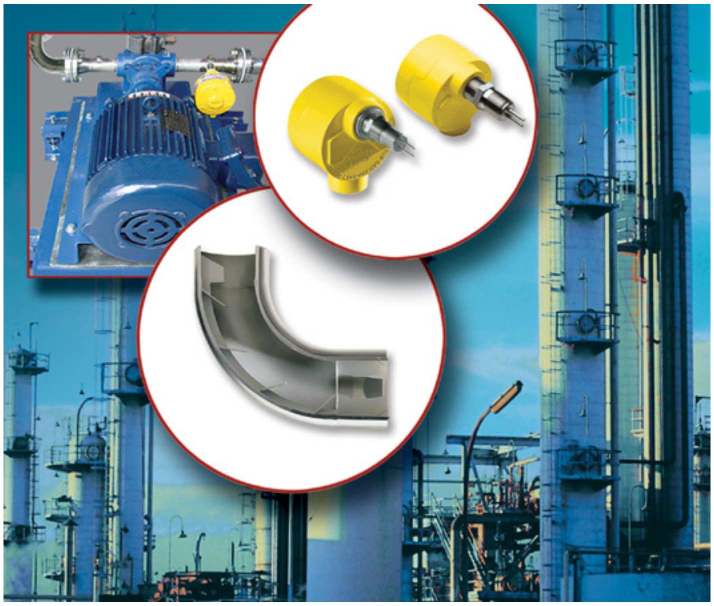
Technical Publication



Keep Your Pumps Running Smoothly To Optimize Process Efficiency

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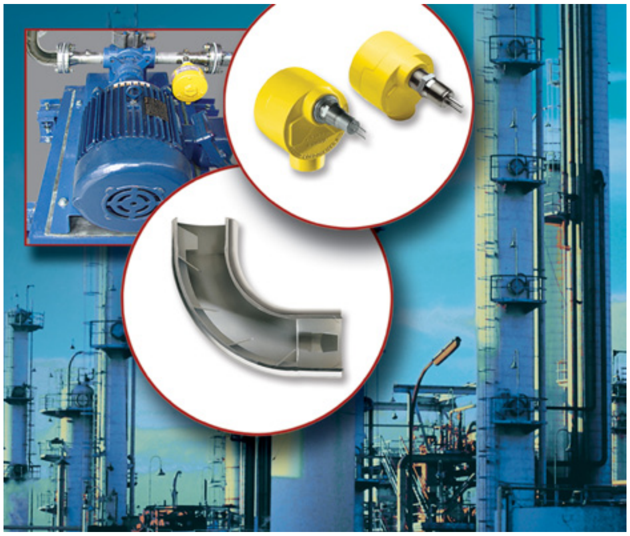

Industrial pumps consume up to 20% of the world's energy production and can be responsible for 25 to 50% of a process plant's energy bill, according to Europump, the Hydraulic Institute and other sources. Nothing moves without them in a process plant, and they are expensive to purchase, maintain and even more to repair or replace. Reducing pump lifecycle costs (their purchase, operation and maintenance) is critical in a process plant optimizing efficiency and product output. The process and the surrounding equipment configuration can be responsible for unnecessary high pump lifecycle costs.

Plants that are concerned about pump efficiency and costs can find some of the fastest returns-on-investment (ROI) by optimizing pump process control loops and protecting pumps against common hazards. Smooth running pumps at full efficiency always provide a payback. There are some simple pump optimization strategies that work well, starting with an analysis of process media flow rates.

Optimizing Plant Processes

With today's focus on turning plants into 24/7 lean operations, the pumps in most plants are running near capacity full time to keep up with material through-put objectives and demand in many industries—such as refineries, specialty chemicals, food/beverage and more.

Irregular material flow is one of the most common impediments to efficient pump operation. The result of irregular material flows can include distorted and asymmetric velocity profiles, turbulent flow, low flows or even dry running conditions. Controlling material flow ensures that pumps operate efficiently, moving stock or products with the least possible expenditure of energy while reducing maintenance requirements and extending service life.

When material flow is irregular, the result can be expensive in terms of equipment maintenance and service life due to cavitation, uneven loads on bearings and seal failure. Cavitation is a destructive and all too common problem, reducing process flow capacity and can cause process quality issues.

The loss of bearings or seals can lead to pump shutdown, possibly a full process line shutdown. These are unfavorable conditions, especially in combustible or toxic material processes.

Start With Flow Analysis

Pump efficiency begins with analyzing the flow. Is the media flowing regular and at the pressure required by the pump with a minimum headloss? Irregular and distorted flow regimes can be especially challenging to diagnose and correct. Eliminating their causes is often difficult, expensive, impractical or impossible—so you often have to work around them instead.

For example, low flow or dry running conditions. Pump damage can occur when liquid flow dramatically reduces or completely stops. With no liquid flowing to provide cooling, the heat can destroy a pump's bearings or seals.

In addition to pump replacement or repair being expensive, these types of pump failures often ruin the material being processed and reduce process line capacity.

Creating Regular Flow Profiles

Pumps require a stable upstream flow profile in the pipeline before liquid enters the pump for efficient operation. When unstable flows or swirl are present they often result in cavitation, noise, or uneven bearing wear.

