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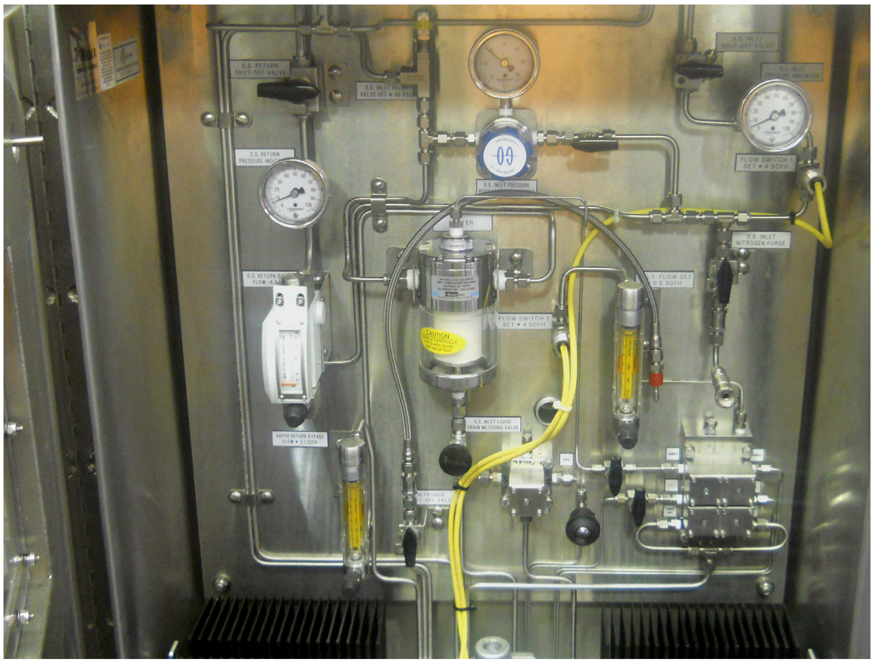

Verify Fluid Flow to Your Analyzer and Keep Your Plant Running

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No matter how sophisticated a fuid analyzer system may be, it will be ineffective if a sample fow fails to reach the analyzer sensor or if the sample is contaminated or stale. The most advanced systems in the world cannot provide accurate results without a valid fuid sample.

Gas chromatographs (GCs), mass spectrometers, optical spectrometers and photometers are a few examples of analyzer technologies applied in process and plant systems that need sample fow assurance. It is an accepted industry best practice that sampling systems have some type of fow monitor to assure valid samples and analysis.

Failing to monitor fuid fow to the analyzer may result in contaminated product batches and discharging regulated substances. The costs of analyzer failure are potentially huge in terms of affecting product materials, damage to equipment, regulatory fnes, liability and more.

While there are a number of fuid fow monitoring technologies on the market, immersible thermal dispersion technology combined with packaging and sensor designs optimized for sampling systems has emerged as the new best-in-class technology. Thermal dispersion mass fow sensors have proven themselves for decades as extremely reliable in other demanding process and plant applications—often in relatively close proximity to analyzer systems.

Figure 1: Typical sampling system

Figure 2: FS10A mounted in SP76 manifold

Recent Developments

The trend to mount the sample-handling system at the process has greatly enhanced process effciency. Recent developments in packaging and speed now make it possible to run analyzer systems more effciently, utilizing the real time information to process on line in batch mode. Developments in continuous fow reactors combine with analytics and new sampling systems to improve reaction times. More and more systems now provide analysis of the process in real time, making the integrity of the readings that much more important to the process success. The ideal fow monitor should provide the form, ft and functions that will accommodate both these new generation analyzer systems and traditional legacy, and hybrid designs *(Figure1)*.

Depending on the analyzer type, sampling fuid is often transported in 1/8 inch to 1/2 inch tubing. Most systems typically draw small samples in 1/4 inch tubes. Also growing in popularity are systems based upon the industry standard SP76 manifold. SP76 is an ANSI/ISA standard approved in 2002 and which is supported and has been adopted worldwide by major chemical and refning companies *(Figure 2)*.

SP76 and NeSSI Basics

Leading the way for the SP76 standard is the New Sampling/Sensor Initiative (NeSSI) organization, initially created in 1999 through discussions in a Center for Process Analytical Chemistry's (CPAC) oil and petrochemical focus group. Other organizations have embraced and are promoting NeSSI/SP76, including the International Forum for Process Analytical Chemistry (IFPAC) and the Federation of Analytical Chemistry and Spectroscopy Societies (FACSS).

Each block of a typical SP76 train is 1.5 x1.5 inch square and effectively becomes a convenient plug and play modular surface mount interface for numerous sampling system components *(Figure 3)*. The NeSSI group remains active in advancing enhancements for the process analysis community. Beyond the initial physical interface of the SP76 manifold itself, the group has defned progressive levels of sophistication, known as Gen.1, II and III, that provide for digital bus communications, hazardous location approval types and the Sensor Actuator Manager (SAM).

