Pump ED 101

Centrifugal Pump Efficiency – Part 5 Curve Shape & Breadth of Efficiency

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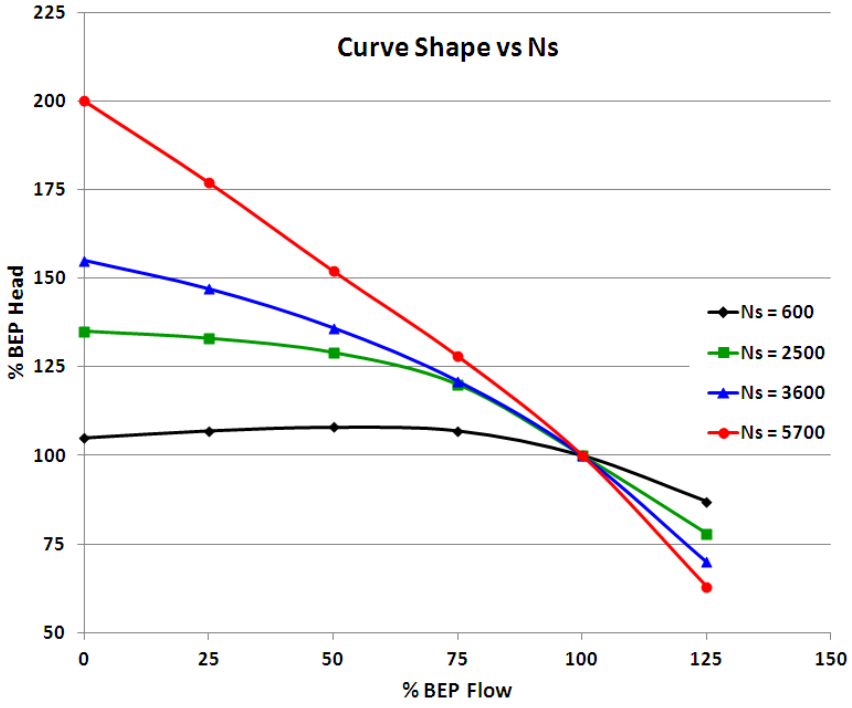
Curve Shape

In Part 2, I showed the effect of Specific Speed (Ns) on the shape of a pump's performance curve and its maximum efficiency. A typical performance curve is relatively flat at low values of Ns and becomes steeper as Ns increases. Pump efficiency is lowest at low values of Ns (500 and below) and increases as Ns increases. It reaches its maximum in the mid to high 2000 range and begins to decrease above 3000. However, the decrease above 3000 is much smaller than it is below 1000.

Figure 1 compares the curve shape of four pumps with various specific speeds. It also shows the percent increase in head from BEP to shut off. As shown, the slope of the curve increases with specific speed. The black curve (Ns=600) is relatively flat and this example actually decreases as it approaches shut off. These pumps can be problematic when running in parallel or starting against varying system head conditions. The green curve (Ns=2500) rises continuously as it approaches shut off and head increases by about 35% from BEP to shut off. The blue (Ns=3600) also rises continuously but exhibits a 55% increase in head. The red curve (Ns=5700) is extremely steep and head increases by 100% from BEP to shut off. Steeper curves usually offer a greater range of control when operated under variable speed control against some fixed elevation or pressure head. Flatter curves work fine in across the line applications as long as the static or pressure



head remains relatively constant. They also work very well in closed (and most open) loop circulation applications when operated under variable speed control.

Although the curves shown are representative of the shape you can expect for those values of Ns, they are not cast in stone. For example, pumps with an Ns range of 900 to 1200 can be extremely flat or they could exhibit a 15 to 20% rise in head as they approach shut off. The same is true of pumps in the 1500 to 2000 range. They can be relatively flat or exhibit a head rise of 20 to 30%. The actual conditions will depend upon the individual pump design.

