

Pump ED 101

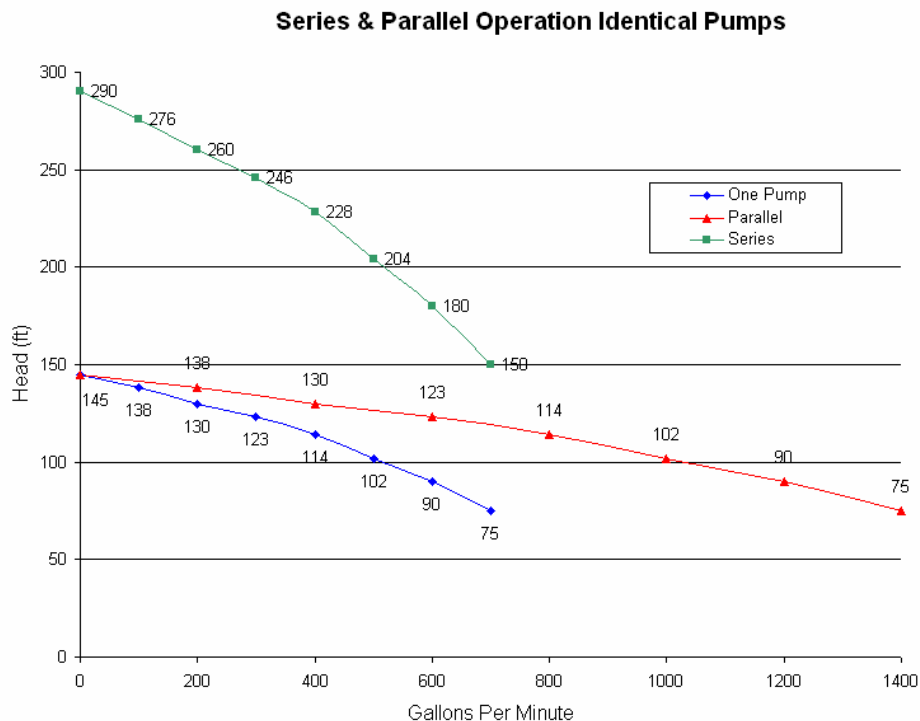
Parallel Pumping - (Part 1) Parallel and Not So Parallel

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Suppose, for a moment, that you are lounging on a beach somewhere in the vicinity of the equator. If you were to draw two lines in the sand, side by side, and both are heading due north they will appear to be parallel. Although our brains will see them as parallel they are not and, if extended, they will eventually intersect at the magnetic north pole. Often pumps operating in parallel can also fool us into thinking that the expected flow will be much greater than the actual flow.

The general rules that describe the head and flow of two identical, centrifugal pumps operating in series or parallel are pretty simple. When operating in series flow remains the same as a single pump but head is doubled at each flow point. In parallel operation head remains the same as a single pump but flow is doubled at each head point. Figure 1 illustrates these rules. The blue curve is the one produced by a single pump while the green and red curves are those that result from series and parallel operation.



It would be nice if predicting parallel pump flow could always be this simple but, in real life, the system conditions will dictate the maximum rate of flow. Let's take a look at a sewage lift station example that illustrates the importance of evaluating pump performance against the actual system curve.

