The Hidden Energy Savings of Pump Installations, Technology

INSTALLATION AND PUMP CHOICES ARE PARAMOUNT IN KEEPING ENERGY COSTS DOWN

November 2022 *By Paul Cardon*

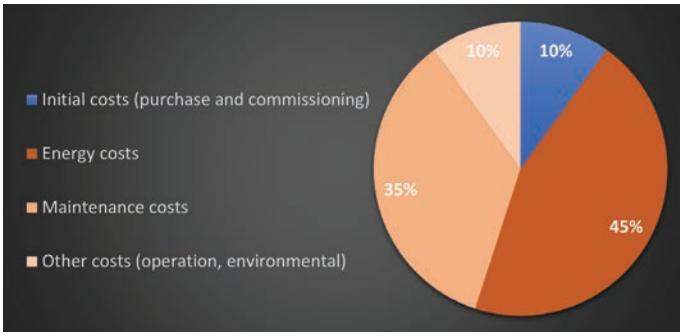
The cost of energy has dramatically increased in 2022, a far cry from its patterns over the past few decades. These costs occurred unexpectedly and quickly, causing all industries to confront it and look for energy savings wherever possible. These new behaviors are key as these costs are unlikely to change in the foreseeable future.

Among all items in an industrial production process, pumping systems can be one of the most "power hungry." According to the Hydraulic Institute (USA), pumping systems account for nearly 20% of the world's electrical energy demand. In these times of pricey and scarce energy, it is paramount to find different ways to reduce the power consumption of pumping systems.

Life Cycle Cost of a Pump

The typical cost breakdown for a positive displacement (PD) pump over its lifetime is as follows:

The initial costs (blue) are only paid once during the installation phase. These are minor costs associated with a pump's total cost of ownership. The major costs are those shown in different shades of brown, which are paid during the life of the installation. Among these costs, energy represents almost half of the total cost of ownership. Given the current energy conditions, it has likely increased more than other parameters, potentially showing an even higher percentage of a pumping installation total cost of ownership.



There are mainly two area to focus on to reduce energy consumption:

