Energy Tips – Pumping Systems

Match Pumps to System Requirements

An industrial facility can reduce the energy costs associated with its pumping systems, and save both energy and money, in many ways. They include reducing the pumping system flow rate, lowering the operating pressure, operating the system for a shorter period of time each day, and, perhaps most important, improving the system’s overall efficiency.

Often, a pumping system runs inefficiently because its requirements differ from the original design conditions. The original design might have been too conservative, or oversized pumps might have been installed to accommodate future increases in plant capacity. The result is an imbalance that causes the system to be inefficient and thus more expensive to operate.

Correct Imbalanced Pumping Systems

If the imbalance between the system’s requirements and the actual (measured) discharge head and flow rate exceeds 20%, conduct a detailed review of your plant’s pumping system. Calculate the imbalance as follows:

\[
\text{Imbalance (\%) = \left(\frac{Q_{\text{meas}} \times H_{\text{meas}}}{Q_{\text{req}} \times H_{\text{req}}} - 1\right) \times 100\%} ,
\]

where

- \(Q_{\text{meas}}\) = measured flow rate, in gallons per minute (gpm)
- \(H_{\text{meas}}\) = measured discharge head, in feet
- \(Q_{\text{req}}\) = required flow rate, in gpm
- \(H_{\text{req}}\) = required discharge head, in feet.

A pump may be incorrectly sized for current needs if it operates under throttled conditions, has a high bypass flow rate, or has a flow rate that varies more than 30% from its best efficiency point (BEP) flow rate. Such pumps can be prioritized for further analysis, according to the degree of imbalance or mismatch between actual and required conditions.

Energy-efficient solutions include using multiple pumps, adding smaller auxiliary (pony) pumps, trimming impellers, or adding a variable-speed drive. In some cases, it may be practical to replace an electric motor with a slower, synchronous-speed motor—e.g., using a motor that runs at 1,200 revolutions per minute (rpm) rather than one that runs at 1,800 rpm.

Conduct quick reviews like this periodically. Especially for multipump systems, this can be a convenient way to identify opportunities to optimize a system at little or no cost.

Example

This example shows the energy savings that can be obtained by not using an oversized pump. Assume that a process requires 1,500 tons of refrigeration during the three summer months, but only 425 tons for the remaining nine months. The process uses two chilled water pumps operating at 3,500 gpm and requiring 200 brake horsepower (bhp) each. Both are used in summer, but two-thirds of the flow rate is bypassed during the remaining months.

Suggested Actions

- Survey your facility’s pumps.
- Identify flow rates that vary 30% or more from the BEP and systems imbalances greater than 20%.
- Identify misapplied, oversized, or throttled pumps and those with bypass lines.
- Assess opportunities to improve system efficiency.
- Consult with suppliers on the cost of trimming or replacing impellers and replacing pumps.
- Determine the cost-effectiveness of each improvement.

Resources

DOE and Hydraulic Institute, Improving Pumping System Performance: A Sourcebook for Industry.

Hydraulic Institute—HI is a non-profit industry association for pump and pump system manufacturers; it provides product standards and a forum for the exchange of industry information for management decision-making. In addition to the ANSI/HI pump standards, HI has a variety of energy-related resources for pump users and specifiers, including training, guidebooks, and more. For more information, visit www.pumps.org, www.pumplearning.org, and www.pumpsystemsmatter.org.


Visit the BestPractices Web site at www.eere.energy.gov/bestpractices for more information on PSAT and for upcoming training in improving pumping system performance and in becoming a qualified pumping system specialist.
One 3,500-gpm pump is therefore replaced with a new 1,250-gpm pump designed to have the same discharge head as the original unit. Although the new pump requires only 50 bhp, it meets the plant’s chilled water requirements most of the year (in all but the summer months). The older pump now operates only in the summer.

Assuming continuous operation with an efficiency ($\eta_m$) of 93% for both motors, we can calculate the energy savings from operating the smaller pump as follows:

$$\text{Savings} = \frac{(200 \text{ hp} - 50 \text{ hp})/\eta_m \times 0.746 \text{ kW/hp} \times (9 \text{ months}/12 \text{ months}) \times 8,760 \text{ hours/year}}{0.746 \text{ kW/hp} \times (9 \text{ months}/12 \text{ months}) \times 8,760 \text{ hours/year}} = 790,520 \text{ kWh/year}$$

At an average energy cost of 5 cents per kWh, annual savings would be about $39,525.

References

- Trim or Replace Impellers on Oversized Pumps, DOE Pumping Systems Tip Sheet, 2005.