NeSSI Manages Moisture in Rubber Process

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Heated, smart, modular sample-handing system enables closed-loop process control in butyl plant in Sarnia, Ontario.

By *Jamie Canton*

Accurate moisture measurement and control is necessary to maintain profitability in many chemical and petrochemical processes. While on-line moisture analyzers provide moisture level and trending visibility through a distributed control system (DCS), many process engineers and operators remain skeptical of these data because sample handling systems (SHS) historically have problems that compromise their analyzers' accuracy.

This article shows why and how Lanxess deployed a modular sample system to monitor moisture in a sensitive butyl rubber process at its plant in Sarnia, Ontario. The system uses compact SP76 modular flow-control components in a heated enclosure with remote sample validation and bypass and analyzer flow indication over the DCS. These tools let operators assign more weight to the analyzer's results.

Legacy moisture analysis systems at Sarnia used conventional sample systems with 3/8-in. and ½-in., carbon-steel pipe that increased sample delivery lag times to the analyzer. These high-volume SHSs require high-flow and fast loops to deliver representative process parts-per-million (PPM) moisture conditions. These high flows led to high steam-trace energy requirements to prevent moisture absorption to the sample-transport pipe wall. Steam is a cost-effective heat trace method at Sarnia, but steam trap or other system failures commonly caused SHS and analyzer downtime.

While operators could see the moisture analyzer's data via the DCS, they were basically blind to the SHS's health and operation. As the analyzer reported moisture nearing out-of-specification levels, the operators typically disbelieved the analyzer, reported the drift to the analyzer maintenance department and sent a technician to physically inspect the analyzer and SHS. A manual validation would be done by cycling stream-switching valves to a reference gas and reading local flow indicators to determine if sample and reference gas flows had been introduced to the analyzer. Callouts for technicians were common, and these SHS inspections could be as long as six hours. These lags were especially costly when moisture levels exceeded specification, causing poor product quality and downtime.

A New Approach

In 2000, the Sarnia plant participated in Lanxess' deployment of an analyzer and SHS downtime measurement system to benchmark its overall performance. A DCS subroutine was programmed internally, providing visibility to an analyzer's online or offline status. However, only the technicians were given status-change authority, and all status changes required inputs documenting the downtime's cause. The program let the plant focus on eliminating out-of-service conditions for its nine process gas chromatographs (GCs). The success of this GC initiative in late 2003 inspired Sarnia to establish future-state-analyzer and SHS requirements to support a butyl rubber plant prone to downtime due to excessive moisture.

The analyzer project team adopted a customer-service perspective and asked: "How can we instill confidence in the process engineers and operators (the customers) to trust and act upon the analyzer's data (the deliverable product)?" They answered: "Include these customers on the project team." This resulted several key deliverables, including:

- Incorporate a "mini-process" with information delivery over the DCS and operator action assignments based on conditions reported;
- Reduce sample volume and delivery lag time, as well as energy requirements for heat trace;
- Provide remote validation functionality and flow indication to control room operators.

Consequently, the New Sample System/Sensor Initiative's (NeSSI) technology was identified as an alternative for SHS fabrication early in the project cycle. Its features included:

- Proven, robust, automated, double block and bleed (DBB) stream-switching capabilities,
- A roadmap outlining more functions, such as smart sensors and on-board analysis,
- Reduced sample volume for faster sample transport times,
- Compact system size allowing added sample systems and analyzers to fit into existing shelters,
- The ability to develop standard system designs for ordering as one supplier's part number.

Sarnia's SHS layout features two separators and valves that direct sample and reference gasses.

The team researched the capabilities of several NeSSI-based manufacturers and chose Parker Hannifin's IntraFlow system, as well as its R-Max air-actuated DBB system to deliver remote validations. Also, these stream-switching functions gave Sarnia's engineers the confidence to conduct previously prohibited, multi-stream analysis on one analyzer. They also developed a remote flow-indication device, which promised to provide analyzer flow information. Parker undertook Sarnia's butyl rubber PPM moisture analyzer SHS project in early 2005.

Securing Simpler Sampling

From a sample conditioning standpoint, the plant's rubber moisture analyzer sampling system is relatively simple (Figure 1). It features two membrane separators in series to protect the moisture analyzer from costly flooding due to heat-trace failures. The separators are configured in-line without traditional bypass legs. Nitrogen is dried in an on-board desiccant dryer and used as a standard reference gas for calibration and validation. A normally closed (NC) R-Max switching valve directs sample flow to the analyzer, while an adjacent, normally open (NO) R-Max directs the standard reference to it. The NO and NC valves are controlled by solenoid-operated pilot valves on-board the SHS, and their orientation provides a power or instrument-air failsafe condition for reference gas flow.