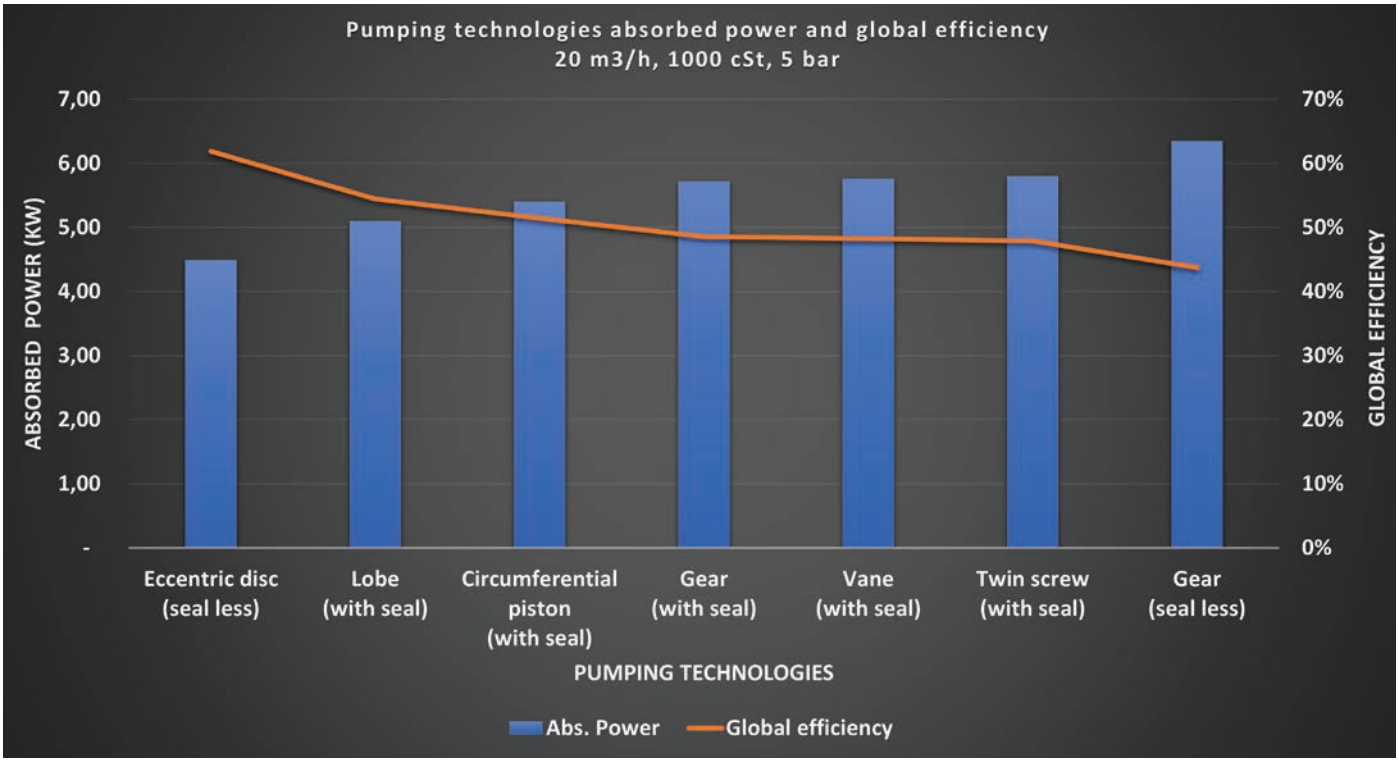
- The pump
- The installation

Focusing on these two areas, either when designing a new installation or improving an existing one, can, in some extreme cases, lead to energy consumption divided by three.