One commonly cited industry pump installation best practice guideline suggests at least 10 diameters of unobstructed pipe be placed between the point of pump suction and the closest upstream flow disturbance. In modern process plants, many real estate restrictions result in the placement of elbows, valves or other equipment too close to pumps. Such flow disturbances can generate media swirl and velocity profile distortions. These distortions can result in excess noise and cavitation, causing wear that shortens pump bearing and/or seal life.

Installing flow conditioners upstream from pumps helps ensure an optimal flow profile for efficient operation. Eliminating the effects of velocity profile distortions, turbulence, swirl and other flow anomalies will result in a repeatable, symmetric, and swirl-free velocity profile with minimal pressure loss.

Pump life generally increases in a less stressful operating environment. Conditioning the flow stream ensures it meets the impeller with a uniform and equally distributed flow pattern, which optimizes pump efficiency while extending bearing life and decreasing cavitation.

Tab type flow conditioners, such as the Vortab Flow Conditioner, have proved successful in these resolving irregular flow conditions (Figure 1). Other flow conditioning technology choices, including tube bundles, honeycombs and perforated plates, can also be considered depending upon the specifics of the process application.

Tab type, which include elbow flow conditioners, are designed with vortex generating conditioning tabs to produce rapid cross-stream mixing, forcing higher velocity regions to mix with lower velocity regions. The shape of the resultant velocity profile is "flat" and repeatable regardless of the close-coupled upstream flow disturbances.

Incorporating anti-swirl mechanisms into the design of the tab type flow conditioners eliminate the swirl condition typically seen exiting 90-degree elbows. The result is a flow stream that enters the pump in such a way that it maximizes the efficiency of its operation and reduces stress. In addition, the tapered design of the anti-swirl and profile conditioning tabs make them immune to fouling or clogging.

Assuring Pump Flow

To eliminate the potential damage from a low flow or a dry running condition, a point flow switch can be installed in the process loop. Combination point flow switches will detect not only a low flow situation, but also detect a dry running condition. This capability allows the control system or operator to take corrective measures before the bearings of the pumps are overheated and fail.

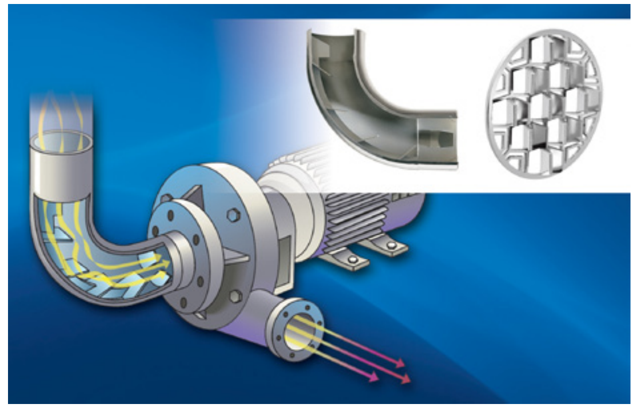

Figure 1: Tab-type Vortab VEL Elbow Flow Conditioner

Figure 2: FCI FLT93 Flow/Level/Temperature Switch

There are many types of point flow switches available. For example, the FCI FlexSwitch FLT93 Series, with its no moving parts design, offers a highly robust solution for pump protection with its dual alarm capability (Figure 2).

When Alarm 1 initiates, the switch will have detected a low flow situation anywhere between 0.003 to 0.9 meters per second (MPS) (0.01 and 3 feet per second FPS). This low flow alarm can be regarded as a pre-warning signal for the control system or operator. The system or operator can then decide to keep the pump running or to shut it down.

Should an Alarm 2 occur when the feed line to the pump is running dry, this condition would be an emergency signal to shut down the pump immediately because the bearings now see gas instead of a liquid as a heat transfer media. In such situations, the temperature of the bearings may rise very fast. Using a flow switch prevents permanent damage to the pump's bearings.

The FLT flow switch is a dual-function instrument that indicates both flow and temperature, and/or level sensing in a single device. It can be specified in either insertion or in-line styles for pipe or tube installation. This single switch monitors your direct variable interest, flow, and temperature simultaneously with excellent accuracy and reliability. The dual 6A relay outputs are standard and are assignable to flow, level or temperature.

Choosing A Flow Switch

When considering a flow switch for pump protection or any other application, the first step is choosing the appropriate flow technology. There are multiple flow switch sensing technologies available, and the major ones now include:

- Paddle
- Piston
- Thermal mass
- Pressure
- Magnetic reed

All of the flow switch technologies have their advantages/disadvantages, depending on the media and your application's requirements. In some media or processes, there might be only one choice. Be sure to review your plant's layout, environmental conditions, maintenance schedules, energy cost and ROI, which will help you quickly narrow the field best choices.

Conclusions

Be sure to consider pump requirements as a top priority when designing new plants, adding plant capacity or when retrofitting older facilities. Optimizing your process with your pumps in mind offers a wide range of benefits: higher capacity, improved quality, lower energy costs, reduced maintenance, longer equipment (pump) life.

Keep in mind that a distorted velocity profile is one of the most common pump problems that frequently results when the minimum pipe straight run required between the point of pump suction and elbows, valves or other equipment is either ignored or pushed to or beyond the limits. The installation of a flow conditioner frequently eliminates cavitation, vibration, and noise issues.

Be sure to protect your pump from accidental low flow or dry running conditions, which can lead to bearing or seal loss requiring expense repairs. Installing a dual alarm flow switch in your process loop not only protects the pump from damage, but will alert you to a potential problem and let you make adjustments before a shutdown is necessary. ■