Prototype Design and Testing Review *Nov. 20, 2000*
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Design Description

The Team 9 human powered pump project is based on a centrifugal style pump driven by a simple bike gear system. The operator sits in the chair, and pedals the crank. The crank transfers the energy via the bike chain to the vane style water pump on top of the riser. A standard garden hose will be attached to the pump to transfer the water from the pump to the upper holding tank. Before the water reaches the holding tank it is channeled through a flume. This narrow flume will have a float in the middle. The float will rise to the top of the water level and will show the instantaneous flow rate past that point at any given time by the calibrated flow gauge

Design Details

The first part of the team 9 human powered pump is the drive system. This system, shown in figure 1, is a simple bicycle design. The force is applied to the pedals. This rotary force causes the large crank gear to turn the smaller pump gear. For our pump the crank gear is approx. 8 inches in diameter and the pump gear is 3 inches. With this setup we will obtain a 2.66 mechanical advantage rate. This means that for every one revolution of the crank gear, the pump gear will rotate 2.66 times. In addition to the mechanical advantages of the drive system, it also uses the largest and most efficient human power source, the legs. This feature allows an operator to operate the pump for extended periods of time with limited fatigue.

The second piece in the pump design is the pump itself. This pump is a flexible vane style pump. Shown in Figure 2, this pump uses rotary motion in its operation. This is very helpful in our design because the pump drive system we will be using also uses rotary motion. In this pump the water enters the pump through the inlet port. Once inside the pump housing the flexible vanes distort. This distortion pressurizes the water by reducing the area between the housing and the impeller. The pressurized water is transferred to the outlet port where the water exits the pump housing. The pump housing is .45 ft or 5.3 inches in diameter. The tubing coming in and going out of the pump is .75 inch tubing.

The seat of the pump allows the user to utilize the pedals of the pump in the most efficient way possible. The recumbent position of the seat allows for a comfortable time using the pump. The seat is also adjustable to many different positions. It is also possible for the user to move the seat all the way forward and utilize the pump with their hands instead of the feet. The seat has a 2 inch steel U bracket on the underside of it. This bracket will mesh with the frame to secure it together and also allow for the adjustability.

The frame is an essential part of the pump design. This frame, shown in Figure 3, is the main part of this design. All the other components to the pump attach to this frame. The frame allows the user of the pump to adjust the position of the seat to fit any size person. This is made possible by holes in the 2x2 inch piece of bar stock that is being used as a frame. The U bracket has a hole in it that will accept a pin. This pin will run

though the bracket and the bar stock. This will do two things. First it will secure the seat to the base. The second is that it will allow for the wide adjustability we desire.

The last piece of the team 9 human powered pump project is the flow meter. This flow meter is one that will calculate the instantaneous flow rate at all times without the need for electronic equipment. The water, after it has risen the 8 feet, will be channeled though a flume. In the middle of the flume is a float (See figure 4). As the water runs past this point the float will rise to the top of the water flow. Attached to the float is a wire. One the other side of the pivot, which the float and wire rest, is a calibrated gauge. This gauge will tell as what rate the water is flowing at any given time.

Assembly for this pump is minimal. Most pieces of this pump are welded together and therefore need no assembly on sight. What little assembly there will be will be the seat and the pump itself. The seat is held in place by a U bracket in the middle of the seat. That will have to be placed on the 2x2 bar and the through pin inserted. For added support there will be four wheels on the outside edge of the seat. This will not only provide some stability by also an easy means by which to adjust the seat forward and backward. The pump will also need to be bolted in place. This is done by four bolts though a mounting plate on the pump riser. Next the chain will have to be put on. There is a tensioner built into the pump design in order to make this installation easy. When the tensioner is loosened, put the chain on the largest gear on the crank and the smallest on the pump. Once the chain is in place put the chain back into tension and tighten the tensioner bolt. The next thing to do is to hookup the hoses to the pump. The hoses will be connected the pump using hose clamps to prevent leakage. The last thing to do is to place the flow meter inside the prefabricated flume that will be present at the test sight, making sure there is a slight down angle on the flume.

Test Results

The start of every test is a prediction. In the calculation below we go through how we obtained our theory line.

This graph shows that our pump is running at just under 50 percent efficiency. This is due to the low rpm we are producing. We hope to increase our rpm by altering the gear ratio as to increase our mechanical advantage. This will be done by either obtaining a larger crank gear, a smaller pump gear, or adding a separate gear assembly between the crank and the pump. By using another small gear welded directly to another large gear we can more than double our mechanical advantage.