Pump ED 101

Centrifugal Pump Efficiency – Part 6 When is Efficiency Important?

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When is pump efficiency important?

The power required by a pump is directly proportional to both the flow and head it produces. As flow and / or head increase so does the power required. Conversely, power is inversely proportional to hydraulic efficiency. For the same flow and head, an increase in efficiency reduces the power requirement. The two equations below illustrate this relationship. The first is hydraulic power and the second is brake horsepower.

$$P = (Flow \times Head) / Ef \qquad BHP = ((Flow \times Head) / 3960) / Ef$$

Pumps that run continuously or for extended periods can experience a substantial reduction in energy costs with a relatively small increase in efficiency. Figure 1 shows two, 3,000 GPM pumps that operate 24/7. With efficiencies of 87% and 84% the HP required is 130 and 135 respectively. The electrical cost per thousand gallons is 5.7 and 5.9 cents. Now two tenths of a cent is not a very big difference but if you consider the annual cost of electricity, the lower efficiency pump adds an additional $3,200.00 to the total electric bill.

Wire to Water Energy Cost Calculator		
REQUIRED DATA	**Pump 1**	**Pump 2**
Pump Operation - Hours / Day	24	24
Pump Operation - Days / Year	365	365
Pump Flow - GPM	3000	3000
Pump Head - Feet	150	150
Pump Efficiency - %	87%	84%
Motor Efficiency - %	95.0%	95.0%
Energy Cost in $/kWh	$0.10	$0.10
RESULTS		
BHP At Operating Point	130.6	135.3
Wire to Water Efficiency (%)	83%	80%
Annual Pumpage (gal)	1,576,800,000	1,576,800,000
Annual Energy Consumption (kWh)	898,499	930,588
Annual Energy Cost	$89,849.86	$93,058.78
kW Per 1000 Gallons Pumped	0.570	0.590
Cost Per 1000 Gallons Pumped	$0.057	$0.059

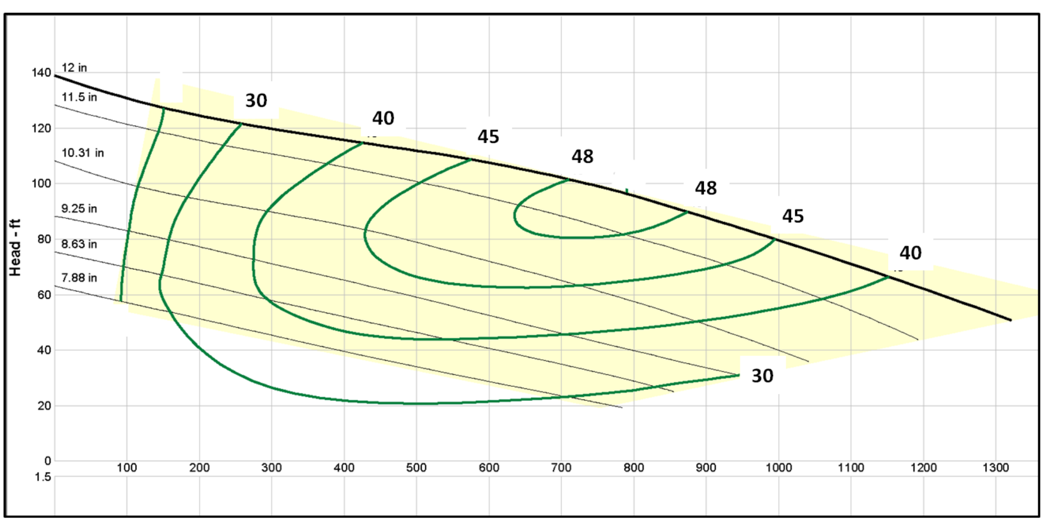
Another factor that can increase the attractiveness of higher efficiency is the cost of electricity. The energy cost of 10 cents per kWh, used in Figure 1, is the average commercial rate for 2010 but, it can vary significantly by state. In some states it can be as low a 6 cents and, in certain parts of Washington, cooperative rates can be as low as 4 cents. New England, however, is in the high teens. What is the worst case? Hawaii - - with Oahu at 23 cents and some outer islands topping out near 40 cents. As the cost per kWh increases, so will the savings due to increased pump efficiency. It will be interesting to see what the average rates will be for 2011. I suspect that they have increased substantially.

Another factor to consider when selecting a pump that will not run continuously is the actual flow rate required. Do you really need 3000 GPM or can you get the same results by running a 2000 GPM pump longer? If you have the same head and efficiency at these two flow rates, the cost per thousand gallons pumped is the same for both. In most cases reducing flow by 1000 GPM will result in a substantial decrease in friction head. Since BHP is directly proportional to head, you could see a substantial reduction in the cost per thousand gallons pumped with the lower volume pump.

When is it not as important?

Selecting the most efficient pumps and motors will always reduce the cost of electrical power but, sometimes, the payback versus first cost does not pencil out. Examples include smaller pumps, pumps that are used infrequently and those installed for back up or emergency use only. Also, in many industrial applications efficiency will take a back seat to a pump's ability to reliably perform a particular process. A good example is a slurry pump where larger clearances increase useful life. Another is the vortex pump which is very popular in both industrial and wastewater applications.

Figure 2 is the H/Q curve for a 4" vortex wastewater pump. At 800 GPM its hydraulic efficiency is just 48%. A standard 4" non-clog with a similar performance would show an efficiency of 68% to 75% - - 20 to 27 points better. The reason for the lower efficiency is that vortex action is a two step process and the overall efficiency is the product of the two individual efficiencies. But, even though efficiency is much lower than



normally desired, there is also an extremely positive side. Almost anything that enters the suction of a vortex pump will exit its discharge. This is due to the fact that the vortex impeller is recessed and seldom contacts any of the solids or other material in the pumpage. This can be extremely beneficial when smaller wastewater pumps are required. The more efficient 4" non-clog can plug frequently when rags and stringy materials are present and this often results in removing the pump from service for cleaning on a weekly basis. In these applications, a vortex pump can be far more reliable and the maintenance cost savings is much greater than the additional energy costs due to lower efficiency. One of the seminars I present to specifying engineers is titled "How Lower Pump Efficiency Can Reduce Costs". It usually gets their attention.

You could probably make a pretty good case that pump efficiency is not too important if the pump is to be driven by a gasoline engine. Although an 80% efficient pump should save quite a bit of energy over one that is 65% efficient, the gas engine (approximately 20%) brings their totals down to 16% and 13% respectively. It may be hard to justify a higher initial pump cost for such a small energy savings, unless the pump is used frequently and for long periods of time.

Finally, there are application design points where reasonable efficiency cannot be attained but a pump is still required. Suppose some million dollar process line cannot use a positive displacement pump but, instead, requires a centrifugal pump that can deliver 20 GPM at 3000' of head. Would we really care if a single stage pump had to be driven at 23,000 rpm and that its efficiency was less than 25%? Probably not, and there are far more of these types of applications than you might suspect.

There is definitely more than one side when it comes to pump efficiency. Efficiency is a good thing and we should always consider a higher efficiency pump if the return on investment pencils out. Often, a peak (BEP) efficiency that adds one or two percentage points is not that important since very few pumps actually operate at BEP. The breadth of high efficiency, on either side of BEP, can be far more beneficial.

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.