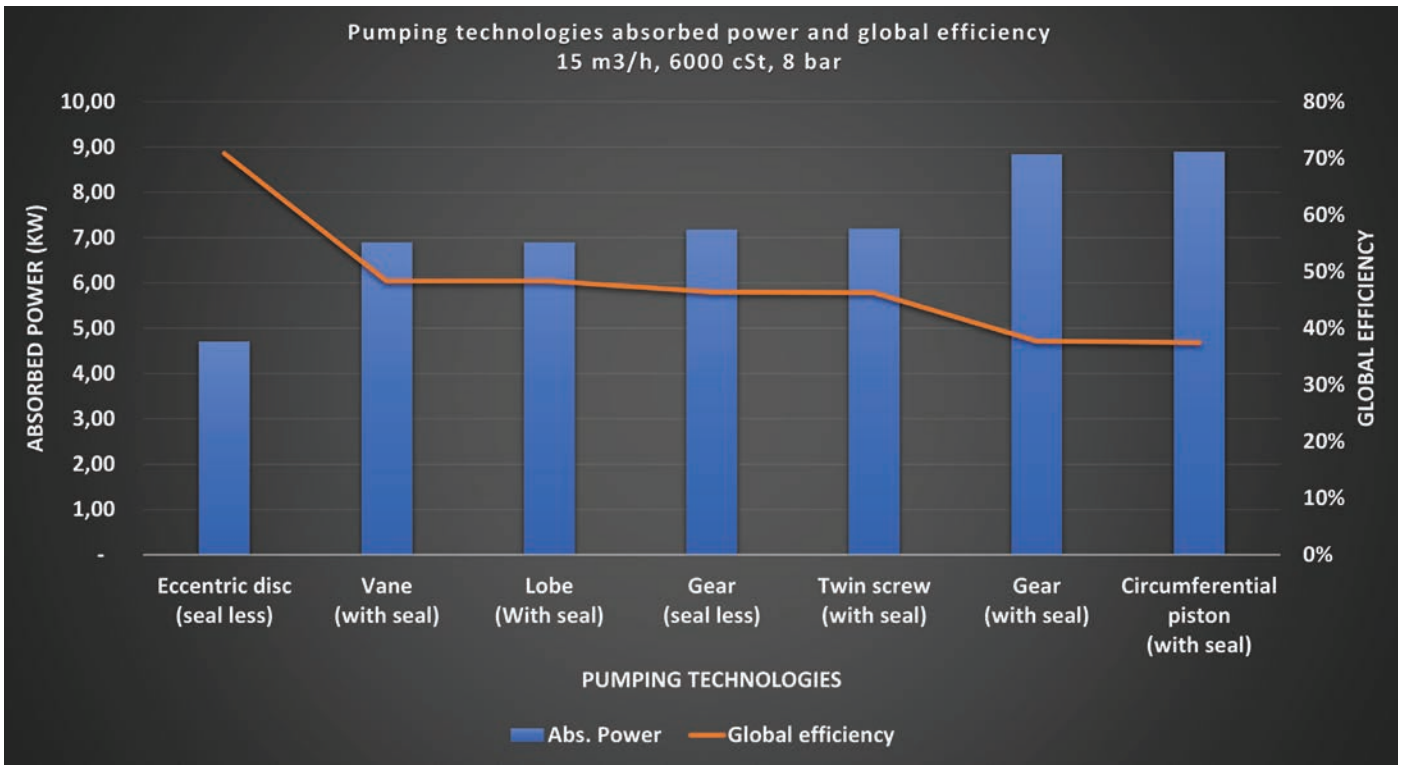
The Pump

There are several positive displacement pumping technologies available on the market. However, they are far from being equal in terms of energy consumption.

On mid/lower viscosities, and for identical flow rate and pressure conditions, deltas up to 40% can be observed between different pumping technologies:



With higher viscosities, discrepancies can sometime be even more spectacular with up to 90% gaps:



In both cases above and in most others, it is the same pumping technology that appears to be the most economical: The Mouvex® seal-less eccentric disc pump.

Why is this pumping technology so energetically efficient?

Single Shaft

Some pumping technologies are based on a two-shaft design with timing gears. Gears and more bearings generate extra friction, both on the power end (with parts rotating in lubricating oil) and the wet end (parts rotating in pumped product).

The Mouvex pump has only one shaft, which rotates in clean oil inside double or triple bellows, isolating it from pumped product. This reduces frictions to a minimum.

No Rotating Parts In The Pumped Product

The Mouvex technology is based on just two pumping parts: a static cylinder and a moving disc, which does not rotate but rather follows a circular translation around the cylinder.

The differential linear speed between cylinder and disc is low and equal on every point of the disc. This "slow motion" requires less energy to be obtained compared with pumps that have rotating parts, which function with high peripheric speed.

No Bushings In The Pumped Product

Some pumping technologies are based on a shaft held by bushings in the pumping chamber. Though manufactured in materials offering a low friction coefficient, these parts are still in a friction zone. As mentioned earlier, in the Mouvex eccentric disc pump, the rotating shaft is not in contact with the pumped product but instead protected by multiple-layer stainless steel bellows. The only parts in contact with the product are the casing, bellows and the disc/cylinder set.

No Mechanical Seal

A mechanical seal is based on the friction between two rotating faces. These faces show low friction coefficient but especially in a multiple seal arrangement (up to four mechanical seals on pumps with two shafts), extra energy is needed to overcome this. Additionally, a double mechanical seal requires a fluid barrier which itself generates energy consumption: fluid circulation, control, etc.

Seal-less solutions such as magnetic drive, which do not have parts in friction, still require more power because of the strong magnetic fields needed for torque transmission.

The Mouvex eccentric disc pump does not have any mechanical seal or magnets. Shaft tightness is provided by the bellows, linked to the pump casing on one side and to the disc on the other side. This solution does not generate any extra friction while providing total containment and lessening the need for frequent maintenance.

