Pump ED 101

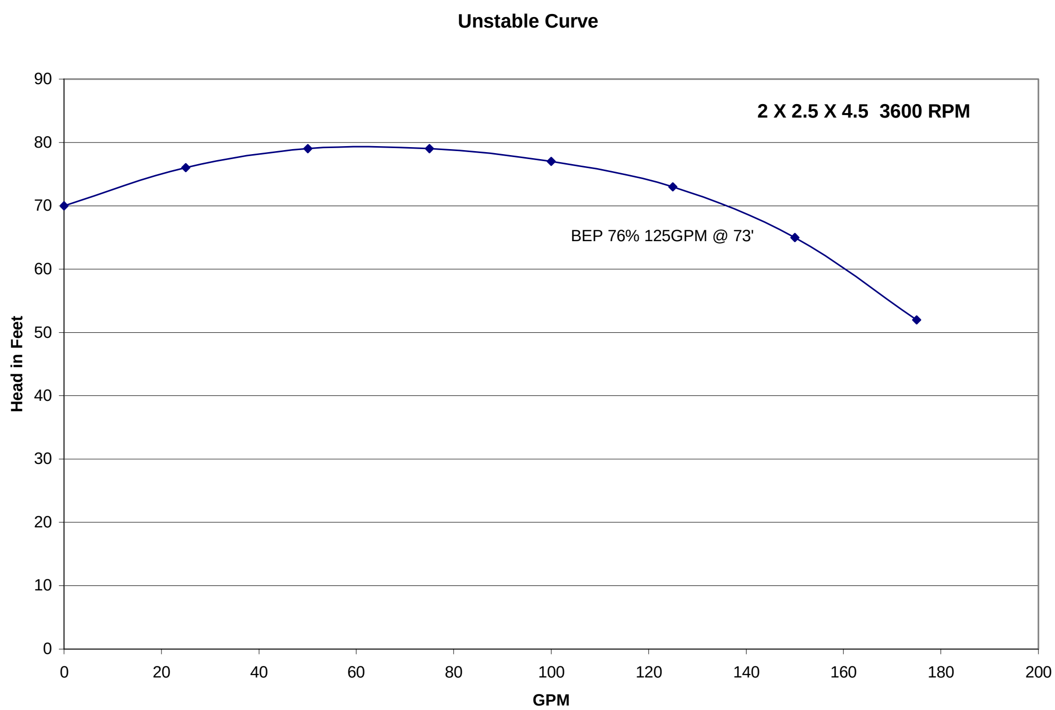
Parallel Pumping – (Part Two) Other Considerations

[Joe Evans, Ph.D](#) http://www.pumped101.com

Last month we took a look at the effect of the system curve on the output of two identical centrifugal pumps operating in parallel. This month we will review several other factors that can also impact their performance.

Unstable Pump Curves

A stable head / capacity (H/Q) curve is defined as one where head rises continuously as flow decreases and reaches its highest level at shut off. This type of curve is typical of most of the centrifugal pumps we use on a daily basis. There are times, however, when a pump design may push the efficiency envelope and end up with an unstable curve similar to the one seen in Figure 1.

