Ram Pump

Location: HLS 160

Major findings in summer 2013

- more weight on wasting valve gives higher pumping rate (this is what theory would predict)
- The wasting valve must have two adjustments. One adjustment sets when the valve opens and the other adjustment sets when the valve closes. These adjustments must be independent to allow tuning of the ram pump for optimal performance.A combination of a weight and a spring may work to provide this adjustment.

Goal

AguaClara needs a ram pump to move filtered water up to the chemical stock tanks and also for use in the water treatment plant bathroom. This need is especially important at larger facilities. For example, at San Nicolas the chemical stock tanks will be 750 L and would require the operator to fill and carry approximately 40 buckets of water. The pumping requirement for San Nicolas is 70 mL/s (750 L stock tank in 3 hr). The best efficiency that we obtained during the summer suggests that we might need 1 L/s of drive pipe water to deliver that flow. A goal for this semester is to improve the efficiency of the pump by tuning the waste valve and by using a 1” drive pipe that is the same diameter as we will be using in San Nicolas.

The ram pump will be located in the filter pipe gallery so the operator can easily check on the pump and verify that it is working. The ram pump will have about 3 m of drive elevation and the drive pipe will either be vertical or have a steep angle as it takes a diagonal down to the floor of the pipe gallery. We have asked that a 1” diameter pipe be installed in one of the filter effluent boxes as the source of water for the drive pipe.

The waste pipe will be a 2” pipe that will exit the filter pipe gallery at a small slope and eventually reconnect with the main pipe going to the distribution tank. The waste from the ram pump must be able to empty into the 2” pipe.

The ram pump team will need to fabricate and a ram pump with a 1” drive pipe and a discharge that can easily be connected or dropped into a 2” pipe. The ram pump needs to be tested and tuned to improve the efficiency. The pump must be able to deliver 70 mL/s of water to the stock tanks at San Nicolas. The stock tanks are 4 m above the water level in the filter effluent box.

Switch to using the hydraulic test rig that uses a centrifugal pump to recycle the flow from the waste valve. Design and fabricate an improve waste valve system that is easily adjusted.

Consider purchasing a ram pump early in the semester both to learn how it is designed and to compare its efficiency with the efficiency of the AguaClara ram pump.

Conduct some testing to determine the required volume of air in the air chamber. Design an air chamber that has a air valve stem that can be used to add or remove air perhaps using a bicycle pump. Then measure the flow of the pump as a function of the volume of air in the air chamber. Use these results to design an small and efficient air chamber. Use a quick calculation based on the physics of the water motion in the drive pipe to determine how much water is pumped per cycle and hence to estimate the required air volume in the air chamber.

Consider adding a flow rate measurement device. Use a vertical pipe that is 70 cm long and that is filled with the pumped water. Measure the height of water in the pipe using a pressure sensor. Dump the water when the measuring device is full using a solenoid valve controlled with process controller.

One of the challenges for this team is to develop a method to produce a pump head of 4 m ABOVE the water level in the constant head tank that is connected to the drive pipe. We experimented with using a restricting needle valve to develop pressure, but when the pump quits running the pressure quickly is released and the pump may require backpressure to easily start pumping again. Given that we don’t have a 7 m tall laboratory space, the other option for producing a high head to pump against is to take a flexible tube that is at least ½” ID and place it on a rack and wind it up and down so that the up sections add up to the desired head of 7 m (counting from the bottom of the filter gallery). Then start pumping water through this looped set of tubing. The water will fill the up flowing sections of the tube and air will be trapped in the down flowing sections. The pressure is (almost) constant in the sections of the tube that are filled with air. Thus the desired head of 7 m can easily be simulated.

A final option would be to use a pressure release valve.