Lower Rotation Speed

In many cases, Mouvex eccentric disc pumps maintain lower shaft rotation speed for equal flow rate and differential pressure. On most applications, a Mouvex pump will have a rotation speed between one and two times lower compared with other technologies. A lower speed requires less energy and improves the durability of moving parts, such as bearings.

Extra Advantages

Mouvex eccentric disc pumps also offer several additional advantages that can lead to indirect energy savings:

- Product recovery: These pumps can run dry and can generate a strong vacuum on the suction side and air compression on the discharge side. This allows operators to recover a significant amount of product from the pipes. If the installation requires clean-in-place (CIP) functionality, piping with less residual product will be easier and quicker to clean, which will also improve energy savings.
- Limited maintenance: Maintaining industrial process equipment requires energy. Mouvex eccentric disc pumps function exceptionally with limited maintenance as they do not have a mechanical seal, do not need shimming, and feature only two pumping parts that are easy to replace. This means less maintenance and less energy consumption compared with similar pump technology.

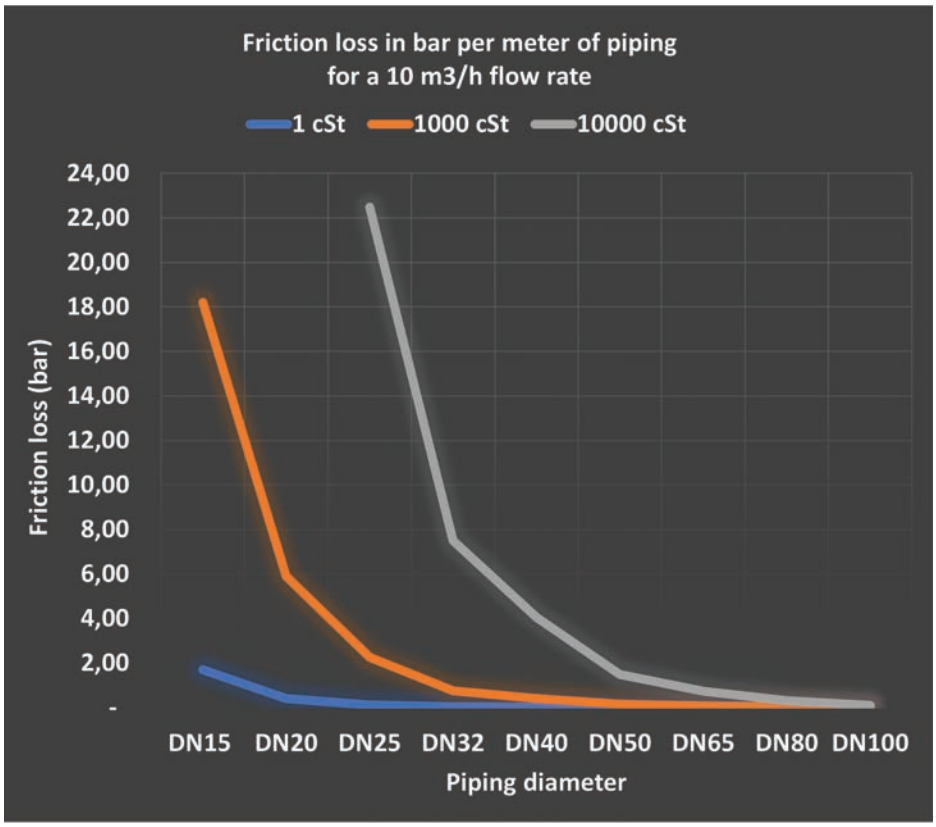
Installation

Piping Diameter

Many operators will look to save on costs by selecting smaller diameter piping when possible. Smaller diameter piping is cheaper and does not need as much support as larger variants. However, these are the typical costs of the "blue section" in the lifecycle cost graph: they are only paid once during the installation phase.

But this parameter can have a huge influence on pumping installation power consumption, meaning the real expense will be paid over the lifetime of the installation.