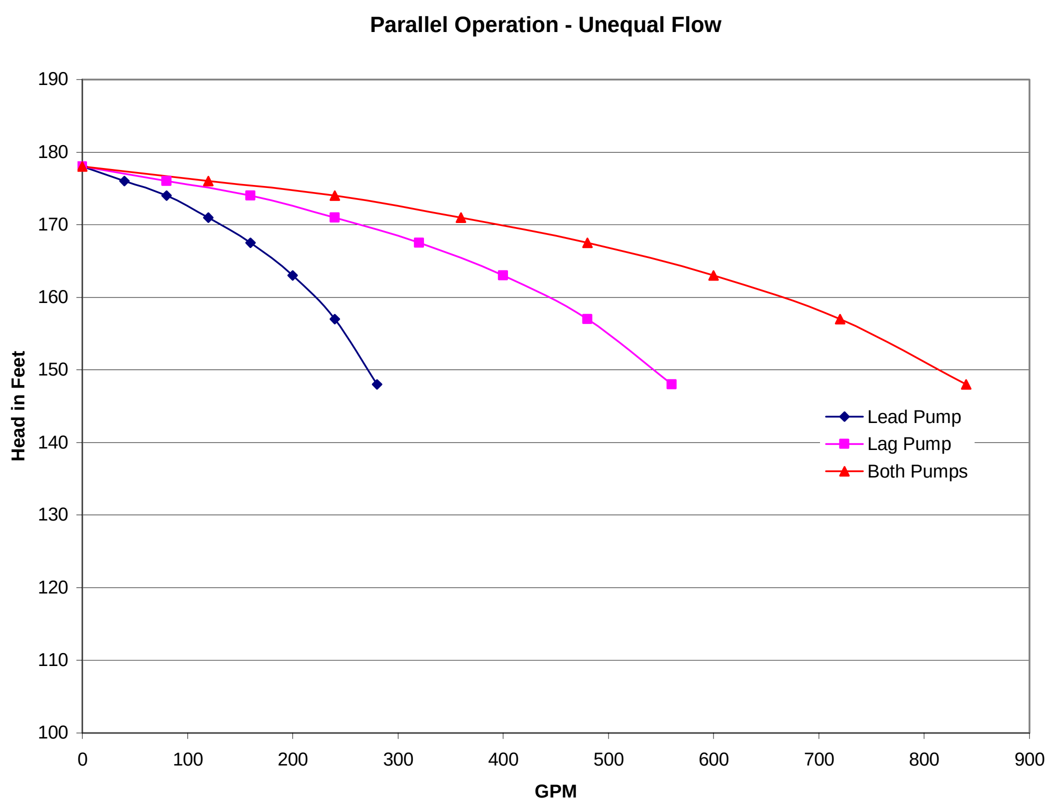


Here we see a curve that reaches its maximum head between 50 and 75-gpm and then falls substantially as it approaches shut off. Even the head produced at BEP (125-gpm) is higher than that produced at shut off! Theoretically, changes in the system conditions could cause this pump to oscillate between higher and lower flows if it is operated in the highest head region of the curve.

Although pumps with unstable curves can work well in many applications, they are not suited for operation in parallel. Why? Pretty simple, if the primary pump is operating at a head that is higher than shut off, the secondary pump may not be able to produce enough head to come on line. This is especially true for larger pumps that may be started against a closed valve. Several agencies recommend that all pumps should have stable H/Q curves. API goes even further and mandates them for parallel operation. They also recommend a minimum head rise from rated capacity to shut off of 10 – 20%.

