: it does not allow water to flow to compounds by gravity. For example, in hill areas province, India, 20 percent of the population lives upstream the closest source of water. A pump is needed to lift the water from this source to their compound. General the power for water-lifting can come from engines, electrical mains, animals, humans or renewable (climatic) sources; in the particular context of rural areas in poor countries the choice is more constrained. There are virtually no rural electrical mains. Engines pose problems of both fuelling and maintenance

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. 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.

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

II. LITERATURE REVIEW:

The Fleming Hydro-Ram is an efficient, lightweight, dependable and inexpensive hydraulic ram pump made possible by modern technology. It works on the same principles of physics that enable its cumbersome predecessors to water the farmlands of Europe, the Mideast and Asia over the past two hundred years. John Whitehurst is credited with inventing a non-self-acting ram pump in England in 1772. By 1796 a Frenchman, Joseph Michael Montgolfier, had added a valve, which made the device self-acting, making the ram pump almost a perpetual motion machine when water supplies were steady.

In 1809, the first American patent was issued to J. Cerneau and S.S. Hallet in New York. But it wasn't until 1832 that information began spreading across the eastern states about the "simple pump that pushes water uphill using energy from falling water." Prior to the 1840's most ram pumps in were imported from Europe, but in 1843, H.H. Strawbridge of Louisiana claimed to be the first to put an American made model into use. His first ram, built entirely of wood, exploded, prompting a later model boasting "cross-bolts and rivets of iron." A cast iron ram soon followed.

Water-hungry rural Americans were intrigued by the pumps. Benson's Patent Water Ram could pump water from the powering stream or spring up a hill or it could use that po Articles in magazines such as the Farmer's Cabinet and American Farmer brought further recognition and understanding of the ram and its possibilities. A detailed book on the ram, published in 1842, was in its 16th edition by 1870. In 1879, The People's Cyclopedia included the hydraulic ram among the 55 most important inventions in the history of mankind. It defined the hydraulic ram as: "A simple and conveniently applied mechanism by which the weight of falling water can be made available for raising a portion of itself to a considerable height."

Benson's ram was said to "raise twice the water than any force pump will, with the same water power." It was described as "very simple and easy to keep in order." Patents on the ram abounded in the 1840's and 1850's, but after 1858 none were secured until 1870 when another burst of interest saw four patents awarded in 3 years. Though many used rams for individual homes and farms, an 1852 advertisement for Birkinbine's Patent Improved Hydraulic Ram proclaimed that the ram had pumped 20,000 gallons a day to the town of Naples, NY. The ad invited individuals to order a "proper ram and pipe sent them with directions for putting up." Birkinbine's rams were "warranted in every respect." One of the best known large rams was the Rife Hydraulic Engine, which could pump 50,000 gallons a day and 200 feet vertically.

In 1844 John Latrobe imported a ram from England at a cost of $100 including 500 feet of pipe. A.J. Downing in 1847 paid only $60.60 for an American made ram and several hundred feet of pipe. Downing's ram itself cost only $12; larger models cost as much as $30. Repair costs ranged from $5 every 5 years for replacement valves on the English models to Birkinbine's claim of "repairs not over 25 cents a year." Ram pumps were allowed to rust in the stream until expensive parts, fossil fuel shortages, and environmental concerns brought back to the public's mind the need for a pump that is inexpensive, requires almost no repairs or maintenance, is self-acting, and which can raise water to a considerable height vertically. The public began searching for a ram it could readily afford, pick up easily and move if necessary.

In 1980 Richard Fleming developed and began marketing the Fleming Hydro-Ram. Constructed principally with off-the-shelf parts, it is lightweight, highly efficient, and designed to provide many years of dependable service. Because of its affordability and effectiveness the Fleming Hydro-Ram is operating successfully for hundreds of people throughout the United States and in many foreign countries.

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

III. WORKING PRICIPLE:

a. Pump body:

The pump body of a Hydram needs to be robust: it is the center of the water hammer effect. The design uses a 4" GI tee and a 4" GI welded together. It gives three openings: one input, the connection to the dive pipe; and two out puts the connections to the impulse valve and to the delivery valve. Similar to the drive pipe , flanges are used because threads are not reliable enough. A rubber seal is added between flanges to protect the pump from leaking. Two supports are also welded to allow the fixation of the Hydram on the pump basement. The water enters from the drive pipe into the pump body and flows directly to the impulse valve.

b. Impulsive 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 design from the DTU. It is composed of three components;

The plate;

The plug; and

The locking;

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 stays the same until further modification during maintenance.

c. 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 boit;

Most of the design of Hydrams uses rubber to close the delivery valve; the design of the delivery valve uses machine belts as material.

