

Monitor Your Pump for Process Efficiency

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Tech Article

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Pumps are all too frequently one of the most overlooked and abused pieces of equipment in process automation, yet nothing moves without them and a process becomes inefficient when they don't operate properly or completely shutdown. While it is convenient to blame the pump manufacturer, more often than not the process or the surrounding equipment configuration is the problem.

Optimizing your process for productive operation, including the pump, and protecting the pump against common hazards, are two of the smartest ways that engineers and technicians can help their plant operations. These efforts will improve end-product or batch quality, cut the material costs, eliminate waste and reduce maintenance costs. Taking good care of your pump always delivers a positive payback and there are some simple strategies that can be employed—starting with an analysis of process media flow rates.

Protecting Your Process

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

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.

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 life.



Fig 1. Plant Overview

Failing to control material flow adequately can lead to some unwanted conditions, such as cavitation, or pump bearing failure, or even seal failure. The first problem—cavitation—can reduce capacity 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.

Analyze The Flow

Protecting your process and pump starts with analyzing the flow to make sure 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.

Nothing can damage a pump faster than the build-up of heat from low flow or dry running conditions, which occurs 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 proposition. Of course, such dramatic failures also often ruin the material being processed or reduce process line capacity.

Eliminating Irregular Flows

For proper and efficient operation, pumps require a stable upstream flow profile in the pipeline before liquid enters the pump. Irregular flows often result in cavitation, a condition where cavities form in the liquid at the point of pump suction. A commonly cited industry pump installation guideline suggests at least 10 diameters of unobstructed pipe be placed between the point of pump suction and the first elbow or other disturbance. Obstructions and/or corrosion in a pipe can change the velocity of the media and affect its pressure as well.

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

An Inline or elbow flow conditioner can be installed upstream from your pump to ensure an optimal flow profile for efficient operation. 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.

Creating a relatively more benign operating environment helps increase pump life. The 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.

When faced 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.



Fig 2. Vortab Inline and Elbow Flow Conditioners

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 specifics of the application.

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

Eliminating the damage caused by a low flow or a dry running condition can be achieved by installing a point flow switch in the process loop. Combination point flow switches will detect not only a low flow situation, but also detecting 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.

There are many types of point flow switches available. The FCI FlexSwitch® FLT Series, with its no moving parts design, offers a highly robust scheme for pump protection with its dual alarm capability



Fig 3—FLT Flow Switch

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. The system or operator can then decide to keep the pump running or to shut it down.

If an Alarm 2 occurs because 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 that will require an overhaul of the pump before more damage occurs.

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. With the FLT, a 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

In selecting 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

All these technologies have 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

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, increased equipment (pump) life.

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 issues.

Don't forget to protect your pump from accidental low flow or dry running conditions, which can lead to bearing or seal loss requiring expensive 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 make adjustments before a shut-down is necessary.