

Energy Savings By The Numbers

Written by Kevin Delaney, Tuthill Pump Group with Bob Matthews, Royal Purple
Wednesday, 01 March 2006 21:31

The Royal Purple plant in Porter, TX, produces synthetic lubricants that are known the world over for their friction-reducing film strength and performance-enhancing properties. The growing popularity of Royal Purple products has resulted in significantly increased production demands. Coincidentally, as that demand has grown, so have energy costs. Thus, Royal Purple management recently requested an audit of pump energy consumption at its production facility.

Two types of pumps are generally used for process services at Royal Purple: internal gear pumps and air-operated diaphragm pumps. Pump duties include unloading raw materials, transfer of materials, product recirculation and unloading of finished products. The liquid viscosities vary greatly and range from very fluid to very viscous (from 5 and 600,000 ssu).

Dealing with a double whammy

The original design for the Royal Purple plant met generally accepted criteria for energy efficiency at the anticipated production levels during the initial plant planning and engineering phases. Unfortunately, the impact of increased production levels, coupled with escalating electrical energy costs, later turned into a true double whammy for the plant.

Not only did the cost per kilowatt-hour increase significantly, but the usage patterns of the pumps and compressors often spiked electricity usage, triggering a very substantial electrical demand charge. A thorough accounting analysis of the electrical charges also revealed that with fees and surcharges factored in, the actual cost per kilowatt-hour was much higher than the more widely quoted base kilowatt-hour charge.

The purpose of the requested energy audit was, first, to understand the situation (i.e. how much energy each pump was consuming), and, secondly, to use this information to make improvements where economically justified, as well as to provide a basis for making more energy-conscious pump selections in the future.

The audit

The first step was to collect the operating conditions of flow, pressure and viscosity. This data was then used to estimate energy consumption at the operating point for each pump. Manufacturer's selection guides downloaded from the Internet were used to estimate power consumption for the operating conditions.

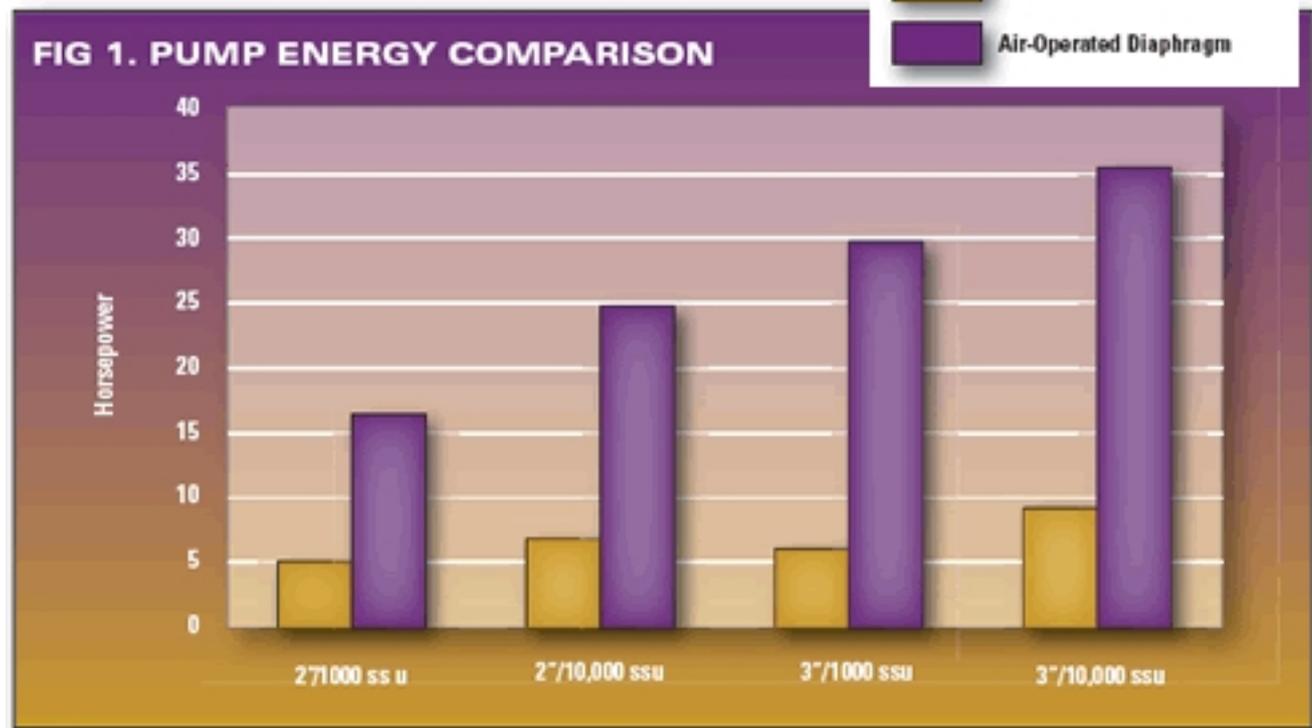
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For the internal gear pumps, power consumption was expressed in terms of BHP or brake horsepower. Brake horsepower is the power required by the pump—it does not take into account motor losses. For the plant’s air-operated diaphragms pumps, power was estimated by taking the CFM required at the operating point, then converting the CFM to BHP using a conversion factor of 4 CFM per horsepower.