Low viscosity products will not have a negative effect on a smaller diameter piping system. As viscosities rise, however, those smaller diameters will become problematic. Consider the graph to the right:



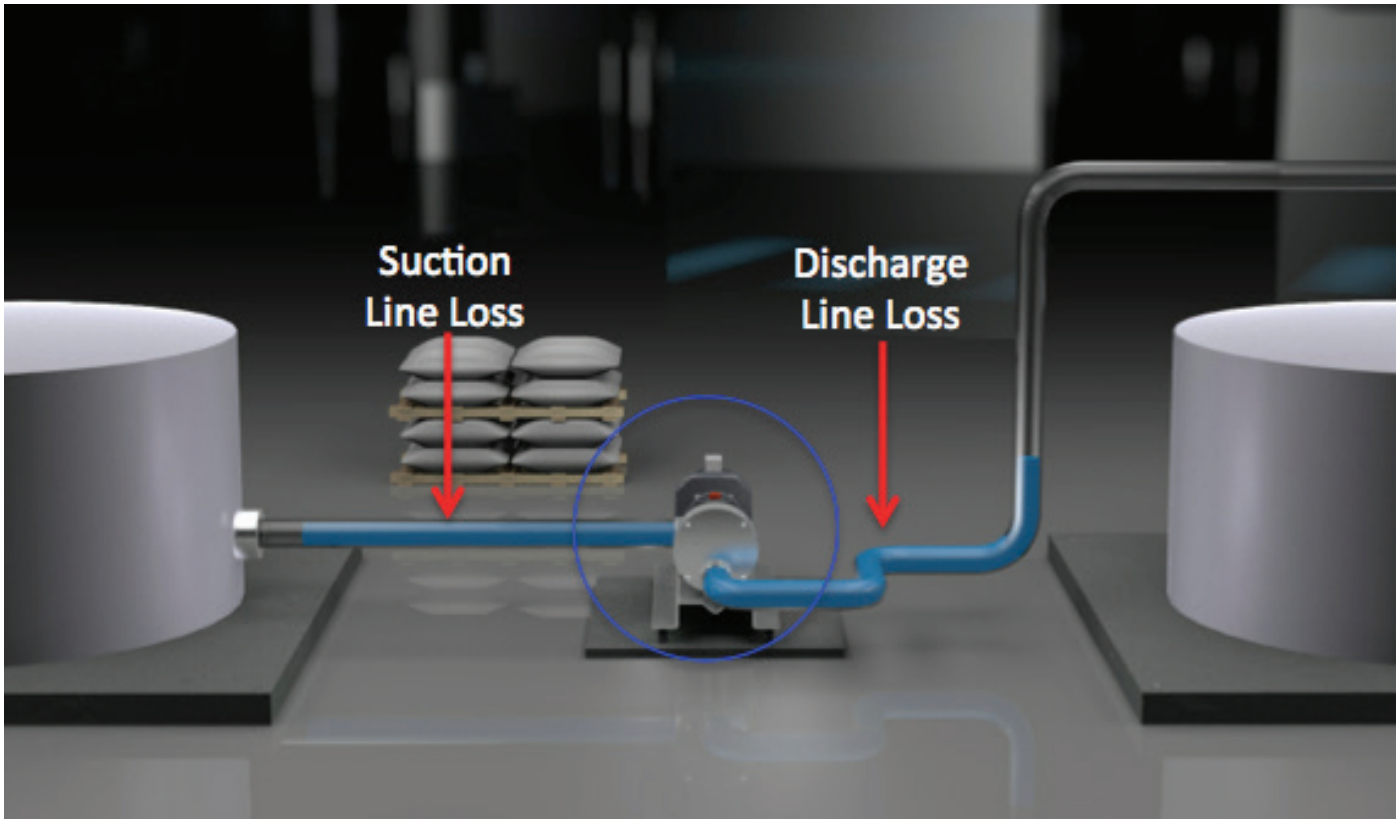
This example will look at the complete installation to show how important this parameter can be regarding energy consumption.

