Technical Paper

Energy efficiency in pumping technology

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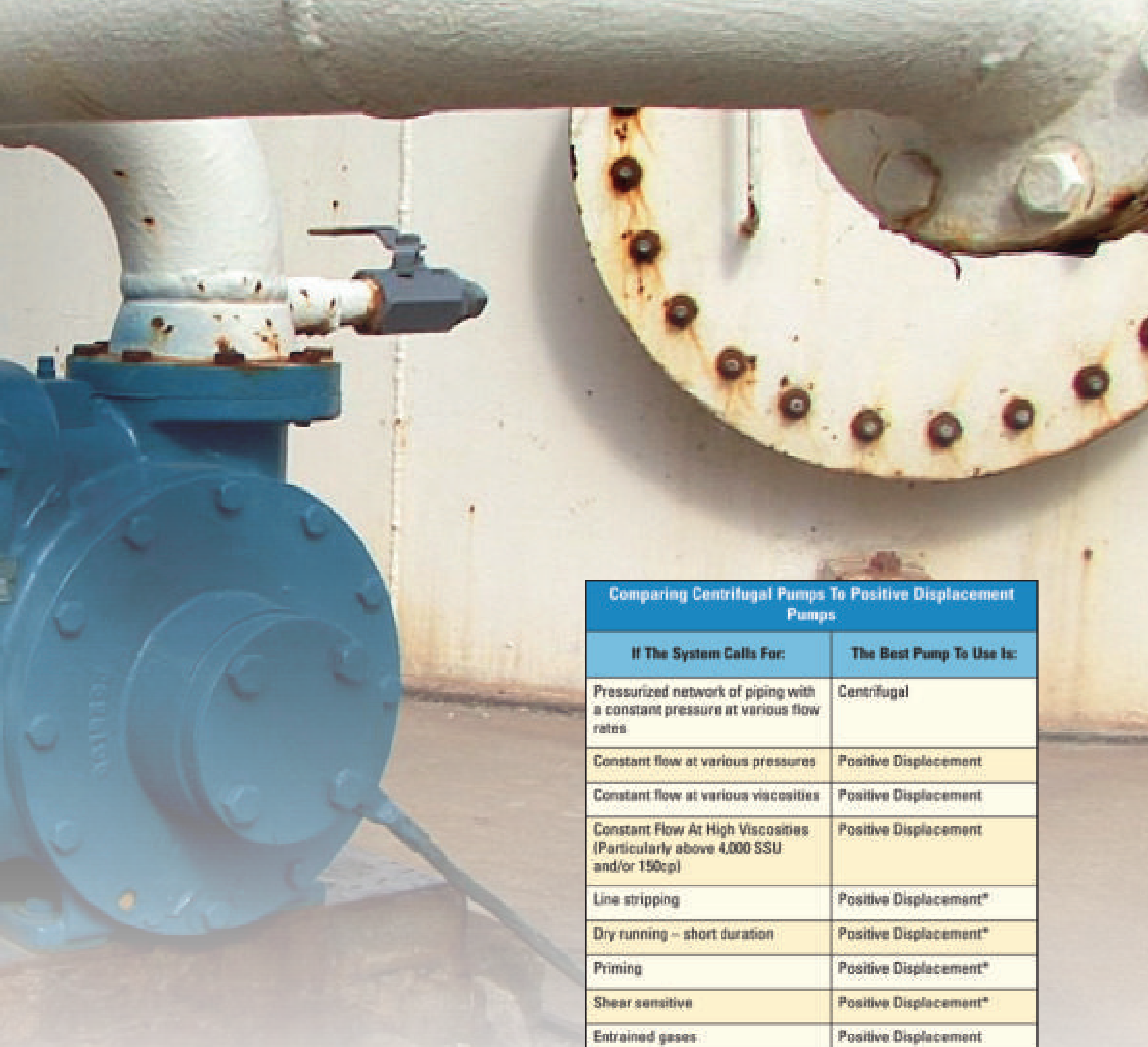
Purchasers of rotating equipment need to get the selection of their pumps right first time, there is no second chance. Selecting the right pump is complicated by the fact that many different types of pumps can be applicable for a single operation. When making the final choice in the type of pump, several crucial factors need to be taken into account: required flow rate, suction and differential pressure, temperature, viscosity, and the corrosiveness of the liquid being handled.