Flow Technologies

Regardless of the analyzer fuid sampling system confguration, fow monitoring is essential to ensure proper analyzer operation. There are numerous methods and technologies available to monitor sample fow on a real time basis. These can be mechanical spring or gravity loaded pistons, variable area types, differential pressure and thermal mass fow.

In most cases, a simple relay contact or solid state output change is all that is desired to indicate a reduction or absence of fow at a predetermined setting. A recent trend is driving the output requirements to include an analog or digital communication signal to monitor the sample fow rate throughout the fow range. This allows operators to better predict fow declines due to disruptions caused by clogging flters, line contamination from fouling fuids, leaky or failing pumps, and other time and wear susceptible components in the system.

Mechanical devices normally have the advantage of not requiring power to operate, however, a minimum amount of wires are still required to transmit an electronic signal (contact closure) back to the control system. As these devices are triggered by the force of the fow stream such that specifc and fxed application details, including the sampled fuid's density, viscosity, temperature, pressure, fow rate and, if non-adjustable type, the trip point, must be known and be specifed when ordering them.

Furthermore, because springs, magnetic components and seals are all in the wetted fow stream, their material compatibility must also be evaluated by the specifying engineer. While mechanical devices with factory fxed trip points can be one of the lower priced solutions, those with adjustable trip points are often double the cost and approaching the price of some of the more robust and sophisticated technology solutions mentioned later.

The leading drawback and most frequent user issue with these mechanical devices is their susceptibility to sticking over time. As all mechanical designs have moving parts in the fow stream,

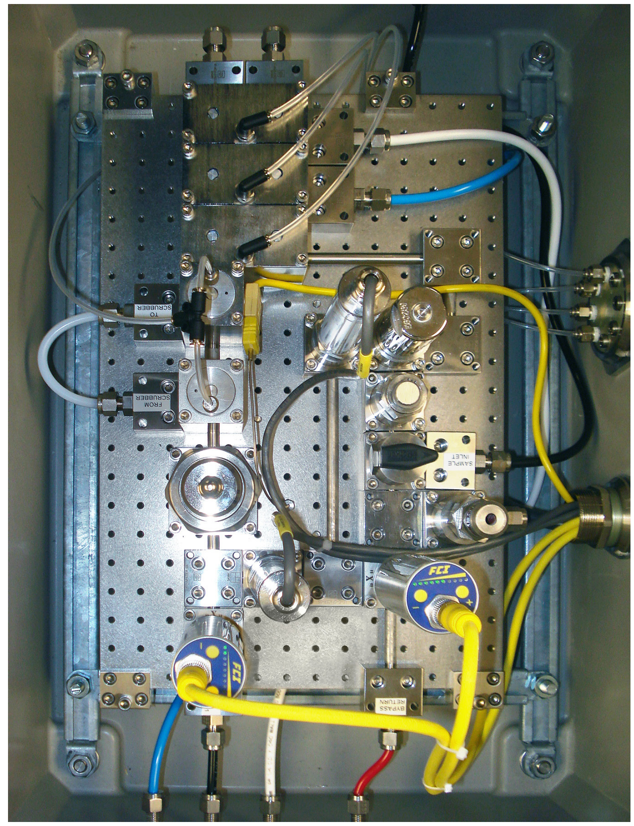

Figure 3: Integral mounting on SP76 platform

contaminating fuids can be a serious source of future failure. Fouling contaminants can progressively build up over months or years and are only detected when other failures in the system are detected.

These devices also can have nooks and crannies that are exposed in the fow stream as they displace the fow path volume. In addition to being another area subject to clogging, they can trap previous samples or purge media which can contaminate subsequent samples. Piston actuated devices also have no continuous visual indication of normal or abnormal fow conditions for the operator, other than their preset trip point.

Variable area meters

Variable area meters have the advantage of continuous visual display of fow; however, they also are susceptible to sticking over time in many fuids. Their longer term reliability is often a concern expressed by analyzer users. Adding a magnetic pickup to provide an electronic relay trip or an analog output adds signifcantly to their cost. Variable area meters tend to take up more valuable enclosure space than desired as they are very orientation dependent; and their fow input and output access are typically on different planes.

Differential pressure (dP) devices can be a sound technology to monitor analyzer fow rates. Even in the small line sizes and at very low fow rates associated with analyzer sampling systems, a properly sized orifce and sensitive pressure transducer can yield desirable results. The two main disadvantages of dP technology are: (1) its limited fow rate turndown capability and (2) the large errors incurred at the low end of the fow rate readings. Very often it is the low end that is critical for sample fow assurance and fow monitoring in analyzers and sampling systems. Unfortunately, optimizing the fow range to the low end of dP sensors can result in an appreciable pressure drop and poor fow measurement performance at normal fows.

Similar to piston driven switches and variable area meters, dP fow monitors must be selected knowing the density and a specifcally narrow fow rate range of the sample process. There are limited dP devices designed for the SP76 manifold. They require at least two block spaces and are the most expensive of all the monitoring devices.

Solving The Problems

An ideal fow monitor for an analyzer sampling system would be one that can be adapted on site and adjusted specifcally in the application. In addition, a more robust fow sensing technology married to fexible and user programmable electronics, which can be specifed without detailed and fnite validation of process variables such as density, viscosity, fow range, fuid type, etc., also would alleviate a pain point for the analyzer system supplier and site engineering team.

