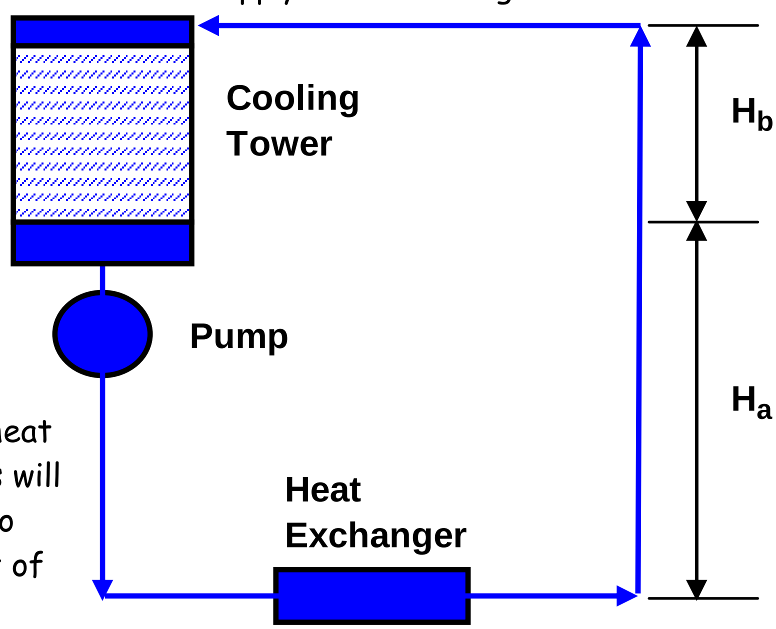
Pump ED 101

Variable Speed Pump Selection – Part 3 Vp-Vf (+Cp)

Joe Evans, Ph.D http://www.PumpEd101.com

Last month we reviewed the pump selection criteria for a closed loop circulation system (Vp-Vf). This month we will take a look at a similar application that adds some elevation to the equation.

Open loop applications are similar to closed loop systems in that friction in the loop varies with flow. The major difference between the two is that the static heads are unbalanced in the up and down legs of the open loop system. Simply stated, the discharge elevation is usually greater than the supply elevation. Figure 1 is an example of a simple open loop application.