As spelled out in "Improving Pumping System Performance: A Sourcebook for Industry," a joint effort between The Hydraulic Institute and the U.S. Department of Energy's Energy Efficiency and Renewable Energy (EERE) Program, poor design and improper system operation are at the root of inefficient pumping systems. As rotating equipment, pumps are subject to wear, erosion, cavitation and leakage. These problems can be exacerbated through improper pump selection and operation. If they are not selected or operated properly, pumps can waste enormous amounts of energy, as well as require considerable maintenance. Facility managers too often choose oversized pumps when outfitting their systems under the incorrect



Comparing Centrifugal Pumps To Positive Displacement Pumps	
If The System Calls For:	**The Best Pump To Use Is:**
Pressurized network of piping with a constant pressure at various flow rates	Centrifugal
Constant flow at various pressures	Positive Displacement
Constant flow at various viscosities	Positive Displacement
Constant Flow At High Viscosities (Particularly above 4,000 SSU and/or 150cp)	Positive Displacement
Line stripping	Positive Displacement*
Dry running – short duration	Positive Displacement*
Priming	Positive Displacement*
Shear sensitive	Positive Displacement*
Entrained gases	Positive Displacement
High flow / low head	Centrifugal
Low flow / high head	Positive Displacement

Figure 1
Noto(*): Dependent on Positive Displacement pump technology/type selected.

belief that such equipment will address future capacity needs. These decisions ignore the added energy costs inherent in operating oversized pumps. The choice when outfitting a pumping system most often comes down to selecting between a positive-displacement (PD) or centrifugal-style pump. While the majority of the world's pumping tasks may currently be performed with centrifugal-style pumps, more and more facility managers and operators are becoming aware of the benefits of sliding vane technology. Although the operating principles of PD and centrifugal pumps differ widely, in many cases both designs can be used for the same services. In these "overlap" applications, choosing positive- displacement technology can result in improved processes, uptime and energy savings.

In looking at a list of the most common system characteristics that need to be considered in a pumping application (See Figure 1), PD pumps outperform their centrifugal rivals in almost all of them. Depending on the technology chosen, PD pumps may offer:

- Constant flow, relatively, independent of changes in system pressure
- Constant flow, relatively, independent of changes in pumpage viscosity
- Ability to pump high viscosity products
- Ability to handle entrained gases
- Ability to self-prime
- Ability to line strip
- Ability to run dry for short periods
- Higher efficiency across varying system pressures

Positive-displacement pumps offer a long list of operational advantages when compared to centrifugal-style pumps, within the PD family of pumps itself sliding vane technology also reigns supreme.

Possible Solutions

Positive-displacement pumps pressurize fluid with a collapsing-volume action, essentially moving an amount of fluid equal to the displacement volume of the pump with each shaft rotation. As such, PD pumps have what is called a "fixed displacement volume," meaning that the flow rates they generate are directly proportional to their speed, and the pressures generated are determined by the system's resistance to this flow.

These characteristics make PD pumps appropriate for applications that feature working fluids that are viscous; systems that require high-pressure; low-flow/high pressure requirements; flows that must be precisely controlled; or when high pumping efficiency is desirable. Within the family of positive displacement pumps there are numerous different types or technologies available. Sliding vane and gear pumps are two of the most widely used rotary types.

Gear Pumps

Simply put, a gear pump uses the meshing of gears to pump fluid by displacement. As the gears rotate, they separate on the intake side of the pump, creating a void, which is filled by the fluid that is being handled. This fluid is transported by the gears to the discharge side of the pump where the meshing of the gears forces the fluid to exit the pump through the discharge port. Gear pumps can be further divided into external gear pumps and internal gear pumps. While the pumping action for both is comparable, external gear pumps utilize two similar rotating gears to mesh, whereas the internal gear pump utilizes a drive, or rotor, gear operating against a smaller internal, or idler, gear. Gear pumps mesh gears and this constant wear increases the internal pumping clearances in the process reducing flow capacity and volumetric consistency. To compensate for these larger clearances, the pump speed or size must be increased, which not only increases energy consumption, but also further accelerates the pump's wear. The other alternative is to live with reduced pumping capacity until the pump's performance drops to an unacceptable level. These wear conditions can often go undetected for a long period of time before the necessary maintenance is performed (see Figure 2). As reported in The Hydraulic Institute's "Testing for Pumping System Efficiency Tip Sheet," "A (gear) pump's efficiency can degrade as much as 10% to 25% before it is replaced, according to a study of industrial facilities commissioned by the U.S. Department of Energy, and efficiencies of 50% to 60% are quite common. However, because these inefficiencies are not readily apparent, opportunities to save energy by repairing or replacing components and optimizing systems are often overlooked." The degradation of internal clearances is also a trait found in centrifugal pumps.

