

Application Case Study: Pressure/Vacuum Protection in Metering Pump Applications



Introduction

Most of us working in industrial fields are endlessly impressed by large scale fluid applications, especially those that seem too complex or massive to comprehend. Intercontinental pipelines, hydroelectric dams, and municipal water treatment plants are just a few examples that come to mind. As impressive as these monstrous systems can be, there's ample reason to be equally inspired by applications on the opposite end of the spectrum, where miniscule amounts of fluids can be pumped accurately down to a fraction of a raindrop in volume. These are referred to as metering or dosing pump applications, and are found throughout industrial processes where they inject, transfer, and blend fluids with extreme, infinitesimal precision. Along these same lines, a premium national manufacturer of metering pumps reached out to Whitman Controls looking to add pressure and vacuum protection to their line of dosing pump systems, which made us think of a new twist on an old phrase: "go *small* or go home!"

About Us

As a veteran-owned small business, Whitman Controls is dedicated to supplying premium quality, reliable, technologically advanced instrumentation for use in nearly any application. Our Bristol, CT manufacturing facility embodies over 40 years of engineering, fabrication, and customer service expertise, serving both end-user and manufacturing customers nationwide through direct and distribution channels.

Application Summary

Fluid metering is a ubiquitous process found in countless wastewater, chemical, water treatment, petroleum, food and beverage, heavy utility, power generation, and general industrial applications. Anywhere that fluid must be precisely, consistently, and repeatably dosed into another material, engineers routinely turn to a special type of fluid transfer equipment known as a metering pump (or dosing pump). Unlike more traditional mass transfer pumps, metering pumps are built around the concept of known displacement, where a predetermined amount of fluid is displaced with each pump stroke or cycle. These cycles can be quantified into very accurate metering flow rates and total metered volumes. Metering pumps can be provided in peristaltic, solenoid, diaphragm, rotary lobe, or rotary gear designs, and come coupled with precision flow control devices and instrumentation. Altogether, these systems discharge consistent fluid flows that can be accurately controlled down to fractions of a gallon per hour. Optional variable drives, scalable turndown ratings, and micrometer displacement adjustments can offer even greater tolerances out of these systems, achieving injection proportions in the parts per million and turndowns greater than 2000:1.

Challenge

Our client produced metering pump skids and systems that needed a solution for detecting unideal pump discharge pressure conditions. These conditions would typically be the result of a failing mechanical backpressure valve or a major system upset. Without a properly functioning backpressure regulator, pumps would be subjected to the downstream systems' direct hydraulic conditions that could change minute to minute, introducing all sorts of pump slip and freewheeling issues. These issues caused metering inaccuracy and stall out, which were the

motive reasons for our client wanting additional inline controls to detect such conditions immediately.

With the hydraulic concerns understood, our client next provided insight into the various types of applications they were working with so that we would consider the specific pressure control needs in play:

- **Water Treatment** - municipal and ground-well potable water systems require chemical dosing to adjust pH, flocculate out particulates, inject fluoride and chlorine, and add electrolytes for taste.

- **Wastewater Treatment** - industrial and municipal wastewater treatment systems rely on a wide range of metered chemicals to neutralize, clarify, and remove contaminants.

- **Chemical Blending** - chemical manufacturers produce custom blends of various high-strength chemicals, diluting batches down to safe concentrations using chemical metering pumps.

- **Microbiological Control** - any captive water body is susceptible to harmful microbiological spore blooms, requiring chemical dosing to add sterilizing agents in applications ranging from cooling tower basins to agricultural irrigation ponds.

"Backpressure regulators do a great job keeping dosing displacement within spec, but if those regulators fail, we don't have a way to keep a pump operating on its curve. We wanted to add the pressure switches to catch anytime a regulator failed, or when system pressures got so high that they deadheaded the pump. With these switches, now we get an alarm and immediately know when we're not dosing correctly." - Design Engineer, Confidential Metering Pump Manufacturer

Solution

After a detailed review of the above example applications and their requirements for metering pump backpressure control, our engineers arrived at three conclusions:

- Metering pumps want a very consistent backpressure applied to their discharge in order to dose fluid volumes accurately.

- Non-automated, mechanical backpressure valves are the normal solution to provide this backpressure, but while these valves are (usually) simple and inexpensive, they tend to drift over

time and fail without warning. The chemicals, temperatures, environmental exposure, and severe duty cycles that metering pump systems experience exacerbate backpressure regulator wear and tear as well.

- To detect such situations where a backpressure valve is not performing as expected, simple pressure monitoring instruments should be added to the pump circuit, and used to drive alarms, secondary pump activation, and if needed, emergency system shutdown.

Following this line of thinking further, our engineers identified that while pump discharge pressure is certainly necessary to monitor, pump suction pressure (or vacuum) is just as impactful to pump accuracy. Loss of suction pressure could lead to reduced flow, entrained air, loss of pump prime, cavitation, and vapor-lock, and should be monitored just as closely as pump discharge.

To serve both pressure and vacuum monitoring intents, Whitman's engineers concluded that inline pressure and vacuum switches would substantially improve our client's metering pump systems and their ability to perform accurately, reliably, and persistently over time. We recommended that for each dosing pump in a system:

- A Whitman J205G pressure switch should be installed between the dosing pump and its backpressure regulator valve, which would switch when a high-pressure condition was detected and halt metering until the high-pressure condition was cleared, and
- A Whitman J205V vacuum switch should be installed on the suction side of each dosing pump, which would switch when excess vacuum was sensed and halt the pump until good suction pressure was restored.

[Whitman J205G Pressure Switches](#) and [Whitman J205V Vacuum Switches](#) were selected based on these key features:

- High Pressure Rating (max 5,000 PSIG)
- J205G Pressure - Low Set Point Range (0.80 to 800 PSIG)
- J205V Vacuum - Low Set Point Range (1.6 to 28.2 InHg Vacuum)
- Designed for Overpressure Conditions without needing recalibration
- High Temperature Range -65°F to 225°F
- SPDT / SPST, 5 Amp Max Switch

- Low Weight of 4.0 oz (varies slightly with electrical interface selection)
- 316 Stainless Steel Diaphragm
- 303 Stainless Steel Body and Fitting
- Buna-N O-Ring standard (other options available)
- Loctite #271 Seal

Results

With our recommendations approved, sensors ordered, and new functionality integrated into their standard system design, our client's metering pump packages now offered a higher level of safety protection and accuracy assurance than most of their competitors. Turns out, this enhanced reliability qualified our client for supplying their standard systems into larger, more complex projects where only custom-designed solutions had been accepted previously. This opened new doors for our client leading to new sales opportunities and competitive advantages, as well as heightened brand recognition within the industry. In the end, we helped our client prove that going *small* can indeed render *big* results.

Data Bullets

- **12%** increase in average dosing system accuracy by halting pumps in high pressure conditions
- **1-2** weeks lead time on custom pressure instrumentation
- **100%** reduction in undetected pump run-dry situations by adding suction pressure monitoring
- **3%** net energy savings by stopping pumps during high discharge and low suction conditions

Here at Whitman Controls, our values drive us to provide the highest level of servant partnership that you can find. To discuss your applications or to learn more about our capabilities, please contact us at (866) 868-8883, via email at info@whitmancontrols.com, or online at www.whitmancontrols.com.