Let's consider the installation below with the following parameters:

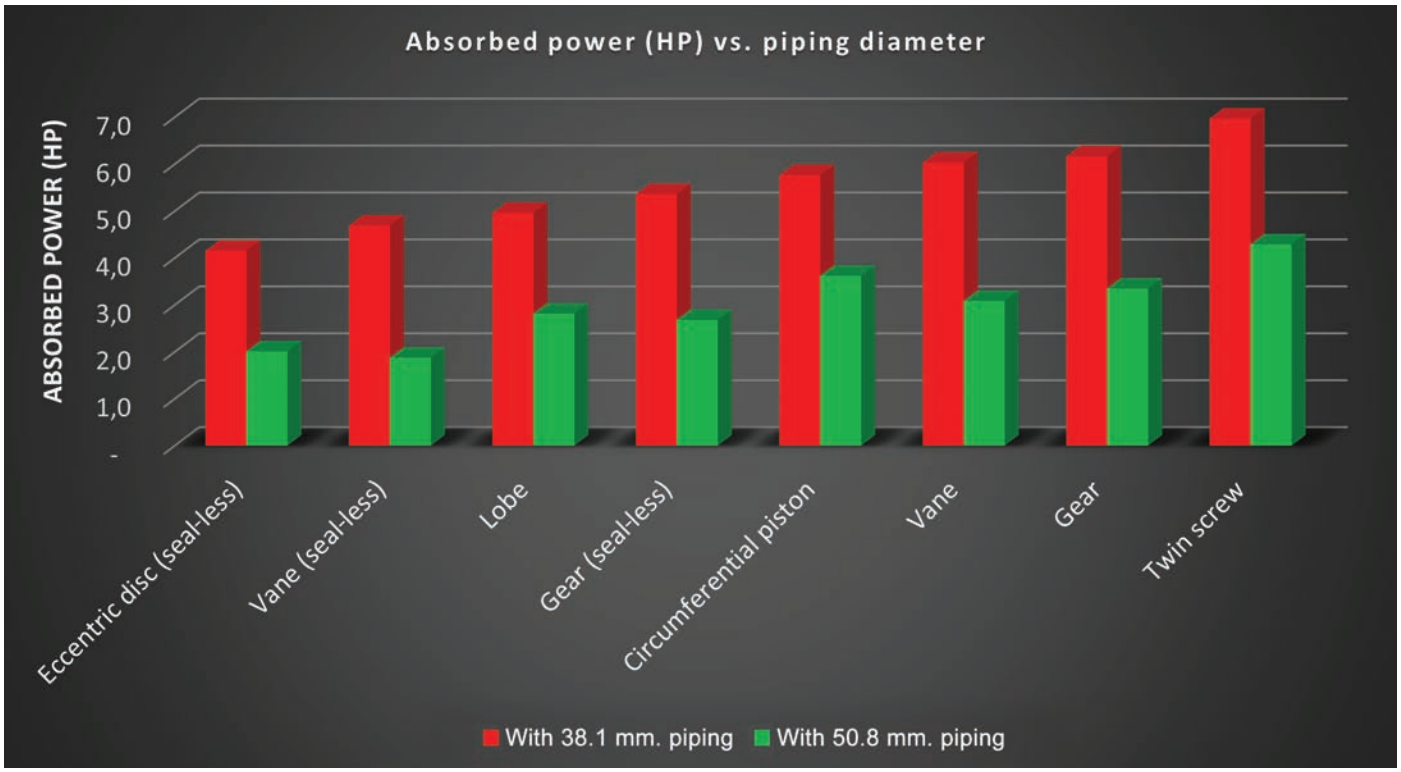
Flow Rate:	**10 m³/h**
Viscosity:	**500 cSt.**
SUCTION LINE:	
Piping Length:	**2 m.**
2 Butterfly Valves	
DISCHARGE LINE	
Piping Length:	**40 m.**
6 Elbows	
2 Butterfly Valves	
6 m. lift	

If we build the installation with 40 mm. piping, the resulting differential pressure on the pump ports will be 9.2 bar. If the differential pressure is within the selected pump limits, the installation will operate without issues.