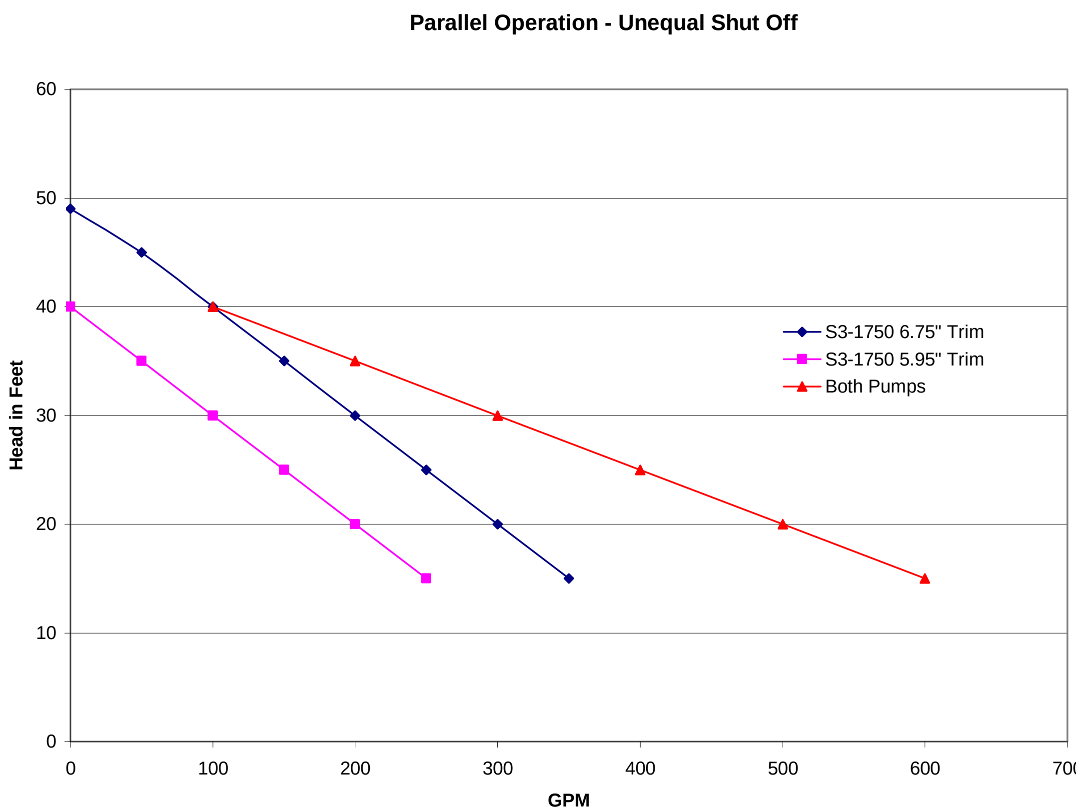
Non Identical H/Q Curves

Figure 2 shows two pumps with unequal flows but identical shut off heads operating in parallel. This example is typical of a duplex pressure booster system that pairs a smaller jockey (lead) pump with a larger lag pump. A similar configuration is sometimes seen in sewage lift stations where infrequent but unusually high flows may occur. Even though the individual flows vary substantially, the equal shut off heads and stable, continuously rising, curves allow them to function properly.



As with identical pumps, each will contribute to the parallel flow based upon their individual flows at a particular head point. And, just like any parallel pumping system, the system curve must be factored into the equation. Often the "as built" system can cause the pumps to operate well to the left of BEP and prolonged operation in this area can have an adverse effect upon pump life. For example, if the system conditions will allow the pumps, shown in Figure 2, to operate at 163' of head both will operate near BEP. If the system curve forces them to operate at 171', both will run much less favorable portions of their individual curves. In the 11/07 Pump FAQs, HI states "For reliable pump operation and maximum energy savings, both pumps must be operated at or near their BEP".

Figure 3 shows the result when pumps with unequal head and flow are operated in parallel. The red (parallel) curve shows that the lower head pump will not begin to contribute to parallel flow until the flow of the higher head pump exceeds 100-gpm. As flow increases and head decreases, both pumps will contribute to parallel flow in the same manner seen in the previous example.



HI and other agencies recommend against using pumps with unequal shut off heads in a parallel application. I agree that this is a good general rule but, in applications where elevation is the primary system component, they can operate successfully. The pumps must be started in proper sequence and the system conditions must allow both pumps to operate at or near BEP.

Variable Speed Control

There are three basic ways that a VFD can be used to control two identical pumps operating in parallel. The first uses a single drive sized to operate both pumps simultaneously. Both run at identical speeds and changes in system conditions result in identical speed changes. This configuration is more often seen in industrial applications and can be the result of application growth and the addition of a second identical pump. This control scheme is best suited for applications where minimum flow always exceeds the capacity of a single pump. Both pumps can also take advantage of soft start and stop via the shared drive.

The second utilizes a single drive that is sized to control the primary pump. If flow reaches some preset maximum or pressure falls to some preset minimum, the secondary pump is started across the line and runs at full speed. The VFD reduces the speed of the primary pump and then attempts to maintain the required conditions. Although this control scheme has a lower initial cost, the savings may not be worth some of the negatives that can arise. For example, in some constant pressure systems, a control valve (PRV) will be required to prevent over pressure by the secondary pump. There is also a good probability that the primary pump will operate well to the left of BEP during parallel operation. And, only the primary pump can take advantage of soft start and stop.

The third uses an individual drive to control each pump and results in a more complex control scheme that allows communication between the two drives. In a typical scenario, the primary pump is controlled by drive 1. If conditions exceed its capacity, drive 2 starts the secondary pump and attempts to meet the system requirements. Over a period of several seconds, the pumps are coordinated and run at the same speed (similar to our first example). As flow decreases, one pump is slowly brought off line and a single pump remains on line. Advantages of this control method include alternation of the primary pump, a wider range of variable speed flow, and soft start & stop of both pumps.

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.