d. 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.

e. Snifter valve:

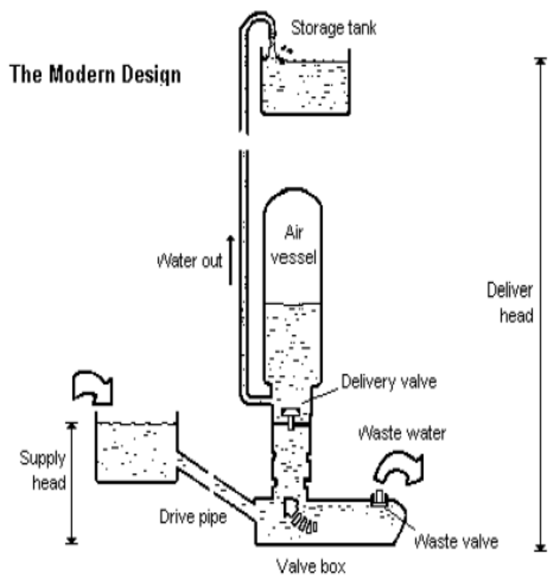
The snifter valve is a device to allow the air to enter in the air vessel. It is important to have this supply of air because the air in the air vessel is mixed with the water while the Hydram is running. As a consequence, the volume of air reduces. The snifter valve allows maintaining a necessary level of air inside the air vessel. The DTU design uses a valve with a rubber seal. If the hole is very small (i.e. 1 to 2 mm of diameter), the system is working and the pressure will not reduce too much even if there is water going out. We chose to use just a small hole.

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

IV. Working of hydram :

As already discussed in previous section hydram is a unique device that uses the energy from a stream of water falling from a low head as the driving power to pump part of the water to a head much higher than the supply head. With a continuous flow of water, a hydram operates automatically and continuously with no other external energy source. We will see operational and constructional features if the Hydram in this section.

A hydram is a structurally simple unit consisting of two moving parts. The waste valve and delivery (check) valve. The unit also consist an air chamber and an air (snifter) valve. The operation of a hydram is intermittent due to the cyclic opening and closing of the waste and delivery valves. The closure of the waste valve creates a high pressure rise in the drive pipe. An air chamber is necessary to prevent these high intermittent pumped flows into a continuous stream of flow. The air valve allows air into the hydram to replace the air absorbed by the water due to the high pressures and mixing in the air chamber.



V. MANUFACTURE OF PUMP

a. Skilled Technician:

The manufacture of the Hydram designed by ACF needs skills available in NTT and in most part of the world. The technician has to know how to;

- Weld for waterproof connections and with different material;
- Drill;
- Cut iron plate;
- Use a lathe machine;
- Read technical drawing.

A mechanic that has worked for repairing car or motorbikes is adapted to this job.

b. Supply of Material:

The technician needs:

- 2” GI pipes, elbows and tees of first quality;
- 1” GI pipes;
- 3/4” pipes for gas;
- A crow bars;
- 6 mm and a 10 mm stainless steel plates (mild iron plate is stronger and can corrode, use anti-corrosion paint under a layer of color paint to improve a little the longevity);
- 3/4” stainless steel bolts and nuts;
- 3 mm rubber surfaces (inside tube of truck can be used if still of good quality: no visible damage); and
- 90˚ profiles 5 x 5 cm.

c. Supply of Material:

The technician needs:

- 2” GI pipes, elbows and tees of first quality;
- 1” GI pipes;
- 3/4” pipes for gas;
- A crow bars;
- 6 mm and a 10 mm stainless steel plates (mild iron plate is stronger and can corrode, use anti-corrosion paint under a layer of color paint to improve a little the longevity);
- 3/4” stainless steel bolts and nuts;

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

- 3 mm rubber surfaces (inside tube of truck can be used if still of good quality: no visible damage); and
- 90˚ profiles 5 x 5 cm.

d. Equipment and Tools:

The workshop needs to be equipped with:

- A lathe machine;
- A welding plant and welding rod;
- A drilling machine and drilling bits;
- A cutting machine and cutting disc;
- A cutting torch and oxygen bottle;
- A grinder;
- Diameter measurer, ruler, carpenter measurer, marker, paint, a level,spanners, keys, etc;
- Safety goggles, safety gloves, ear plug, mask to protect from metallic dust;and
- A generator in case of black-out of electricity.
- Cutting of Flanges and Plates