Table I. Pump Energy Comparison

Flow GPM	PSI	Viscosity SSU	AODD Size	AODD CFM	AODD HP @ 4 CFM per HP	Internal Gear Size/ Motor HP	Internal Gear Motor BHP at rating	Potential HP Savings (Difference)	Potential Annual Energy Savings Per 1000 Hours Operation
80	40	1000	2"	84	21	2"/7.5	4.75	16.25	\$1,043
80	40	10000	2"	126	31.5	2"/7.5	6.8	24.7	\$1,585
120	40	1000	3"	143	35.75	3"/10	6.03	29.7	\$1,905
120	40	10000	3"	178	44.5	3"/10	9.2	35.3	\$2,265



Annual energy costs for a pump may be calculated by the following formula:

$$\text{Brake Horsepower} \times ([.746 \text{ HP}] / [\text{KW}]) \times ([\$ \text{KW}] / [\text{HR}]) \times \text{Annual Operating Hrs.}$$

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This formula is useful for making comparisons between pumps. Actual electrical costs will be modestly higher taking into account motor and system losses. With this data, a table and chart can be constructed as in Table I and Fig. 1. Reviewing them leads to some interesting observations:

1. The air-operated diaphragm pumps take four to almost six times the energy of the internal gear pumps on the services surveyed.
2. Pumping more viscous liquids widens the energy premium for air-operated diaphragm pumps.
3. Larger pumps and flows have proportionately greater impact on energy consumption and costs.
4. Energy costs are directly affected by the number of operating hours.

The bottom line

The energy consumption difference between air-operated diaphragm pumps on the surveyed services is clearly substantial. With that said, many air-operated diaphragm pumps are used for intermittent duty services, only few hours per week, and for these applications, the energy cost impact may be relatively small. Also, if air-operated diaphragm pumps are of a very small size, there may not be enough total energy consumption involved to really matter.

What made such an unwelcome impact on the electric bill for Royal Purple was the fact that many of the company's pumps are of significant size and many of them are being operated for several thousand hours per year. Some, in fact, are operated continuously at low cycle-rates for recirculation. This is what has caused electricity costs to really add up for the production plant.

But, the electrical cost, while important, is only one of several cost factors to consider in pump selection. For example, an air-operated diaphragm pump can cost approximately \$1400 and an electric-motor-driven gear pump for the same service can cost in the neighborhood of \$5000. (Add the wire, variable speed drive, pressure transmitter and labor and the total cost jumps to approximately \$8,000.) This is why it is so important to take all the factors into consideration. Royal Purple has had close to zero maintenance on its gear pumps, while its air-operated diaphragm pumps have required more maintenance. The company recognizes that growth requires change to operate and maintain this quality focused facility. As is heard around the plant, "we like to think that none of us are as smart as all of us."

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Royal Purple is using the information from this energy audit in two ways. First, it wants to identify existing applications, where the return on investments are attractive enough to justify replacing air-operated diaphragm pumps with internal gear pumps. Secondly, it wants to make sure that any new pumps will be evaluated for energy consumption based on the actual or projected operating conditions.

Granted, energy consumption may not have been primary criteria for pump selection in the past, but by the numbers at today's rates, it has become an important consideration. Royal Purple and many growing manufacturers today can be more costeffective by partnering with good suppliers to look at the cost to operate their equipment, the associated requirements and projected expansion(s) along with their equipment cost. **MT**

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