Pump ED 101

Centrifugal Pump Efficiency – Part 4 Preservation of Efficiency

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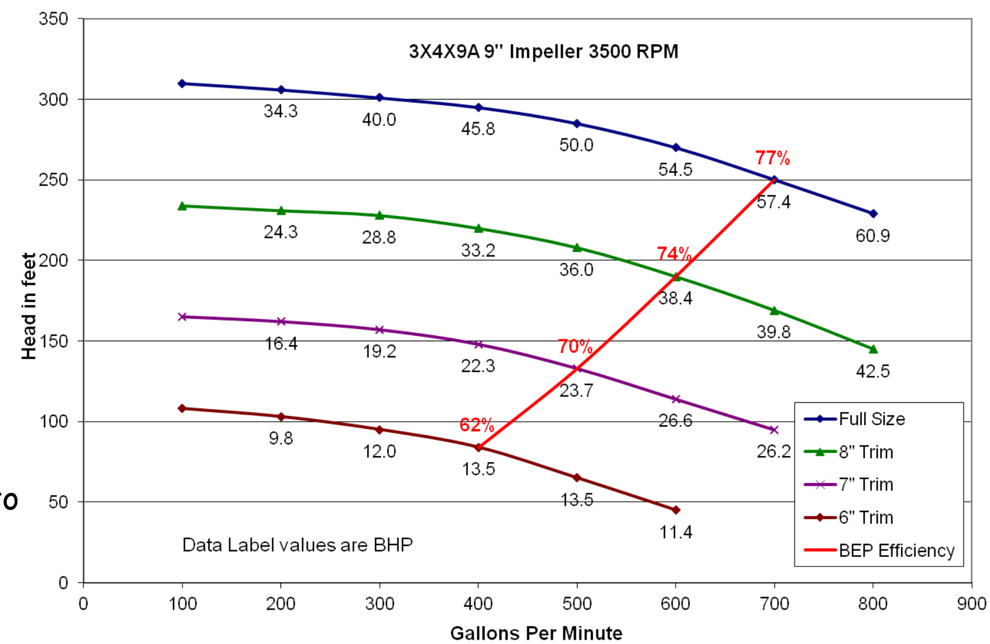
The Effect of Impeller Trim versus Speed Reduction

The performance of a centrifugal pump with a trimmed impeller will follow the affinity laws as long as that trim is relatively small. Many experts recommend a maximum of 10% reduction from the full design diameter but, if you look at a typical set of manufacturer's catalog curves, you will see trims as great as 30% to 35%.

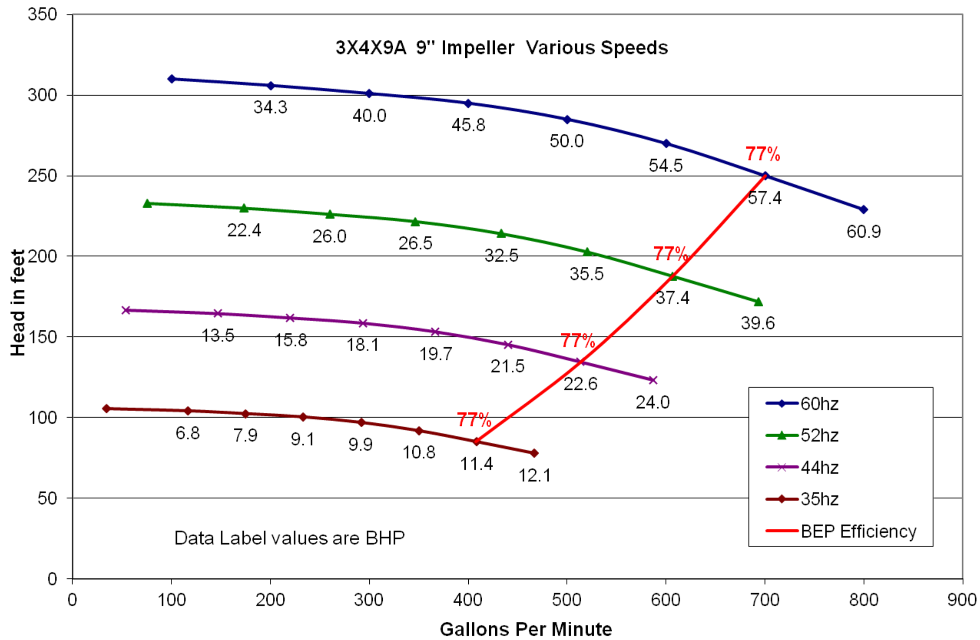
In Part 3 of this series we looked at the volute's contribution to hydraulic efficiency. An important part of the volute is the tongue, or cutwater, and its purpose is to maintain flow into the throat while minimizing recirculation back into the case. The optimum clearance between the tongue and the impeller periphery is the smallest distance that does not give rise to pressure pulsations during vane tip passing. A well designed pump will have a full size impeller that meets these clearance criteria. When an impeller is trimmed, this distance increases and allows more fluid to recirculate back into the case. As recirculation increases, hydraulic efficiency decreases.

Figure 1 shows the catalog curves for a centrifugal pump with a 9", full size impeller and several trims. At BEP the hydraulic efficiency is 77% for the 9" impeller. When trimmed to 8" (11%), BEP efficiency drops to 74%. A 23% trim (7") reduces BEP efficiency to 70% and a 33% trim (6") lowers it to just 62%. Although not shown on the graph, if the trim was just 6% (8.5"), BEP efficiency would remain at 77%.



The trims shown on manufacturer's catalog curves are the allowable trims, not necessarily the most prudent ones. Although an efficiency reduction of 3% could be acceptable in certain applications, reductions of 7% and 15% should seldom be acceptable. If you have to trim an impeller that much to meet the requirements of the application, it is time to consider a smaller pump.

An alternative to trimming the impeller is to alter its speed and this can be achieved by a number of methods. Figure 2 shows the same pump with four different speed curves that were selected to match the trims shown in Figure 1. These speed changes were produced by a VFD so the curves are labeled in Hertz.



Other speed change options include belt drives and adjustable, magnetic couplings.

The result is that BEP efficiency remains at the full speed (diameter) efficiency (77%) across a broad range of speeds. This occurs because the impeller periphery to tongue clearance remains unchanged and recirculation is limited to its design conditions. The affinity laws also hold true across this range.

Next month we will compare the impact of peak BEP efficiency versus a broad range of high efficiency. We will also show how a pump curve's breadth of efficiency can affect both fixed and variable speed operation.

Note:

In Part 2 (March) of this series I forgot to mention that parts of Europe use an alternative method when computing Specific Speed (Ns) for double suction pumps. Their method uses half of the BEP flow. In the US we use full flow regardless of the pump design. When Ns is calculated using half the BEP flow, the result equals

0.707 that of the full flow calculation.

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.