But let's see what happens if we build the installation with 50 mm. piping (only one standard pipe size above). Differential pressure drops down to 3.7 bar.



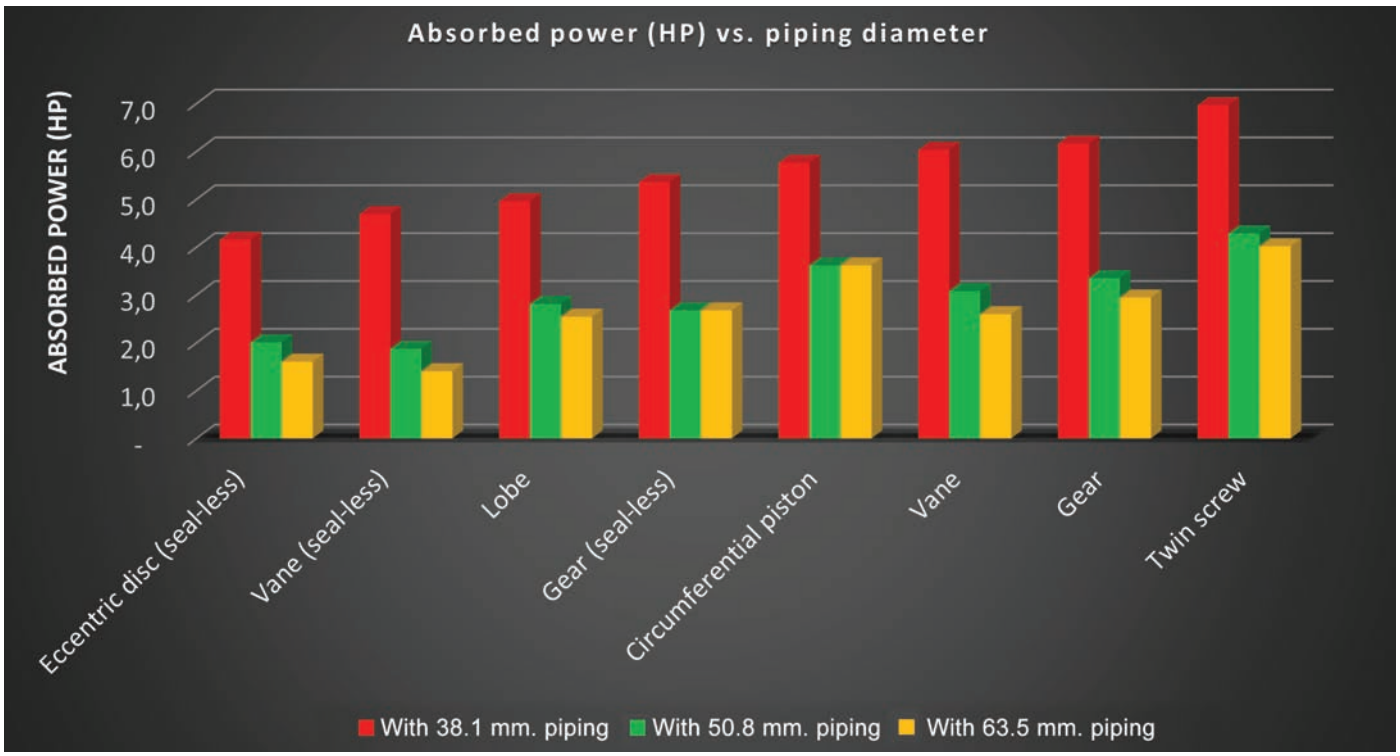
Regarding energy consumption, the result on the pump's absorbed power is telling:



By selecting a slightly larger piping, power consumption and costs drop from 37% to more than 50%, depending on the selected pumping technology. By increasing the piping diameter and switching to a more energy-efficient pumping technology – like the Mouvex eccentric disc pump – the difference becomes exponentially greater, dividing the energy consumption by three in some cases.