Breadth of Efficiency

All pumps reach their peak efficiency at BEP but the range of peak efficiency can vary significantly from model to model. Some pumps, especially lower flow models, exhibit a very narrow BEP range and once flow is out of that range efficiency drops very quickly. For example a 2 X 2.5 X 8 centrifugal with a BEP efficiency of 70% at 200 GPM drops to 63% at flows below 190 GPM or over 210 GPM. Since pumps seldom operate at BEP, a wide range of high efficiency can allow for design errors and potential changes in the system.

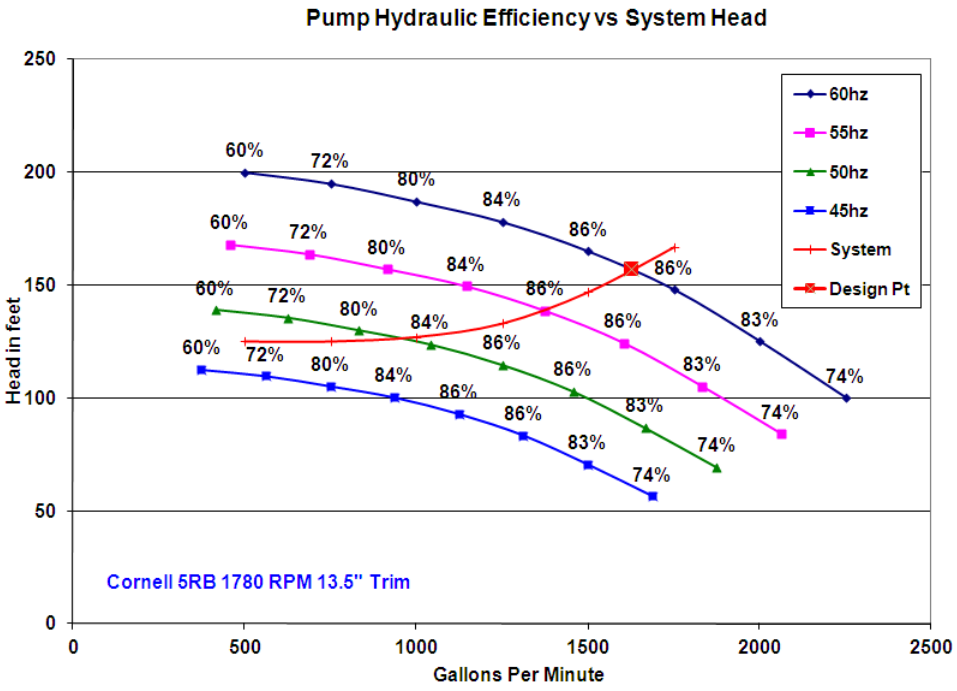


Figure 2 shows the variable speed curves for a pump with an Ns of 1654. It exhibits a rise in head towards shut off of about 30% and a very wide range of high efficiency. When running across the line (60 hz curve), this pump will maintain its BEP efficiency of 86% from 1500 to 1750 GPM. The head change across this range is about 17 feet and allows for incorrect duty point head calculations as well as ageing of the system. It still performs at 85% from 1375 to 1875 GPM and will maintain 84% from 1250 to 1900 GPM.

If this pump was operating in a variable speed application, against the system curve shown in red, its control range would be about 12 Hz (49 – 60 Hz) and it would maintain 86% efficiency from 1375 to 1625 GPM. Efficiency would still be at 85% down to 1250 GPM and remains at a robust 84% all the way down to 1050 GPM. This high efficiency across the range of flow enhances the power reduction due to a change in speed.

Next month we will end this series by looking at some examples of when pump efficiency is important and when it is not so important.

Joe Evans is responsible for customer and employee education at PumpTech Inc, a pump & packaged systems manufacturer & distributor with branches throughout the Pacific Northwest. He can be reached via his website www.PumpEd101.com. If there are topics that you would like to see discussed in future columns, drop him an email.