Technical Publication

Take Care of Your Pumps and They'll Take Care of You

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The old saying, "an ounce of prevention is worth a pound of care" may have been coined by process and plant engineers tired of repairing or replacing pumps. Pumps are often the most under serviced pieces of equipment in process automation when it comes to maintenance and prevention best practices. Unfortunately, nothing moves without the humble pump and a process becomes inefficient when they don't operate properly or completely shutdown. Many times the pump manufacturer is seen to be the problem, when in fact the process or the surrounding equipment configuration is the cause.

Engineers and technicians looking to optimizing their process for productive operation can start with the pump, and protecting the pump against common hazards. Pump protection improves end-product or batch quality, reduces material costs, eliminates waste and lowers maintenance costs. Taking good care of your pump delivers a positive payback. Here are some simple strategies that can be employed—starting with an analysis of process media flow rates.

Protecting Your Process—24/7

Today's highly competitive global market finds demanding process industries such as petrochemicals (Figure 1), food/beverage, pharmaceutical, and water/waste treatment among others, transforming their plants into 24/7 lean operations. The result is that the pumps in most plants are running near capacity to keep up with material through-put objectives and demand. One of the most common hazards to efficient pump operation is irregular material flow, which can result in three negative conditions: (1) flow turbulence, (2) low flows, or (3) dry running conditions.

A key process protection step taken by facilities and plant engineers is controlling material flow to ensure that pumps operate efficiently. This results in moving stock or product with the least possible expenditure of energy and at the same time reducing maintenance requirements and extending the life of the pump. Failing to control material flow effectively can lead to some unwanted conditions, such as cavitation, pump bearing failure, or seal failure. The first problem — cavitation — can reduce through-put, or even cause quality problems. Losing a bearing or a seal can lead to pump shut-down, possibly process line shut-down and the unfavorable conditions could get worse the further you take this type of scenario.

Figure 1. Today's demanding industry applications require highly efficient pump operation.

Monitoring for Irregular Flows

The first step in protecting your process and pump starts with analyzing the flow. You want to analyze the flow to ensure the media is flowing regularly at the pressure required by the pump with a minimum headloss. Any number of process conditions can cause irregular flow, such as turbulence, temperature changes, unwanted air ingestion, etc. The problems of irregular flows and turbulence, in particular, can be especially challenging to solve because eliminating the root causes are often difficult to impossible—so you need a workaround strategy.

The chief culprit when it comes to damaged pumps is the build-up of heat from low flow or dry running conditions, which occur when liquid flow dramatically slows down or stops flowing altogether through the line or the pump. When the liquid isn't there to provide cooling, the heat can destroy a pump's bearings or seals. If repair is even possible, it is going to be a very expensive due to repair or replacement costs and down time.

Eliminating Irregular Flows

Pumps require a stable upstream flow profile in the pipeline before liquid enters the pump for proper and efficient operation. Irregular flows often result in cavitation, a condition where cavities form in the liquid at the point of pump suction. One often cited industry pump installation guideline suggests at least 10 diameters of unobstructed pipe be placed between the point of pump suction

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Figure 2. Vortab inline and elbow flow conditioners help eliminate upstream straight run requirements for pumps and other process equipment.

and the first elbow or other disturbance. Obstructions and/or corrosion in a pipe can change the velocity and flow profile of the media and affect its pressure as well.

In most cases, plant real estate limitations result in the placement of elbows, valves or other equipment that are too close to a pump, and these devices can create swirl and velocity profile distortion in the pipeline (as well as pressure changes). Such disturbances can result in excess noise and cavitation, resulting in reduced bearing and/or seal life.

A good solution to ensure an optimal flow profile for efficient operation is to install an inline or elbow flow conditioner upstream from your pump. Isolating the effects of velocity profile distortions, turbulence, swirl and other flow anomalies in your pipeline will result in a repeatable, symmetric, and swirl-free velocity profile with minimal pressure loss.

To increase a pump's life, start with a more stable operating environment. A conditioned flow stream enters the pump's impeller in a uniform and equally distributed pattern, optimizing pump efficiency and extending bearing life while at the same time decreasing noise and cavitation.

If there is no choice other than to deal with less than ideal piping configurations, an inline or elbow flow conditioner will eliminate all upstream straight run requirements for pumps, compressors, flow meters and other critical process equipment (Figure 2). Tab type flow conditioners, such as the Vortab® Flow Conditioner, have proved successful in these applications. Other flow conditioning technology choices, including tube bundles, honeycombs, and perforated plates, may also be considered depending upon the pressure drop limitations.

The inline or elbow flow conditioner's profile conditioning tabs 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 flow conditioner eliminates 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. .

Pump Flow Monitoring

Avoiding the damage that is caused by a low flow or a dry running condition can be achieved by installing a point flow switch in the process loop. Dual relay flow switches will detect not only a low flow condition, but also alarm on a dry condition too. This capability allows the control system or operator to take corrective measures before the bearings of the pumps are overheated and fail.

Many types of point flow switches are available. For example, the FCI FlexSwitch® FLT Series, with its no moving parts design, offers a highly robust scheme for pump protection with its dual alarm capability (Figure 3). With Alarm 1, the switch will detect a low-flow situation anywhere between 0.01 and 3 feet per second (FPS) (.003 to.9 meters per second MPS). This low flow alarm can be regarded as a pre-warning signal for the control system or operator. Alarm 2 can be set at a no-flow condition. The system or operator can then decide to keep the pump running or

Figure 3. FCI's FlexSwitch FLT Series offers a robust scheme for pump protection with features such as dual alarm capability.

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to shut it down.

This dual-function flow switch 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 large pipe or small line applications. This single switch monitors your direct variable of interest, flow, and temperature simultaneously with excellent accuracy and reliability.

Choosing A Flow Switch

When evaluating a flow switch for pump protection or any 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

Each of these technologies has their advantages/disadvantages, depending on the media and your application's requirements. Some may be the only choice in certain media for your application. By looking at these factors, as well as your plant's layout, environmental conditions, maintenance schedules, energy cost and ROI, you will quickly be able to narrow the field to one or two best choices

Conclusions

Don't fall into the trap of early pump replacement or repair by ignoring best installation and maintenance pump practices. Here are three preventive proactive steps to take to avoid early pump replacement:

- When designing new plants or retrofitting old ones, be sure to consider pump requirements. Optimizing your process with your pumps in mind offers a wide range of benefits: higher capacity, improved quality, lower energy costs, reduced maintenance, and increased equipment (pump) life.
- Consider inserting a flow conditioner to eliminate turbulent flow problems. One of the most common pump problems is irregular flows caused by turbulence that frequently results when the minimum pipe straight runs required between the point of pump suction and elbows, valves or other equipment are either ignored or pushed to the limits. Inserting a flow conditioner frequently eliminates turbulent flow problems.
- Another key safeguard is to protect your pump from accidental low flow or dry running conditions, which can lead to bearing or seal loss requiring expense repairs. Inserting 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 be proactive in evaluating the necessity of pump shut down.