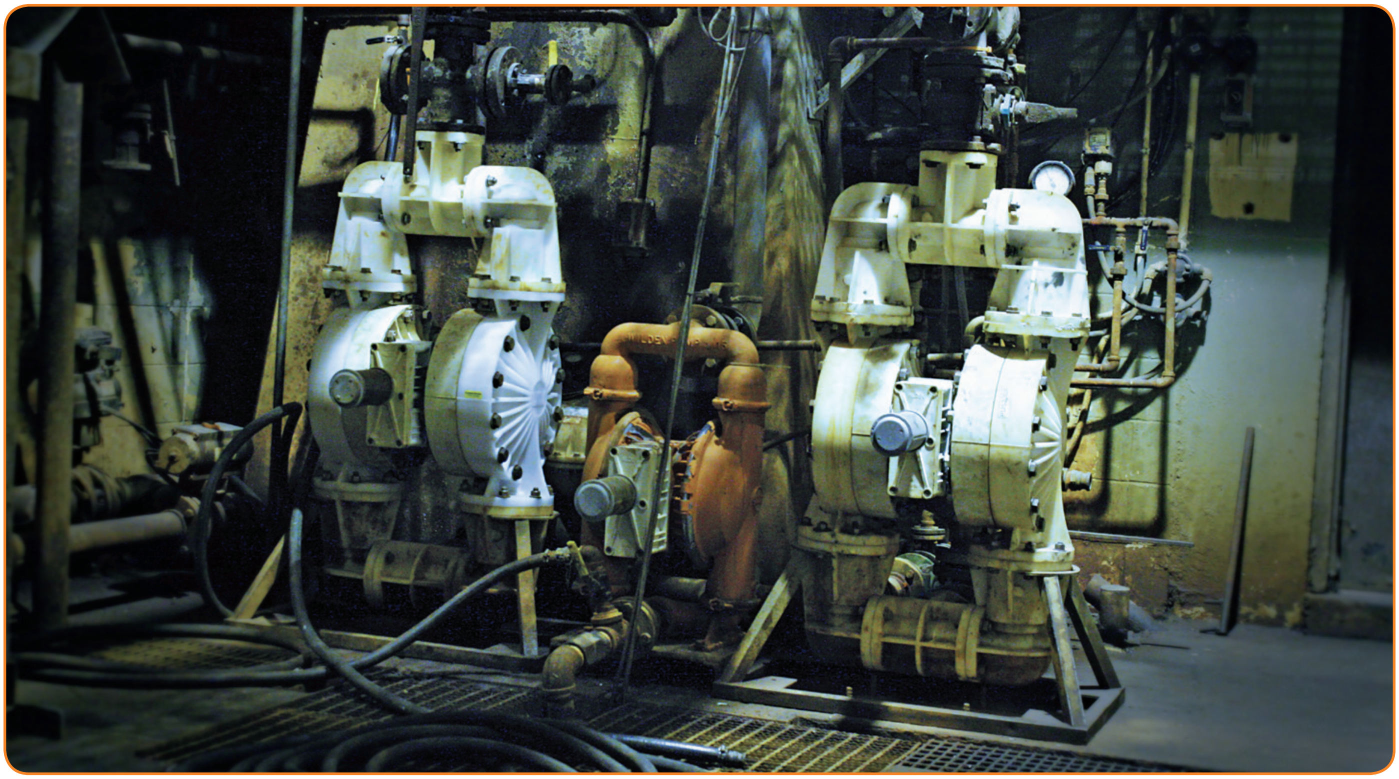
Minimizing Pumping-System Friction Losses

ELIMINATING THE CAUSES AND CHOOSING THE PROPER PUMP WILL INCREASE EFFICIENCY AND COST-SAVINGS

By Curtis Dietzsch



Pumping systems that are designed to maximize efficiency eliminate the causes of friction losses where ever possible.

Introduction

Imagine a major-league pitcher standing on the mound. He looks in for the signal, nods in agreement, starts his windup, rears back and propels the baseball toward home plate. The pitch's maximum velocity is reached at the moment the ball leaves the pitcher's hand. From that point, studies have shown that the velocity decreases by one mile-per-hour for every seven feet traveled. So, if a pitch leaves the pitcher's hand at 100 mph, by the time it covers the 60 feet, 6 inches to home plate it will be traveling around 92 mph.