The next question is would we gain even more by enlarging the piping again?

Of course, the question is then, would we gain even more by enlarging the piping again? If taking DN65 piping, differential pressure will decrease to 2.9 bar vs. 3.7 bar with DN50. The delta is this time reduced. And the absorbed power reduction

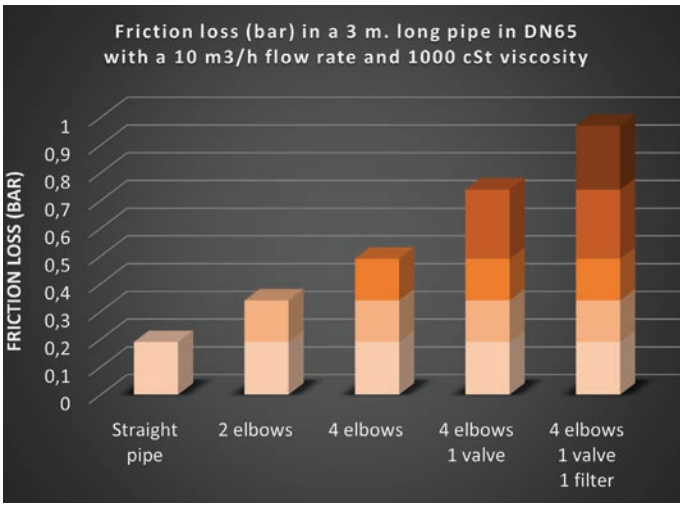


is much less spectacular and even close to zero on some pumping technologies.

Therefore, the right thing to do is to check friction losses and differential pressure results with different pipe sizes and see which one offers the strongest energy consumption reduction. In the example on Page 5, DN50 piping is the most balanced choice between piping enlargement and building cost.

Piping Design

Another way to reduce energy consumption is by "streamlining" piping with as few elbows as possible and only strictly necessary ancillaries.



A simple example reveals this. Consider a piping section with the following possible designs:

On this short section, depending on the design and ancillaries, resulting friction loss can be multiplied by five. Naturally, more pressure means more energy consumption.

Piping Length

Longer piping on a pumping system will generate more friction loss, resulting in a higher pump operating differential pressure. With other equal parameters, the friction loss is proportional to piping length.

It is not always possible to shorten the piping on an existing site. But when designing a new one, this parameter should be considered. It will reduce the building and operating costs.

Conclusion

Lighting, heating or heavy manufacturing equipment are often seen as the first items to reduce to obtain energy savings. Some operators do not consider the energy savings that are possible with pumping installations. By selecting low-power consumption pumps like Mouvex combined with the proper design of new installations and the improvement of existing ones, operators can generate noticeable energy savings on industrial production processes.

About the Author:

Paul Cardon is Business Development Manager PSG Auxerre - FRANCE. He can be reached at (+33 6 88 70 22 90) or paul.cardon@psgdover.com. *Mouvex was created in 1906 and is a leading brand of positive displacement pumps, screw compressors, and hydraulic coolers for use in the refined-fuels, oilfield, energy, food/sanitary, military, transport, and chemical-process industries. Mouvex is a brand of PSG®, a Dover company. Headquartered in Oakbrook Terrace, IL, USA, PSG is comprised of several major pump brands, including Abaque®, All-Flo™, Almatec®, Blackmer®, Ebsray®, em-tec®, Griswold®, Hydro™, Malema, Mouvex, Neptune®, Quantex™, Quattroflow®, RedScrew™, and Wilden®. For more information on Mouvex or PSG, please go to psgdover.com/mouvex or psgdover.com.*