Sliding Vane Pumps

As opposed to gears meshing together, sliding vane pumps operate through the use of a number of vanes that slide

Comparison of Sliding Vane Pumps Vs. Internal Gear Pumps

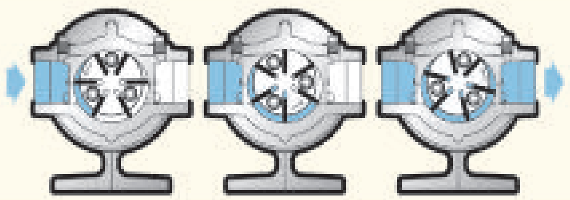
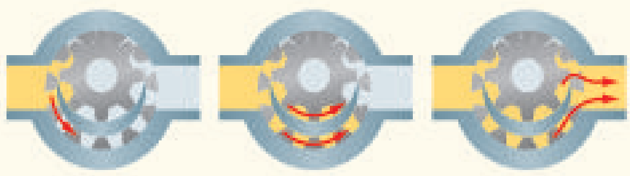
Sliding Vane Pumps	Internal Gear Pumps
■ **Superior Mechanical Performance** ■ **Provides Greater Energy Savings** ■ **24% More Efficient Than Gear Pumps**	■ **Less Mechanically Efficient** ■ **Consume more energy than vane pumps**
	
■ Sliding vane pumps have a number of vanes that slide into and out of slots in the pump rotor ■ When the pump driver turns the rotor, centrifugal force, rods and/or pressurized fluid causes the vanes to move outward in their slots and bear against the inner bore of the pump casing, forming pumping chambers ■ This fluid is passed around the pump casing to the discharge port ■ Each revolution displaces a constant volume of fluid ■ Variances in pressure have minimal effect ■ The sliding vanes automatically adjust to maintain near perfect clearances throughout operating life ■ Energy-wasting turbulence and slippage are minimized and high volumetric efficiency and low energy consumption are maintained	■ Internal gear pumps utilize an outer gear called a rotor that is used to drive an inner gear called the idler ■ The gears create a void as they come out of mesh - the volumes are reduced and liquid is forced out the discharge port ■ Each revolution displaces a constant volume of fluid ■ Variances in pressure have minimal effect ■ The metallic gears wear over time resulting in wider clearances; this increases energy-robbing slippage and significantly decreases volumetric efficiency ■ In order to compensate for performance degradation, pump speed or size is increased which requires greater energy consumption

Figure 2

into or out of slots in the pump rotor when the pump is rotating. The vanes move outward from the rotor and ride against the inner bore of the pump casing, in the process forming pumping chambers. As the rotor revolves, fluid enters the pumping chambers from the suction port. The fluid is transported around the pump casing until it reaches the discharge port where it is forced out into the discharge piping. This type of design virtually eliminates slippage, meaning that the pump's high volumetric efficiency is maintained. Because the self-adjusting sliding vanes continuously adjust for wear, sliding vane pumps are able to maintain near- original efficiency and capacity throughout the life of the pump. The pump speed also does not need to be increased over time, making sliding vane pumps inherent energy-savers (See Figure 2). If the sliding vanes do wear out, or are damaged, replacing them is easy and quick. Replacement of vanes can be accomplished by removing the outboard head assembly, removing the old vanes, inserting new ones and reinstalling the head, all without the need for special tools. Sliding vane pumps are used in a wide variety of process and transfer applications within numerous markets, such as: chemical process, crude oil, refined fuels, bio-fuels, pharmaceuticals, cosmetics, food processing, health care manufacturing, pulp & paper, wastewater, military, commercial marine, soap & detergents and paint & coatings.

Conclusion

Sliding vane technology can solve everything from suction, product shear and volumetric-efficiency problems to offering unique benefits such as line-stripping capabilities and metering —all while saving energy. It offers numerous advantages in the quest to reduce energy consumption and cost without sacrificing performance, making them an excellent positive-displacement pump choice in these increasingly energy-conscious times.

About Blackmer

Sliding vane technology was invented by Robert Blackmer in 1899. Blackmer manufactures multiple lines of sliding vane pumps, each with areas of primary applicability, ranging in size from 3/4-inch ports to 10-inch ports with flow rates ranging from 1 gmp (3.8 lpm) to 2,200 gpm (8,328 lpm) with a maximum viscosity of >500,000 SSU (108,000 cP). Sliding vane pumps are a key component of Blackmer's Smart Energy Program, which emphasizes the ability of its positive-displacement pumps to increase the energy efficiency of plants where pumping systems are in operation.