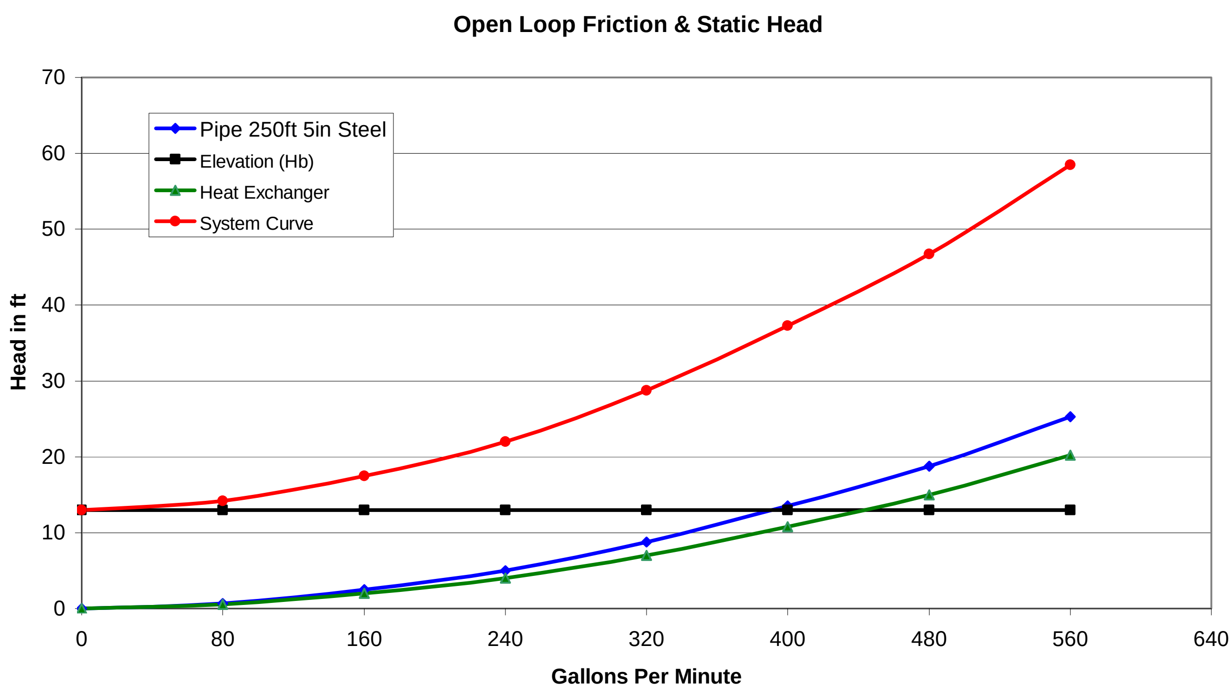


Here we see a pump circulating water through a piping system that includes a heat exchanger and a cooling tower. In this example friction will arise from two sources - - the flow in the piping and the flow through the heat exchanger passage. These values will be added, as we did last month, to produce the frictional component of the system curve.

The elevation component is composed of H_a and H_b. H_a is the balanced elevation in the loop. The lower (solid blue) portion of the cooling tower is the pan or reservoir that collects the cooled process water. The distance from the surface of the water to the bottom of the down leg will produce the same elevation in the up leg. Therefore no energy is required to produce the static elevation of H_a. H_b is the unbalanced elevation and is the distance from the surface of the water in the reservoir to the piping entrance in the upper (solid blue) portion of the tower. Therefore H_b becomes the elevation head that must be produced by the pump.

Depending upon the tower design, another head component can be required. Some cooling towers have a collection pan in the upper portion of the tower that distributes the water to the cooling area via gravity. Others rely on nozzles to spray water into the cooling area. When nozzles are used, a certain amount of pressure is required to create a spray pattern. In our example we will assume that the water is distributed by gravity. We will also ignore the potential siphon effect that can be produced by the so called "down comer" that was often used on older cooling tower designs.

Figure 2 is a graphical representation of the components that make up the system curve for the open loop system seen in Figure 1. The blue and green curves are the



frictional components and the horizontal black line is the elevation component. The red system curve is the sum of the other three curves at each flow point. The total head required to operate the loop ranges from 13 feet at 1 GPM to about 58 feet at 560 GPM. The resulting system curve is similar to the one we saw last month in our closed loop example. The difference is the influence of the elevation component. We will see later that a combination of friction and elevation can have an effect on the operating points of the H/Q curves produced at lower frequencies.

Figure 3 plots the H/Q curve of a pump, selected for this application, against the system curve we generated in Figure 2. The application calls for a flow range of

240 to 480 GPM. The data labels show that this pump will meet the maximum flow at a hydraulic efficiency of 75% and requires 7.5 HP. As expected HP drops as flow is reduced. At minimum flow efficiency drops to 69% and the power required is reduced by about 2 HP from that required at maximum flow.

