Minimizing *Lifecycle Costs*

The design and selection of new pumping systems provides the opportunity for facilities to purchase systems optimized for minimum lifecycle costs. Because industrial and municipal pumping systems often have life spans of 15 years or longer, the initial cost of a pumping system represents only a small portion of the total expenditures needed to operate and maintain the system.

By Robert K. Asdal

Selecting an energy-efficient pumping system

Minimizing lifecycle costs often requires tradeoffs between cost elements, such as paying higher initial or installation costs to avoid unnecessary maintenance, energy and downtime costs. Matching the right pump to the system requirements at the design process is the best way to achieve the highest efficiency.

Pumping System Components

When choosing the proper pumping system according to specific needs, it is important to remember that several other major components can greatly affect system efficiencies. For instance, the selection of efficient and properly sized electric motors is vital, along with the use of variable speed drives when appropriate. Adequate piping inlet and outlet configurations are also important for efficient system operation.

Additionally, the appropriate selection and operation of valves is critical, especially any throttling or bypass valves. Along with pump speed control and multiple pump arrangements, bypass valves and throttling valves are the primary methods for controlling rates of flow in pumping systems.

The most appropriate type of speed control depends on the system size and layout, fluid properties and other factors. Bypass arrangements allow fluid to flow around a system component, but at the expense of system efficiency because the power used to bypass any fluid is wasted. Throttling valves restrict fluid flow at the expense of pressure drops across the valves and the associated energy loss.

Furthermore, pumping systems are typically designed to support the needs of other systems, such as process fluids transfer, heat transfer and the distribution of water and wastewater.

Systems are generally classified as closed-loop or open-loop systems. Closed-loop systems recirculate fluid around set paths, while open-loop systems have specified inputs and outputs, transferring fluids from one point to another. For closed-loop systems, the frictional losses of system piping and equipment are the dominant loads. Open-loop systems often have significant static head requirements due to elevation and tank pressurization needs. Pumps, prime movers, piping, valves and end-use equipment typically comprise these systems.

Other common pump system components include filters, strainers and heat exchangers. Any evaluation of a pumping system should consider the interaction between these components, not just the pump itself. This is referred to as the "systems approach" to pumping system evaluation. The pump(s) and the system must be designed and treated as one entity, not only to ensure correct operation but also to reap the benefits of energy-efficient pumping.

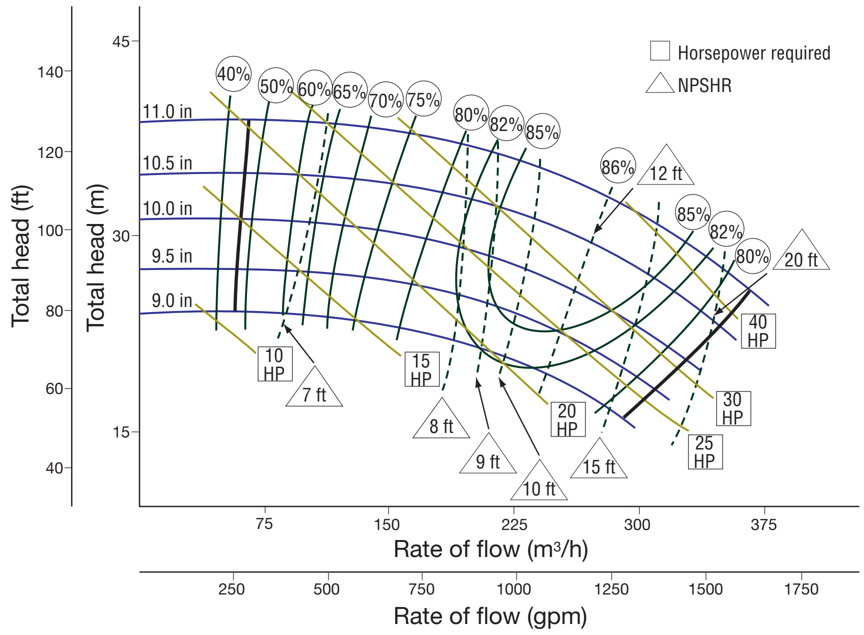
Selecting Pump Models

The Hydraulic Institute recognizes about 40 different types of pumps, broadly classified into two categories that relate to the manner in which the pumps add energy to the working fluid: positive displacement and rotodynamic (centrifugal).

Of these two types of pumps, rotodynamic pumps are the most widely used because of their compactness and easy maintenance. Rotodynamic pumps have few moving parts and the wear caused by normal operation is minimal. Rotodynamic pumps can also handle high flow rates, provide smooth, nonpulsating delivery and regulate the flow rate over a wide range.

Rotodynamic pumps are manufactured with different impeller designs to produce pumps that can perform efficiently under conditions that vary from low flow rate with high head

Figure 1 - Example Pump Curve
A typical manufacturer's published curve for a given pump size and speed showing the available range of impeller diameters.



to high flow rate with low head. The amount of fluid a rotodynamic pump moves depends on the differential pressure or head it supplies. The flow rate increases as the head decreases.

Manufacturers typically provide a chart or performance curve that indicates the zone or range of heads and flow rates that a particular pump model can provide; but generally, the amount of fluid a rotodynamic pump moves depends on the differential pressure or head it supplies.

Before you select a pump model, examine its performance curve, which is indicated by its head-flow rate or operating curve. The curve shows the pump's capacity—in gallons per minute and cubic meters per hour—plotted against total developed head (in feet and meters). It also shows efficiency (percentage), required power input (in brake-horsepower), and suction head requirements (net positive suction head required in feet) over a range of flow rates.

Pump curves also indicate pump size and type, operating speed (in revolutions per minute) and impeller size (in inches). It also shows the pump's best efficiency point (BEP). The pump operates most cost effectively when the operating point is close to the BEP.

Rotodynamic pumps can be ordered with a variety of impeller sizes. Each impeller diameter has a unique performance curve (Figure 1). To minimize pumping system energy consumption, select a pump so the system curve intersects the pump curve within 20% of its BEP, and select a midrange impeller that can be trimmed or replaced to meet lower or higher flow rate requirements. Select a pump with high efficiency contours over your range of expected operating points. A few points of efficiency improvement can save significant energy over the life of the pump.

A few suggested actions for achieving optimal pump system efficiencies include:

- Accurately identify process flow rate and pressure requirements;
- Measure actual head and flow rate;
- Develop a system curve;
- Select a pump with high efficiency over the expected range of operating conditions;
- Select a correctly sized pump and drive motor; and
- Develop an index. A useful index for comparing pumps in the same application involves calculating the gallons of fluid pumped per kilowatt-hour of electrical energy used (gal/kWh).

This index illustrates the fluid transported per unit of energy expended. Calculating the inverse—kWh/gal—is equally useful, and provides the basis for an energy cost comparison. *wqp*

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