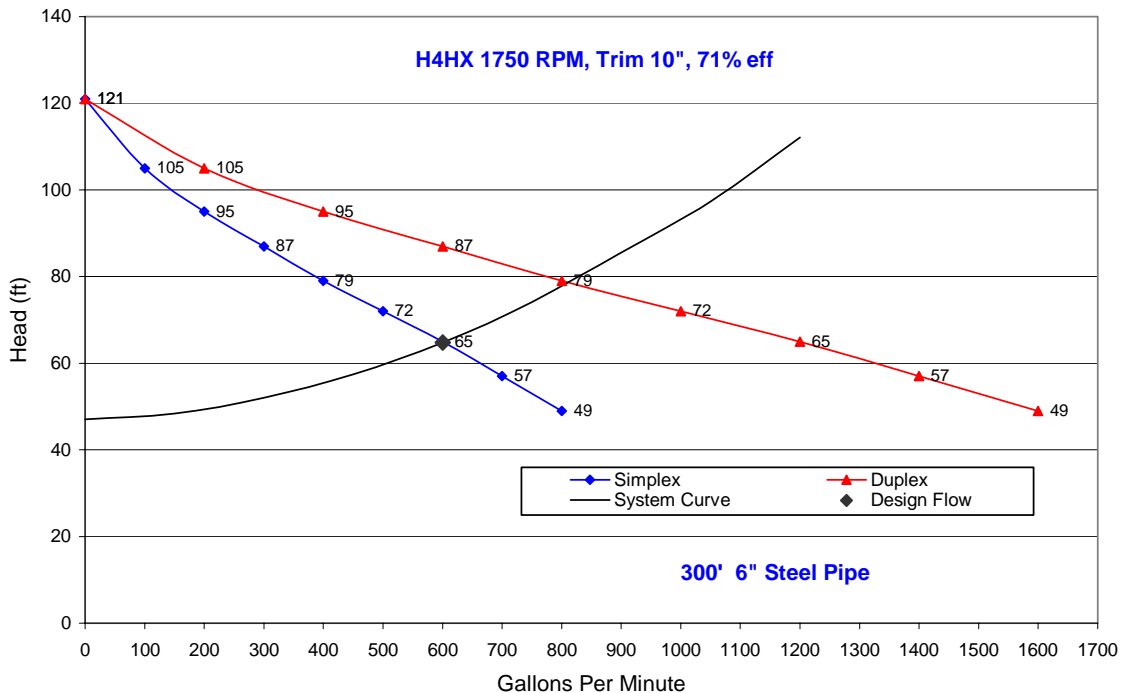
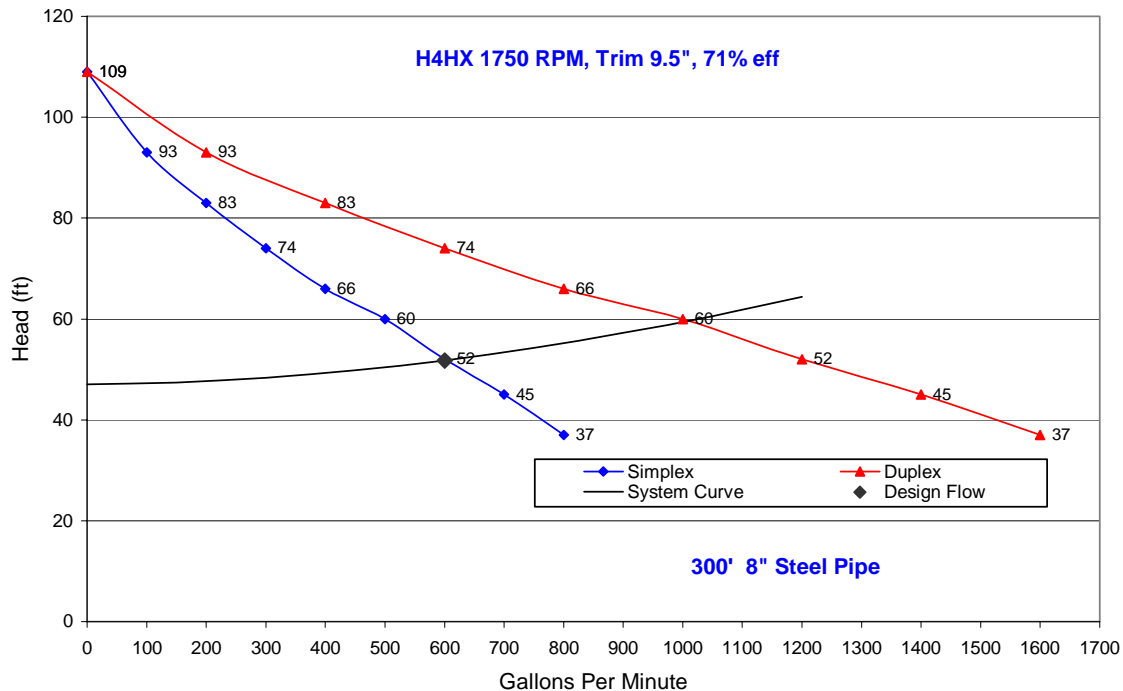


Figure 2 shows the performance of two identical wastewater pumps operating in a simplex and duplex (parallel) environment. The black system curve is composed of a static head of 47' and the friction head produced by 300' of 6" steel pipe. Valves and fittings increase the "equivalent" pipe length to 381'. The black marker on the curve represents the simplex design flow of 600 GPM and it intersects the single pump, H/Q curve at 65'. As flow increases so does the system head and results in the system curve crossing the duplex H/Q curve at approximately 79'.

The result is a maximum duplex or parallel flow of about 800 GPM, not the doubling some of us may have expected. (It should also be noted that each pump is operating at 400 GPM which is 25% below BEP. We will address this in detail next month.) Now an 800 GPM peak flow may be adequate in some cases but, if it is not the conditions that influence the system curve will have to change. Figure 3 shows the same application with a couple of system changes. The discharge pipeline size has been increased to 8" and the pump impellers have undergone a small trim that

allows them to meet the new design point head. The result is a system that performs quite a bit differently than the previous one.



Although the static head remains the same, the friction head is reduced substantially due to the increased pipe diameter. The original simplex design flow requires just 52' while duplex operation requires 60'. The result is a duplex flow of 1000 GPM or an increase of 200 GPM over that of the previous example. Additionally the decreased friction reduces the power required at design flow from approximately 14 HP (6" pipe) to 11 HP. Under duplex operation the 24 HP required to produce 800 GPM in figure 2 is reduced to just 22 HP at 1000 GPM.

Some duplex lift stations are not designed to accommodate parallel operation. Instead the pumps are sized to meet maximum in-flow with a single pump. In these designs the purpose of a duplex system is simply to extend pump life through alternation and provide back up in case of a pump failure. Others are designed for parallel operation but max flow can vary substantially. In some cases the "as built" system will differ from the original design. I have seen this many times in subdivision wastewater stations (and also in the domestic water and circulation piping in commercial buildings). Often, these field changes are not communicated to the design engineer and the original drawings are seldom updated. These changes can affect both parallel operation and the ability of a single pump to meet its design flow.

In addition to the influence of the system curve, there are several other important

conditions that should be considered when operating pumps in parallel. These include use of non identical pumps, stable versus non stable H/Q curves, and various methods of VFD control. Next month we will take a detailed look at these topics and show how they can affect both constant pressure and lift station applications.

The Excel spreadsheets that produced Figures 1 - 3 are available for download on my web site. Look for "Series-Parallel Pumping Calculator" and "Simplex-Duplex System Curve Analyzer". The first one will let you compare identical or non identical pumps, operating in series or parallel, to a simple system curve. The latter allows comparison of simplex and duplex, lift station pumps to the more complex system curves produced by a combination of vertical lift, force main pressure, and friction.

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