Conversely, if the mound were only 30 feet from home plate, a 100-mph pitch would be moving at 96 mph upon arrival at the plate, the pitched ball lost a smaller amount of energy, making it harder to hit. While a 100-mph pitch thrown from second base to home plate – a distance of approximately 128 feet – would have a velocity of only 82 mph when it crossed home plate. This ball lost more energy on its way to the plate and would therefore be easier to hit.

The pitched ball slows down because of the air resistance, or drag, it encounters upon leaving the pitcher's hand. Many variables contribute to the drag that is imparted on the ball, among them air density, gravity, altitude, temperature, wind velocity and direction, and barometric pressure. If the pitch were delivered on the Moon, for comparison's sake, it would travel much farther, due to its gravitational pull being one-sixth of the Earth's and maintain its initial velocity because there is no atmosphere on the Moon to slow it down.

Now imagine a piping system in which the medium that travels through it is propelled by a mechanical pump. Much like the thrown ball, the pumping systems that operate most efficiently are those that are designed to have the media – which can range from water to more viscous fluids to semi-solids like concrete – travel the shortest, most unobstructed path possible.

The Challenge

The challenge during fluid-pumping operations, though, is the unavoidable fact that energy and efficiency losses are inevitable. The culprit in this scenario is friction. As fluids flow through pumps, pipes and fittings, there is resistance, resulting in a decrease in the pumping pressure and the velocity of the fluid, which adversely affects pumping efficiency.

The amount of energy that is lost due to friction is dependent on a number of factors. The losses are caused by friction between the fluid and piping walls, the friction between the adjacent fluids (higher viscosity fluids have higher losses), the surface roughness on the interior of the pipes, and the turbulence created when redirecting the fluid via a bend in the pipe or a restriction of some sort, such as a valve, fitting or reducer.

Physics also plays a role in the amount of friction that is created. The higher the flow rate and the smaller the pipe, the higher the resistance – and the higher the friction with its resultant affects on energy loss. System design is also a major consideration when attempting to limit friction and increase efficiency. The longer the pipe in which the fluid must travel, the more energy-robbing friction losses there are. Also, anything that changes the course of the flowing fluid in a piping run, such as, bends, kinks, or sharp turns increases friction losses, so they must be minimized.

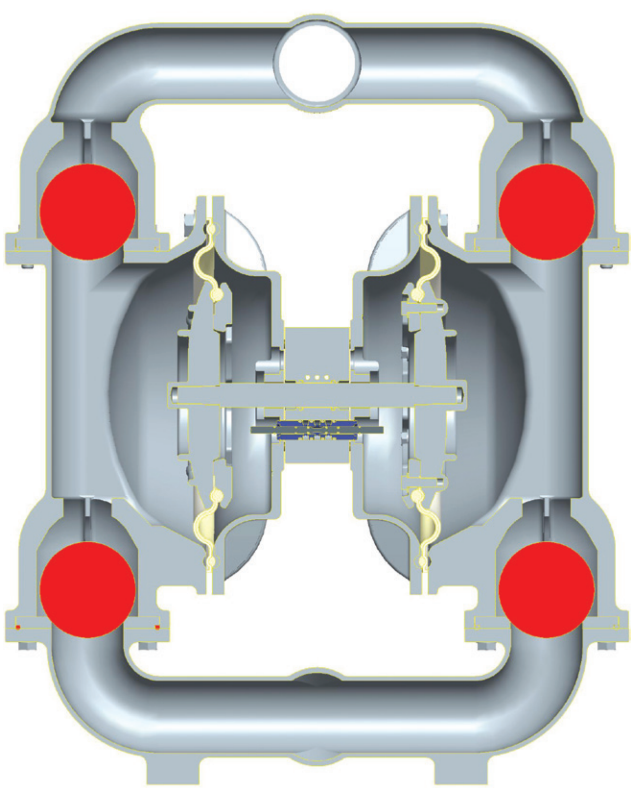
The Solution

Basically, there are four ways to reduce friction losses in a piping system:

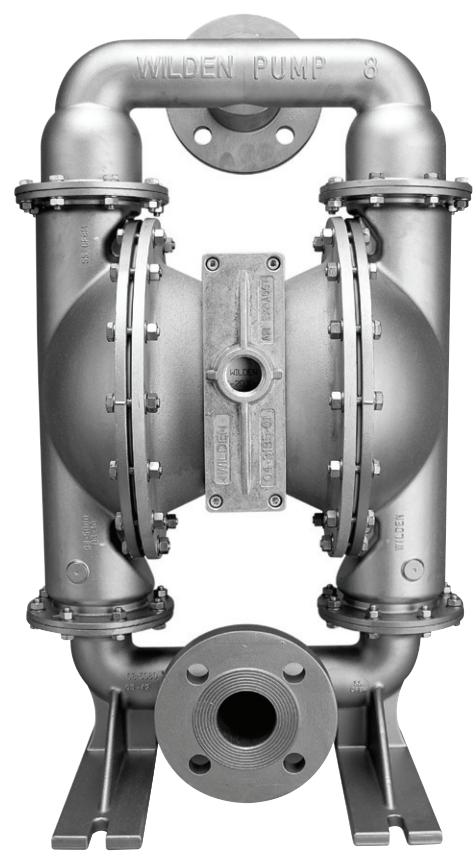
- Increase the pipe diameter of the system
- Minimize the length of the piping in the system
- Minimize the number of elbows, tees, valves, fittings and other obstructions in the piping system, while simplifying the layout as much as possible; if you have to turn a corner, a gentle bend is better than a sharp 90-degree turn
- Reduce the surface roughness of the piping in the system

One other vital consideration is the type of pump that is being used to move the fluid. Over the years, positive displacement pumps that utilize air-operated double-diaphragm (AODD) technology have been proven to be one of the most versatile for pumping fluids, no matter the viscosity.

Any type of diaphragm pump can only develop a certain amount of head pressure, or "pressure energy" that is needed to move a fluid from one place to another. The more efficient the piping and pump system are, the more the "pressure energy" can be used to actually move the fluid. If the piping system is restrictive in some



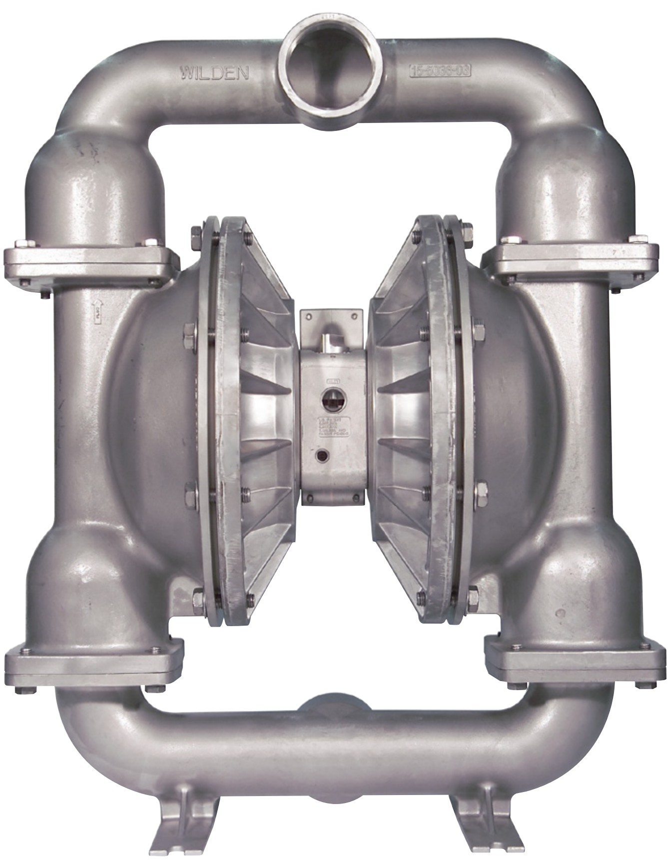
A cross section of the Wilden® Advanced™ Series 3-inch stainless steel "drop-in" wetted path. It features a larger cross sectional area (compared to a traditional 3-inch stainless-steel wetted path) to reduce internal friction losses.



Wilden® Advanced™ Series PX800 Metal AODD Pump way (undersized and/or excessively long piping with unnecessary elbow/tee sections) much of the pump's energy is wasted in overcoming these restrictions. In this case, at some point the excessive restrictions will cause the pump to "dead head," meaning that it will no longer have enough "pressure energy" to move the fluid. The design of AODD pumps allows them to handle this dead-heading without being damaged. This is not the case for all types of positive displacement pumps.

Taking into account all of the factors that contribute to friction loss and the ways to combat it, advances in AODD pumping technology have led to the creation of pumps that have been designed with minimizing friction losses front of mind. These pumps have been designed with a larger flow/wetted path that reduces internal friction and maximizes output and efficiency.