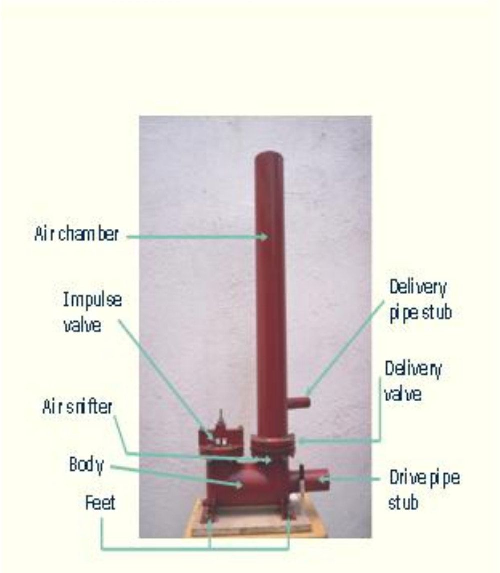
e. Cutting of Flanges and Plates:

The technician cuts the 10 mm stainless steel plate to produce the flanges with the cutting torch. After grinding, the flange (i.e. or reducer…) is taken to the lathe machine to for surfacing and making the PCD. The PCD are concentric circles on the surfaces that will be in contact to the rubber seal. It helps the rubber seal to anchor and resist to the high pressure given by the water hammer effect. If not, the rubber moves and leakages appear. Finally, drill the holes for the bolt and flanges are ready for being welded to the pump body.This step is the same for the flanges for the drive pipe and for reducing on end of the tee for connecting the drive pipe. A pipe used for the drive pipe (i.e. 2”) is welded on to create the inlet of the pump.

VI. PARTS AND ITS WORKING:

Hydraulic ram pump contains following parts:

A Hydram cannot work automatically if air enters inside the Hydram body. It means that the entrance of the drive pipe must be always under water. As a consequence, the size of a header tank is decided according to the flow available by the source of water. Then, if the quality of the water is poor (e.g. from a stream), it is important for the sediments to have time in the header tank to settle down in the bottom of the tank. Two compartments can be constructed.



VII. OPERATING SEQUENCE OF HYDRAM:

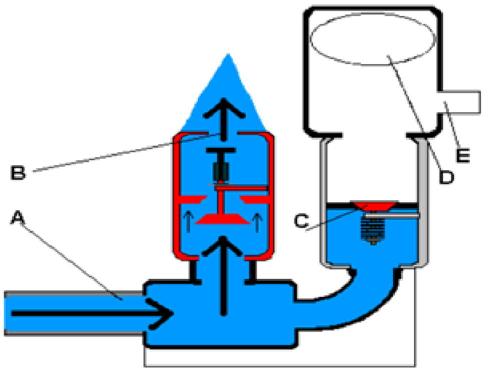


Fig 4.4 Operating sequence 1

Sequence 1

Water from the source flows through the drive pipe (A) into the ram pump body, fills it 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 spring and water pressure in the Tank (D) and the Delivery Pipe (E). (No water in the tank prior to startup) 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.

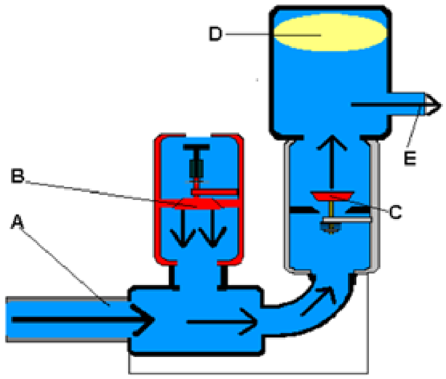


Fig 4.5 Operating sequence2

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, water is forced out of the Delivery Pipe (E) to the holding tank.

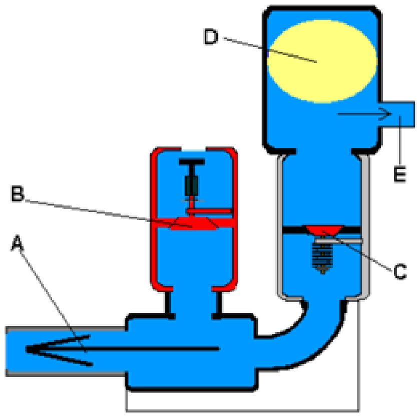


Fig4.6 Operating sequence 3

Sequence 3

Water has stopped flowing through the Drive Pipe as a "shock wave" created by the "water hammer" travels

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

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).

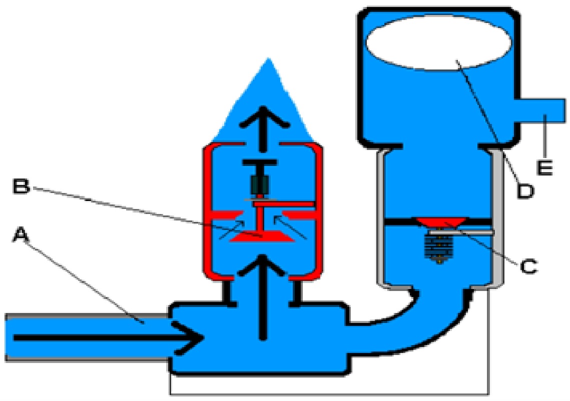


Fig 4.7 Operating sequence 4

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.