Flow monitors designed with thermal dispersion technology match up extremely well with the ideal universal use criteria to support an analyzer sampling system. Depending on the manufacturer's fow element and electronics design, they can be user set-up in situ to assure the feld engineer a successful, frst time correct installation. These devices may be confgured in the feld to operate in gases or liquids at most any density or viscosity with no special consideration at time of ordering.

There are two major types of thermal devices on the market. One type utilizes a capillary bypass technique and is better known as a Mass Flow Controller or MFC. MFC's divert a portion of the main fow into a small bypass and sense the heat transfer of fowing fuid in the bypass channel. This technique can be very effective; however, the capillary tube is highly susceptible to contamination and clogging and should only be considered for use with clean or pre-fltered fuids. Capillary bypass fow

Figure 4: FS10A in tube tee

monitors are generally applied in lab use and agency approvals (e.g. FM, CSA, ATEX, IECEx, etc.) for use in hazardous, explosive environments are rare. Flow range selection is also important when specifying MFC type fow monitors.

Immersible Thermal Dispersion Technology

The other type of thermal dispersion fow monitoring device is one that uses thermo-wells in the fow stream, sometimes referred to as immersible-type. These types of devices typically apply heat to one thermal sensor relative to a second thermal sensor measuring the process temperature. The temperature difference changes with fow rate. In the case of gases, the measurement is directly related to mass fow. Immersible thermal fow monitors are very effective over wide fow ranges in gases, and over smaller low fow ranges in liquids.

Thermal technology is particularly advantageous in process analyzer systems because it has no moving parts to wear, stick or foul. With their tiny thermowells and wetted materials typically made of 316L Stainless Steel and/or Hastelloy alloys, they are highly compatible and well suited for application in most analyzers and sampling systems.

The thermal probe can be threaded into industry standard tube tee branches (e.g. Parker, Swagelok, Circor) *(Figure 4)* or even into a single block in the previously mentioned SP76 manifold, resulting in minimal dead space. There are no cavities to trap previous samples so sample integrity is always the highest. Another key characteristic of thermal fow monitors for analyzer applications is their superior sensitivity to low fow rates.

Figures 5 & 6: FS10A in remote configuration; hot process sampling system (VAM/new shelter)

It is not uncommon to fnd analyzers requiring preheated or hot process fuids. As thermal devices typically do not require elastomer seals, and can be easily confgured with the sensor element and electronics separated (remote), they are often the best and only solution for higher temperature service requirements, up to 260°C [500°F] is common. Other features may include indicators/displays of trip point status and fow rates, isolated SPDT alarm contact and analog and/or digital output to monitor fow trends *(Figures 5 and 6)*.

Perhaps the most important beneft of some types of thermal devices is their ability to be feld set and feld adapted by the user for inexact, unknown or changed process and application conditions. Precisely and completely defned process conditions and fuid variables are often lacking during the preliminary design and engineering phase. Variations in tubing confguration, fow direction layout, ambient and fuid temperature conditions, pressure and density variations, viscosity, fow range, fuid type and trip points are variables that are often only fnally determined after installation and site commissioning. Thermal dispersion fow technology based products with smart electronics can provide maximum feld adjustability and site adaptability.

Based on its 50-plus years of experience with immersible thermal dispersion technology, FCI has developed the FS10A Analyzer Flow Switch/Monitor specifcally for gas and liquid process analyzers and sampling systems. It features a fast responding, highly repeatable sensor that installs easily into a standard tube tee ftting or new SP76 (NeSSI) modular manifold. Its microprocessor-based electronics, on-board keypad and serial I/O computer interface provide easy and extensive feld adjustability. FS10A's are also small, compact and lightweight so they ft in virtually any tubing array or mounting orientation. They are now operating successfully in multiple user sites worldwide.

Conclusions

Flow sensors and monitors are just one of the components required in complex process analyzer and sampling systems. While there are several fow monitoring technologies available that can be considered, their diversity can make proper selection a major challenge. The question becomes, "Which fow technology is optimum for the particular type of analyzer application and its operating environment?"

Properly selecting a fow sensor for an analyzer sampling system can take an inordinate amount of an engineer's time because of the complex factors that must be reviewed. Consideration must be given to:

- Diversity in measuring range
- Fluid type and condition compatibility
- Temperature and pressure condition suitability
- Outputs and user interfaces
- Approvals for Ex locations
- Site adaptability and adjustability
- Tube tee and SP76 compatibility
- Dimensions, weight and orientation
- Total installed cost

Even then there is still worry about whether or how well the chosen fow monitor really functions when the system is commissioned, launched and put into operation.

To resolve these issues, look for the most fexible fow technology solution. A fow monitor that is adaptable and can be site set for most any feld condition variables, such as those based on immersible thermal dispersion technology, provides maximum confdence that the analyzer system will perform as expected upon installation. The end result is an analyzer that operates reliably, avoiding costly reworks and delays. ■