Putting a Value on Efficiency
by Steve Wilson

Since efficiency is a function of good pump design, and not a benefit of itself, the benefits of that function may be important in understanding the true value of pump efficiency, or wire-to-water efficiency. An easy way to place a value on efficiency is to discuss operating costs. That approach is given here, but it is noted that operating costs (which reflect power draw) have a direct link to power generation and environmentally disturbing factors (such as “greenhouse gasses”). This paper will illustrate one such approach.

COST PER HOUR OF PUMPING

There are many methods to evaluate the cost of pumping, since HP is directly linked to kilowatts. One approach is to use the formula:

\[ CPH = \frac{.000189 \times GPM \times TDH \times \$/KWH \times SG}{PE \times ME \times DE} \]

Where:

- \( CPH \) = Cost Per Hour of pumping
- .000189 = A constant which ties energy to gallons and feet
- \( GPM \) = US Gallons Per Minute
- \( TDH \) = Head in feet
- \$/KWH = Cost of power per kilowatt hour
- \( SG \) = Specific Gravity
- \( PE \) = Pump Efficiency
- \( ME \) = Motor Efficiency
- \( DE \) = Drive Efficiency (if present)

Looking at the formula, a couple of points should be made:

- Pump efficiency and motor efficiency have the same weight in the formula, both being equally important. Assuring that both efficiencies (known as the “wire-to-water” efficiency) are maximized will assure the \( CPH \) is minimized. (If a drive is used, WWE is equal to \( PE \times ME \times DE \))
- If a drive is used and no reduction in \( GPM \) or \( TDH \) is obtained, the \( CPH \) will increase, since no machine is 100% efficient
- The formula represents operating costs for a machine in operation. It does not include Power Factors, which are normally assessed for a plant based on total PF as part of the energy “bill”: Those factors become part of the \$/KWH number.

AN EXAMPLE

Perhaps the easiest way to illustrate the impact of efficiency is through an example.

For exercise sake, we will assume a site requires two pumps, each delivering 3200 GPM at 160’ TDH. Both pumps will operate around the clock, 365 days per year.

A pump selection is made and the pump curve as shown in Figure 1 is studied.
provides a good average number for use. While (as of August, 2009) the power cost varies widely by state and region and type of energy user from around $.05/kwh for industrial users to over $.22/kwh for residential users, the average for both commercial users and the national average for all classes of users is $.10, which is what will be used for this exercise.

So, performing the calculations:

\[
CPH = \frac{0.00189 \times 3200 \times 160 \times 0.1 \times 1}{0.908 \times 962}
\]

\[
CPH = \frac{9.6768}{0.873496}
\]
To appreciate the value of Pump Efficiency, of course, a comparison needs to be made. Another pump that meets the conditions of service is shown in Figure 2. In this case, efficiency is 83.75%, and the cost of operation can be calculated using that efficiency. (Using the same motor and other assumptions.) Of course, the “numerator” does not change, so:

\[
CPH = \frac{9.6768}{.87375 \times .962}
\]

\[
CPH = \frac{9.6768}{.805675}
\]

So, the difference between the operating cost of the pump in Figure 1 and the operating cost of the pump in Figure 2 is attributed purely to difference in pump efficiency. In this example, that value is $210,590 - $194,487, or $16,503 per year. If the pumps run for 20 years, even if the power cost did not rise during that time, this would equate to a minimum operating life cost savings of over $330,000.
CONCLUSION

While the terms “efficiency” and “high efficiency” are often discussed, the importance of efficiency is clearly related to power requirements. Putting a value such as operating cost on the efficiency of a pump may be of great importance in making the best possible selections and minimizing the life cycle cost of a pump and system. (Of course, for actual studies of existing installations as part of any retrofit program, a study of the piping and valving would need to accompany a look only at the pump. If, for example, the 160’ head in the exercise were created by improper sizing or partially closed valves, much energy savings could be made by re-selecting the pumps for that reduced head, employing a VFD and new pumps and motors (and removing the valves), etc.)