VIII. EXPERIMENTAL TEST RESULTS:

The calculated design parameters for the hydraulic ramp pump are done based on the following specifications of supply and delivery heads from a published manual on the hydraulic ram for pumping water.

Design Specifications:

- Supply Head = 0.75m
- Delivery Head = 5.25m

The pump was tested for variable delivery head and for different stroke length of impulsive valve.

The testing showed that effect of varying stroke length of increased valve increased and decreased supply as well as delivery head. The experimental rig limitation didn't allow experiments at higher head but the test and their results indicate that pump operate normally in the test region.

Test results for Hydraulic Ram Pump

Parameters	Values
Drive pipe diameter	25 mm
Drive pipe length	90 mm
Speed of diaphragm	96 beats/min
Flow discharge in drive pipe	2.3 l/min
Total head losses in the system	11.71×10^{-4}m
Force on waste valve	7.2 N
Pressure at waste valve	3668 kN/m^2
Power developed by the hydram	1.273 kW
Hydraulic pump efficiency	53.3 %

XI.RESULT AND CONCLUSION:

The model results show that model simulates well. In all case the model prediction are much higher than experimental data. The required pressure and velocity for good operation of hydram is successfully built to our boundary conditions. So there would not be much difficulty for operation of our designed hydram at these conditions.

1. The hydraulic ram pump of good quality and high performance was successfully fabricated and tested at Visakha institute of technology & science in visakhapatnam. The skills gained with this project where fabrication, modification, computer analysis and testing capability.

2. A proven and effective methodology to identify suitable sites for hydraulic ram use was evolved and tested. A locally made hydram was successfully developed and tested. It is recommended that ministry of water and agriculture department to establish small scale water supply schemes using hydram pumps to utilize the this pump so that it would greatly solve water problems for agricultural as well as domestic purpose.

3. There is broad prospect of utilizing the country's abundant surface water runoff potential for various purposes or requirements using locally designed and manufactured hydraulic ram pumps and other similar appropriate technologies.

4. To disseminate hydrams at potential sites throughout the country, there is a need to create awareness through training and seek integrated work with rural community, government institutions like water, energy and mines bureau of local region and non-governmental organizations.

5. Hydraulic Ram pumps made by casting have many advantages, but they could be expensive. In addition, considering the cost of civil work and pipe installation, the initial investment could be very high. To reduce cost of hydrams made by casting, there is a need for standardization. Standardizing hydram pump size will also have an advantage to reduce cost of spare parts and facilitate their easy access when they are needed.

X.REFERENCE:

1. Teferi Taye, "Hydraulic Ram Pump", Journal of the Ethiopian Society Mechanical Engineers, Vol. II, No. l, July 1998.
2. Jeffery, T. D., "Hydraulic Ram Pumps - A Guide to Ram Pumps Water Suppl System", Intermediate Technology Publications, 1992.
3. Fluid mechanics and hydraulic machines by R.K.Bansal, laxmi publication pvt ltd.
4. DTU Ram pump program publication published by university of Warwick
   Mihelcic, J. R., Fry, L. M., Myre, E. A., Phillips, L. D., & Barkdoll, B. D. (2009). Field guide to environmental engineering for development workers: Water, sanitation, and indoor air. Reston, VA: American Society of Civil Engineers.
5. ↑ A. Tessema, "HYDRAULIC RAM PUMP SYSTEM DESIGN AND APPLICATION ," ESME 5th Annual Conference on Manufacturing and Process Industry, Vol. , no. , pp. , September 2000. ESME.
6. ↑ B. W. Young, "Generic design of ram pumps," Proceedings of the Institution of Mechanical Engineers, vol. 212, pp. 117-117, 1998.
7. Dnadhar, M.M and Sharma, K.N, 1979, Water Power Engineering, Vikas Publishing House Pvt. Ltd. India.
8. David, J.P. and Edward, H.W., 1985, Schaum's Outline of Theory and Problems of Fluid Mechanics and Hydraulics, SI (Metric) Edition, McGraw-Hill Book Company, Singapore.
9. Dnadhar, M.M and Sharma, K.N, 1979, Water Power Engineering, Vikas Publishing House Pvt. Ltd. India.
10. Hydraulic machines by R.K.Rajput.