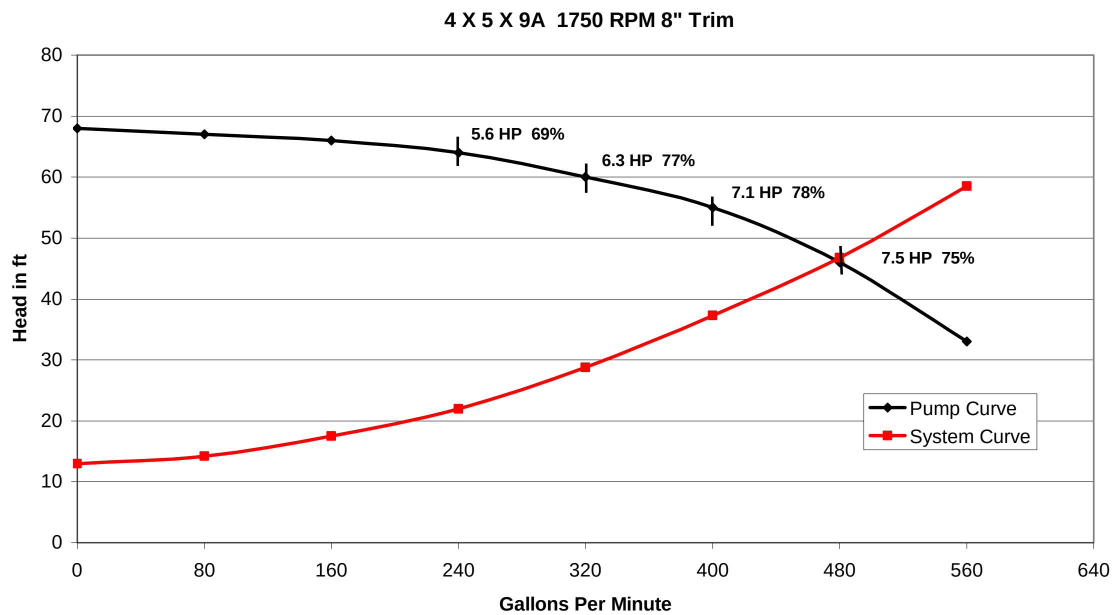
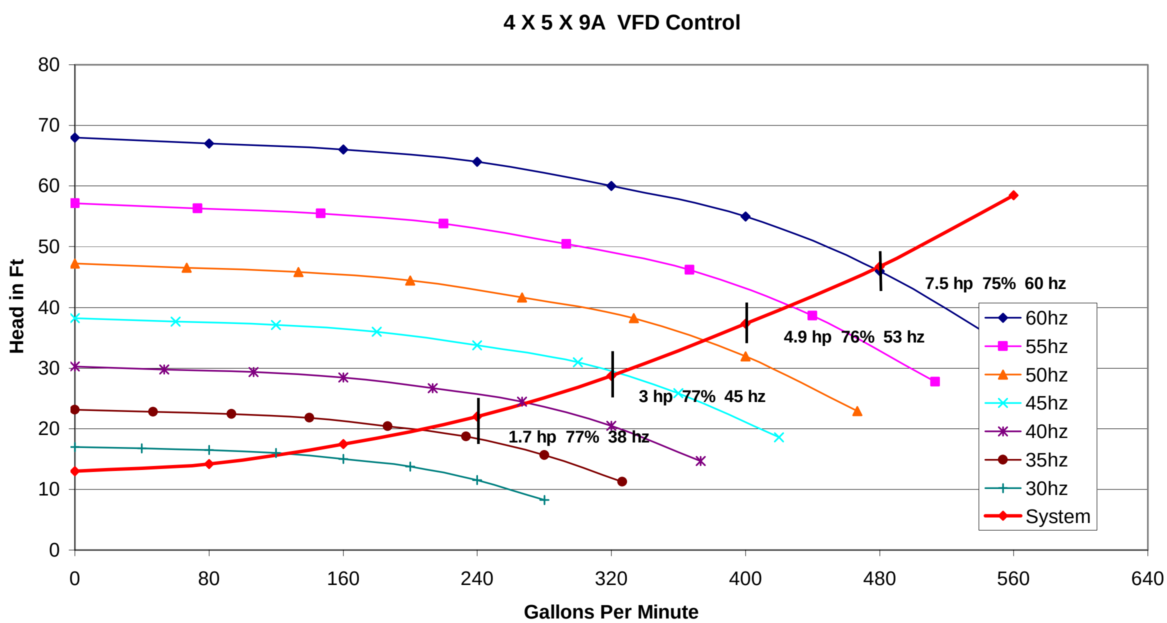


Figure 4 shows the same pump operating under VFD control. The data labels show a major reduction in HP at each of the flow points. For example the power required at minimum flow (38 Hz) is reduced from 5.6 (constant speed) to 1.7 HP.



I mentioned earlier that the elevation component can affect the operating points of the lower frequency H/Q curves. In last month's closed loop example the system curve (friction only) closely followed the H/Q isomer of the 60 hz flow point as speed was reduced. This occurred because friction changes as nearly the square of a change in flow and thus closely matches the change in head. In this example the linear, elevation component changes the shape of the system curve as flow is reduced. Thus the system curve moves further and further to the left as pump speed is reduced. This is typical of systems that are composed of both elevation and friction. In our example, it doesn't matter because the peak 60 hz efficiency occurs at 400 gpm. Therefore the system curve moves towards and eventually through that efficiency isomer as speed is reduced. There are, however, times when it can have an effect on lower speed efficiency and pump selection.

Joe Evans is the western regional manager for Hydromatic Engineered Waste Water Systems, a division of Pentair Water, 740 East 9th Street Ashland, OH 44805. He can be reached at joe.evans@pentairwater.com, or via his website at www.PumpEd101.com. If there are topics that you would like to see discussed in future columns, drop him an email.