Home made Hydraulic Ram Pump

Information, diagrams and some pictures from: http://www.clemson.edu/irrig/equip/ram.htm
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Compiled by: aspireonescs

What is a hydraulic ram pump?

From wikipedia.org:

“A hydraulic ram, or hydram, is a cyclic water pump powered by hydro-power. It functions as a hydraulic transformer that takes in water at one "hydraulic head" (pressure) and flow-rate, and outputs water at a higher hydraulic-head and lower flow-rate. The device utilizes the water hammer effect to develop pressure that allows a portion of the input water that powers the pump to be lifted to a point higher than where the water originally started. The hydraulic ram is sometimes used in remote areas, where there is both a source of low-head hydro-power, and a need for pumping water to a destination higher in elevation than the source. In this situation, the ram is often useful, since it requires no outside source of power other than the kinetic energy of water.”

So basically it is a no power needed (save for the kinetic energy of the intake water) pump, that takes the downhill force of a water source, pressurizes an air chamber, which then allows water to be pumped above the elevation of the source water. Albeit at a great loss of efficiency.

Sounds great for the off grid homestead right? There are commercial hydraulic rams available, but they run close to a thousand dollars us. This is a Do it yourself one, and can be customized as you see fit! It should only run around $100 in parts. (depending on locality)
How do these things work?

There are two moving parts in the operation of the ram pump, the spring loaded check valve, and the brass swing check valve (a “flapper” valve). When the head water first enters the pump it first encounters the brass swing check valve (hereinafter referred to as the “waste valve”), which is normally open. As the water enters at a ever increasing head (pressure), it rushes around and closes the waste valve. This creates higher pressure in the pump and forces the spring loaded check valve open.

Some of the water enters the the pressure chamber by way of the spring check valve, and the rest of the water with no place else to go (as the waste valve is closed) heads back up the intake pipe. (the water hammer, or pressure spike) This creates a low pressure zone, which lets the spring check valve close, and the waste valve open. As the spring check valve is now closed, and the pressure chamber now has some air pressure in it, the air pressure forces the water in the chamber out of itself and into your delivery line.
How they work (Diagrams).

Stage 2

Stage 3

image by: habolooby, @instructables.com
Parts listing

Here is a list of all materials (all in PVC unless otherwise noted) The hydraulic ram pump can be constructed from PVC or steel pipe. I choose PVC as did the instructables author, for its low price and ease of use. However for a longer lasting pump, I would suggest you go with steel. (if it is not cost prohibitive for you)

List of materials:

• (1) 1-1/4” valve
• (1) 1-1/4” union
• (2) 1-1/4” tees
• (1) 1-1/4” pipe to thread fitting
• (1) 1-1/4" brass swing check valve
• (1) 4”x2” reducing fitting
• (1) 4”x28” pipe
• (1) 4” end cap
• (1) 1-1/4”x2” bushing
• (1) spring check valve (with 1-1/4” connections)
• (1) 3/4” valve
• (1) 3/4” union (get one with threads on at least one side, this is the pump outlet)
• (1) 6” of ¾” pipe (either threaded or smooth, depends on what kind of ¾” fittings you got)
• (1) 4' section of 1-1/4” pipe (for the connections between the fittings)

Optional:

• (1) intact bicycle inner-tube (for pressure chamber, reduces water logging)
• (1) 24” piece of round closed cell foam (a piece from those kids toys, “noodles”, for the swimming pool)
• (1) screen (shower or regular drain, for intake pipe to keep debris out)

Pipe runs:

• enough 1-1/4" pipe to get a good drop from your water source (intake pipe)
• enough ¾” pipe to get from the pump to where you want your water delivered. (PVC, PEX or even a garden hose)
Tools:

- PVC cement
- PVC primer
- hacksaw
- Teflon Thread Tape
- measuring tape
- pocket knife (to remove the burrs on the inside of the pipe after cutting with the hacksaw)
- safety equipment

Illustrated list of parts:
Put it together!

Below is a visual diagram of how all the pieces go together. Pay special attention to the direction of the flow arrows on both the brass swing valve and the spring check valve. If these are not put in the proper orientation, your pump will not function at all. Assemble in a well ventilated area (if using PVC), as the primer and cement are toxic, and you don't want to be breathing it in. Also it is advisable to wear gloves, but not necessary for temporary contact. Do not allow primer compound to be in contact with any oxidizing materials. As this can cause dangerous peroxide compounds which are explosive, and do not allow vapors to accumulate in an enclosed area, as a small spark or flame will ignite it.

Assembly is pretty straightforward, use the 4’ section of 1-1/4” pipe, and cut off small sections to use to connect all the fittings together. Try to keep the connecting pieces as short as possible, but not too short so as to not fully seat in the fitting.
Detail of pressure chamber.

In the image below, you can see a partially inflated bicycle inner-tube, inserted into the pressure chamber (the 4”x28” pipe). This is there to prevent water logging of the pressure chamber. (Air will dissolve readily into water while under pressure, and will then exit the chamber with your water.) You could also use a section of one of those foam “noodles” that the kids use in the pool.

image by: habolooby, @instuctables.com
Installation of the ram pump

There are many factors to consider when building and installing a hydraulic ram pump, chief among them is the amount of head available and how high you need to pump the water to. Here are a couple equations to help determine the drive pipe length (inlet pipe) Where L equals the length. All pipe sizes are in inches, the result of L, will be in inches as well (12 inches to a foot):

- Minimum inlet pipe length: \( L = 150 \times \text{(inlet pipe size)} \)
- Maximum inlet pipe length: \( L = 1000 \times \text{(inlet pipe size)} \)

Example: If the drive pipe is 1-1/4 inches (1.25 inches) in diameter, then the minimum length should be \( L = 150 \times 1.25 = 187.5 \) inches (or about 15.6 feet). The maximum length for the same 1-1/4 inch drive pipe would be \( L = 1000 \times 1.25 = 1250 \) inches (104 feet).

Image by: http://www.nowonthespot.org
Operation of the pump

Your pump is going to have to be manually started each time it stops, or you turn it off. (the miracle of a non electric pump lol) To start up the pump you:

1. close the delivery valve (the 3/4” valve)
2. open the inlet valve (the 1-1/4” valve)
3. when the swing check valve closes, push it open with your finger (keep doing this until it does it by itself, the air in the system needs to be pumped out)
4. when it is pumping by itself, slowly open the delivery valve, a small amount at a time (the 3/4” valve)
5. you may have to repeat these steps, until the pump is up to pressure

Expectations

Don't expect this pump to be a 20 gallon per minute pump. This pump based on minimal intake flow rate, non optimal elevation and drive pipe length. Is capable of around .90 gallons every 3 minutes. Or around 18 gallons an hour. When operating at maximum flow rate, proper elevation and optimal drive pipe length, it is capable of around 1-1/2 gallons per minute (75 gallons an hour)! Plenty enough for the small to mid sized off grid homestead. If combined with a holding tank or cistern at the delivery point, the pump no matter its flow rate will be able to adequately supply your water needs.

Conclusion

If you are off grid and need a simple low maintenance pump, that requires no fuel or energy to supply your homestead or retreat with water. Then in my opinion the hydraulic ram pump is an ideal match for your needs. They require little maintenance, and are cheap to make and repair. If you have a large enough water source you can even combine two pumps to maximize the height and flow rate of your delivery point. They can even be rigged up to some sort of modified steam engine to provide a small amount of mechanical or electrical energy. For a video of a ram pump in action see:

http://www.youtube.com/watch?v=Q3tBecQOQfw&feature=related
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