GRUNDFOS

WHITE PAPER

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 x ME x 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.

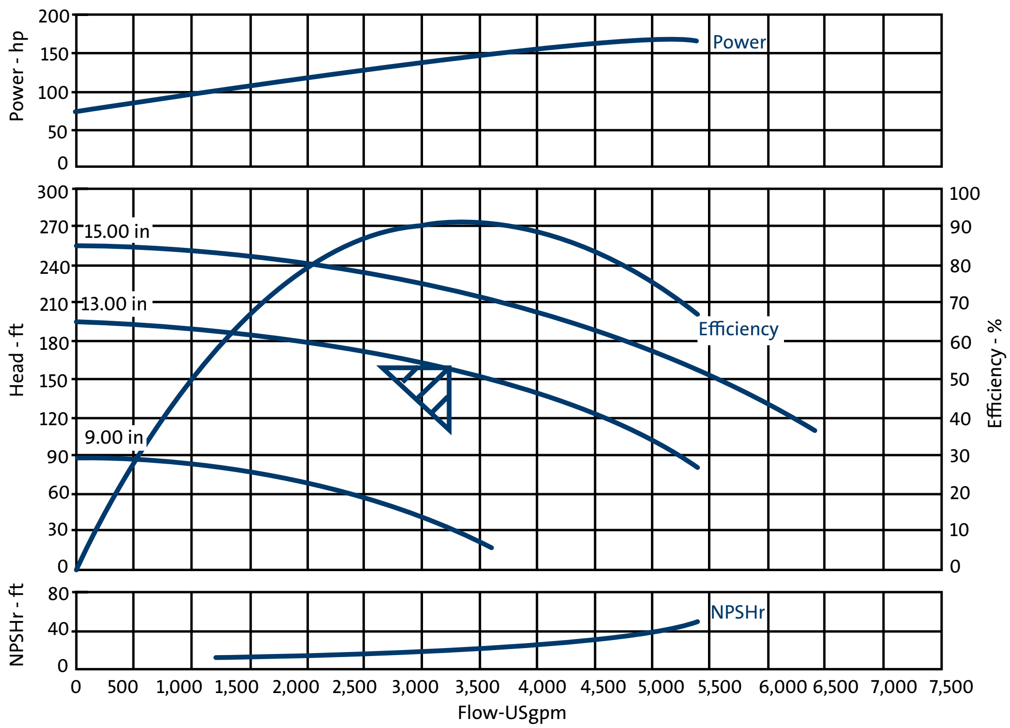

Figure 1. *Pump 1: A pump selected for 3200 GPM at 160' TDH (4-pole speed)*

Study of the data reveals this pump to be 90.83% efficient, and a 200 HP motor would typically be selected in most commercial applications to assure that nameplate HP would not be exceeded should the head be less than predicted. This exercise will use a NEMA™ Premium Efficiency motor as a constant. (Of course, motor efficiency will vary under load, but given the variety of motors and their characteristic curves, we will not change that efficiency as would need to be done for actual analysis). A NEMA™ Premium Efficiency motor in 4-pole speed has a nominal efficiency of 96.2%. We will assume the specific gravity (SG) to be 1.

One more piece of information is required: The cost of power. Using the US information (www.eia.doe.gov) and looking at report DOE/EIA-0226 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:

$$CPH = \frac{.000189 \times 3200 \times 160 \times .1 \times 1}{.908 \times 962}$$

$$CPH = \frac{9.6768}{.873496}$$

CPH = $11.078 (per pump per hour)

CPH = $11.078 x 2 = $22.156 (2 pumps)

CP Year = $22.156 x 24 x 365 = $22.156 x 8760 = $194086.56

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:

$$\text{CPH} = \frac{9.6768}{.87375 \times .962}$$

$$\text{CPH} = \frac{9.6768}{.805675}$$

CPH = $12.02 (per pump per hour)

CPH = $12.02 x 2 = $24.04 (2 pumps)

CP Year = $24.04 x 24 x 365 = $24.04 x 8760 = $210590.40

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.

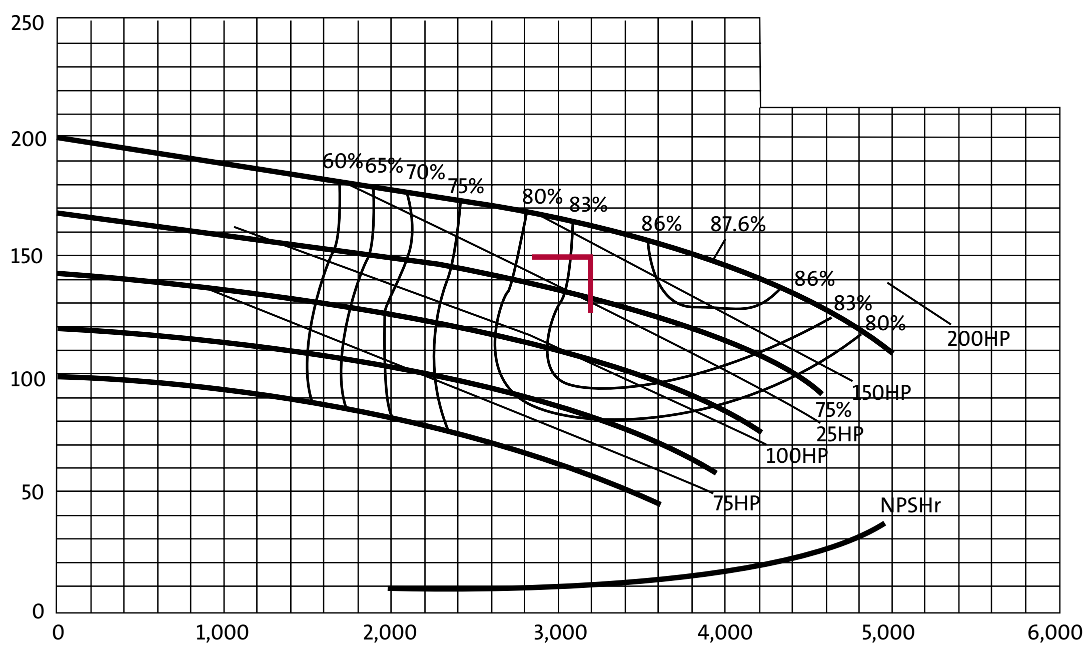

Figure 2. *Pump 2: A pump selected for 3200 GPM at 160' TDH (4-pole speed)*

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 installaions 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.

USA
GRUNDFOS Pumps Corporation
17100 West 118th Terrace
Olathe, KS 66061
Phone: (913) 227-3400
Telefax: (913) 227-3500

USA
PACO Pumps – National Headquarters
Grundfos CBS Inc.
902 Koomey Road
Brookshire, TX 77423
Phone: (800) 955-5847
Telefax: (800) 945-4777

CANADA
GRUNDFOS Canada Inc.
2941 Brighton Road
Oakville, Ontario
L6H 6C9
Phone: (905) 829-9533
Telefax: (905) 829-9512

MEXICO
Bombas GRUNDFOS de Mexico S.A. de C.V.
Boulevard TLC No. 15
Parque Industrial Stiva Aeropuerto
C.P. 66600 Apodaca, N.L. Mexico
Phone: 011-52-81-8144 4000
Telefax: 011-52-81-8144-4010

L-CBS-WP-12 • Rev. 12/09 (US)