These advanced pumps can also feature a bolted configuration that ensures total product containment, while a variety of elastomers are available to meet abrasion, temperature and chemical-compatibility requirements. Advances in air-distribution systems also help to increase the efficiency of these pumps, no matter the application.



Wilden® Advanced™ Series PX1500 stainless steel AODD Pump

Minimizing Friction Losses Case Study:

Diversified Chemical Technologies, Inc. Detroit, MI

Diversified Chemical Technologies, Inc (DCT) is a manufacturer of chemicals used in various industrial and food applications. Since it was founded in 1971 DCT has grown into a global powerhouse that consists of six closely integrated subsidiaries with a client list that features some of the world's most recognizable brands in the automotive, food and beverage, packaging, electrical, and consumer product industries.

DCT subsidiaries use industrial pumps on a daily basis to transfer chemicals. When Santos Flores, Corporate Director of Maintenance since 2005, started working for DCT he immediately noticed inefficiencies in their operations. Minor issues that had almost imperceptible effects on specific operations but as a whole resulted in lost efficiency and revenue for the company.

"I saw a lot of processes that they had here that I knew could have great improvement, especially with a lot of our fluid-processing, our pumping different things, our metering," said Flores.

Flores went through the plants and replaced many of the pumps with Wilden air operated double diaphram (AODD) pumps. Wilden pumps, manufactured in Grand Terrace, CA, are known for the their durability, versatility and reliability. DCT chose Wilden's Advanced™ lines of metal and plastic AODD pumps that featured Wilden's patented Pro-Flo™ air-distribution system (ADS) to meet its diverse production needs.

The dependability of the Wilden pumps is now paramount to the success of DCT's operations because it's impossible to overstate how varied its operations are. That is a critical consideration when you're charged with handling materials of varying viscosities, levels of corrosiveness and susceptibility to shearing, all areas where excessive friction can lead to lost efficiency or product degradation.

"With the Wildens, it's almost like a free-flowing movement through the pump so it isn't creating the friction or the heat that some of the other pumps in the past have done, which could scrap an entire batch of product," explained Flores. "You can make the whole finished product and when it's time for the last pumping step to put the product in a tote or a drum or whatever the container may be, with Wilden, at the end, we're confident that we know that if we pump it, it won't add the heat or the shearing effect. That saves us a ton of money."

Santos Flores, Director of Corporate Maintenance for Diversified ChemicalTechnologies, Inc., next to one of the many Wilden AODD pumps that have helped him stimulate the bottom line by reducing downtime by 50%.

Conclusion

Think back to that pitcher and the game of baseball. In effect, the game's creators laid out their "system" perfectly. In the search for competitive balance, placing the pitcher's mound 60 feet, 6 inches from home plate maximized both the pitcher and the hitter, making the game what it is today; if the mound were 30 feet closer, the pitcher would be at an unfair advantage, if the mound were 60 feet farther back, the score of a "pitcher's duel" would be 20-18.

The same considerations must be taken into account when designing a piping system. The most efficient systems – ones that make the best use of a pump's "pressure energy" – are those that have been designed with the least amount of impediments to maintaining the optimum flow. That means creating a piping configuration that contains the shortest possible piping runs, few or gentle pipe bends, a minimum of obstructions and larger pipe diameters that maximize flow rate.

The best systems also need pumps that work hand-in-glove with the piping to maximize the operational ability of the system through the minimization of friction losses. The AODD pumps that satisfy those parameters are ones that feature advanced wetted paths that are larger and reduce energy-robbing friction losses. All of these considerations will also result in a more cost-effective system in the form of energy savings and reduced maintenance and downtime.

Curtis Dietzsch is a Development Engineer for Wilden Pump & Engineering, LLC, Grand Terrace, CA, USA, a leading manufacturer of air-operated double-diaphragm (AODD) pumps. Jim Wilden, founder of Wilden Pump & Engineering, invented AODD pumps in 1955. Since then, the company has created a line of distinctive pumps that have proven to be reliable solutions to pumping applications in a wide variety of industries. Mr. Dietzsch can be reached at (909) 422-1730 or Curtis.Dietzsch@wildenpump.com. For more information, please go to www.wildenpump.com. Wilden is a member of Dover Corporation's Pump Solutions Group (PSG™), Downers Grove, IL, USA. PSG is comprised of six leading pump companies – Wilden®, Blackmer®, Griswold™, Neptune™, Almatec® and Mouvex®. You can find more information on PSG at www.pumpsg.com.

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