Bypass and analyzer flow indication is accomplished with 1 psig differential pressure (dP) sensors measuring pressure drop across restricted orifice plates embedded between the sensors and the substrate blocks on which they're mounted. The sensor from Honeywell Sensotec has a micro-machined silicon structure that changes resistance (ohms) when force is applied. A wheatstone bridge, arranged to measure diaphragm movement from pressure changes up and downstream of the restricted orifice, provides 1% accuracy over a wide temperature range. The sensor's transmitter sends a 4-20 mA output to the DCS system to make flow conditions visible.

Representative sample delivery in PPM moisture analyzer applications is susceptible to temperature influences throughout the system because moisture cools stainless-steel surfaces, and levels equilibrate throughout the system. As a result, electric-traced sample transport lines and an enclosed, heated SHS maintaining a constant 50°C sample temperature were specified. With the first NeSSI-based system, Parker's "pegboard" backplane-design feature supported Intertec Instrumentation Ltd.'s (www.intertec-inst.com) Class 1, Division 1 "smart" conductive heater block clamped between the pegboard's backside and the top of the enclosure's rail mounting. This allows the system's inflexible conduit to be installed independently of its flexible tube and power runs. The enclosure's instrument air purge also is preheated via the pegboard.

Successful Field Results

The plant's NeSSI system was commissioned in June 2005 and provided analyzer and bypass flow-rate information to the control room's DSC terminal. This allowed users to remotely actuate the stream-switching valves to validate the analyzer's calibration.

The bypass flow signal indicates inlet pressure fluctuations, and it initializes when nitrogen reference gas flows through the cell for 9 min 25 sec. This is followed by a 5-sec flow interruption, when the switching valves—actuated from the control room—shut off the reference gas and open the sample flow. The sample flow signal is a slightly different value, revealing the specific gravity difference between the sample and the nitrogen and their influences on the dP sensor. This signature repeats as 9 min 25 sec switching intervals continue during the one-hour snapshot.

Training operators on the new tools was straightforward because they were involved early project. The validation function sends an "OK to use analyzer data" signal through the DCS, which eliminated costly lab-sample validations. Technicians' time spent checking properly functioning systems also has been reduced. Now, a flag is sent to the operator and technician requesting correction when a validation doesn't pass. Understanding signal limits and signatures based on normal events provides benchmarks of normal operating conditions, while abnormal conditions present signatures that are easily detected as different. A library of these condition signatures was cataloged, and these indicate corrective actions.

Consequently, confidence in the analyzer and SHS has increased, and the analyzer's data now plays a much bigger role in Sarnia's process. Since startup, the plant's sampling system has posted a 100% uptime record, and the analyzer's data is regarded as absolute and conclusive. Process instrumentation hasn't been installed to run closed loop yet, but the new system recently proved its worth when an unexpected moisture event was detected. Following protocol, a validation cycle was initiated from the DCS, including flow confirmation to the analyzer, which reported the same uncharacteristic moisture condition that prompted correction of the process. The plant's staffers agree that if this event had occurred before its new SHS tools were installed, they would have faced a costly plant shutdown. The tool that overcame the shutdown was the analyzer's sample flow indicator over the DCS. Sarnia's process engineers had requested this dP flow-inference solution for many years.

The project's design, implementation and commissioning were a collaborative effort between Lanxess, Parker and their local distributor, Viking Instrumentation. Lessons learned during the project included:

- Plant operations' involvement in the early stages of the project was invaluable. Their early input and buy-in created an atmosphere of teamwork that set the stage for a win-win conclusion.
- A radical departure from legacy mindsets and breaking free of "the way we've always done it," requires open mindedness to determine the vision and single-mindedness to work through the inevitable hurdles.
- Selling management on the future state vision of SHS capabilities, then fulfilling it with a successful implementation easily overcomes initial budgetary concerns. Since the initial project's conclusion, the value provided by confidence in the analyzer's data and prevention of a plant shutdown has resulted in a strategic implementation plan for installing such systems throughout the Sarnia site.

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The article was also posted as a White Paper, where Steve Doe 's name was noted. The Editor wanted to highlight the end customer for the readers. Parker IPD approved of the change to the "hard copy" article

White Papers

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Heated, smart and modular sample handling system: Enabler for closed-loop process control

This white paper/case study documents the rationale and steps for deploying a modular sample handling system solution in a moisture-sensitive process, from concept through commissioning and operational performance.

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ACCURATE moisture measurement and control is necessary to maintain profitability in many chemical and petrochemical processes. While on-line moisture analyzers provide plant operators with moisture level and trending visibility through a Distributed Control System (DCS), many process engineers and control room plant operators remain skeptical over the accuracy of such data. This is because sample handling systems (SHS) are historically prone to problems that compromise the analyzer's data accuracy.

The system utilizes compact SP76(3) modular flow control components in a heated enclosure, with a novel proportionally controlled conductive heater for both the sample system and enclosure purge. Key tools enabling operators to interface with the system include an automated validation function and sample bypass and analyzer flow indication available over the DCS. These tools enable the process engineer to assign more weight to the analyzer's results in the application program. Lessons learned from this project and a resulting strategic plan for deploying the technology in other areas, including closed loop process control applications, will also be discussed.

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