talkline

Technology and Water

Endress+Hauser
People for Process Automation

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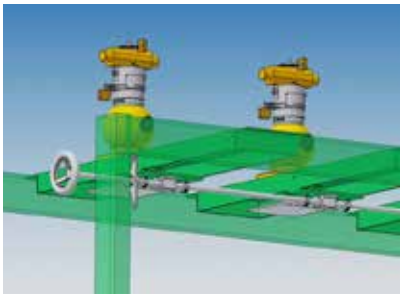

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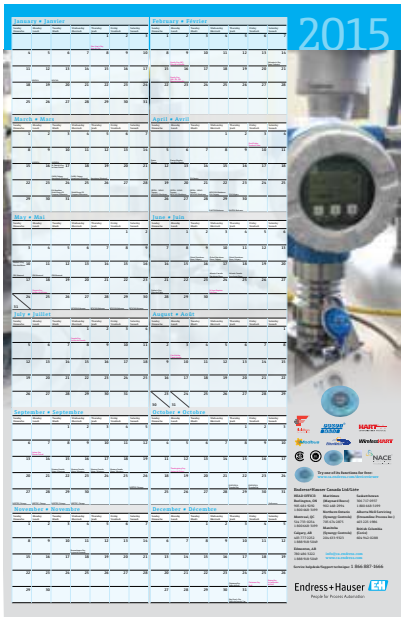


Endress+Hauser 2015 Calendar

There's still time — place your order for our FREE calendar at info@ca.endress.com

Our valued friends, customers and business partners

Dear Reader,

This issue of *Talkline* arrives as we prepare to say goodbye to 2014. It is hard to believe that 2015 is a matter of days away. Looking back on 2014, each and every one of our customers and business partners deserves our thanks - for their continued trust and support. In these challenging times, we have continued working together with a spirit of partnership, trust and mutual respect. This is the way to ensure we all continue meeting our challenges while ultimately sharing in the achievement of success.

2015 will no doubt be another challenging year. Meaningful achievements will be derived from partnerships, shared objectives, collaboration and ultimately, mutual growth and reward. By actively working together we pave the way forward. By working through challenges together, we contribute to our collective and individual successes. Of course, you can count on Endress+Hauser to continue its long standing investments in R&D. Next year we continue to introduce state-of-the-art technologies, products, services and innovative, yet practical solutions. Our organization and the *People for Process Automation* are here to work with you to help maximize your processes and product quality. At Endress+Hauser we partner with our customers so as to realize process improvements, while ensuring a high level of safety.

When it comes to safety in process industries, Endress+Hauser has a safety foundation built on field expertise. Reliable measurement sets the basis for safe processes. In all that we do and in all that we develop and produce, safety comes first. The instruments we manufacture begin with the safe design and testing experience gained by over six decades of practical know-how, collaboration with customers and engagement with industry organizations. We have embedded this expertise into the development of our devices, which is evident and proven through their use in the field. I hope you will consult us for all your safety critical applications.

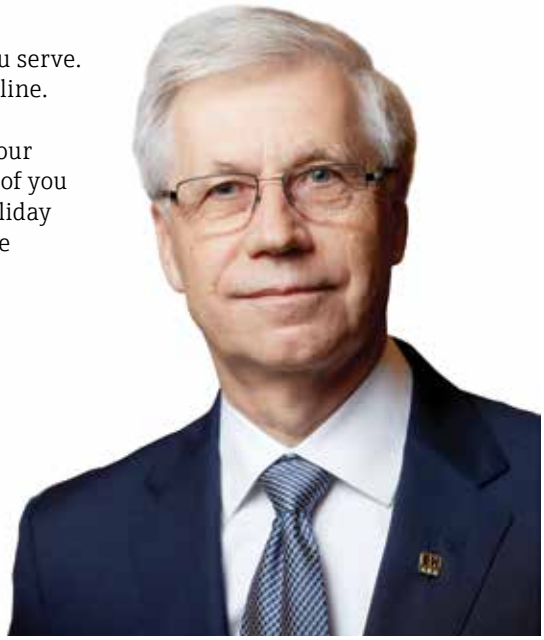
We are here to help you be as competitive as possible in the markets you serve. Our aim remains unchanged: to deliver tangible results to your bottom line.

On behalf of all of us at Endress+Hauser Canada, thank you again for your continued support and friendship this past year. To each and every one of you and your families, we extend our best wishes for a safe and relaxing holiday season. We look forward to working with you again in 2015 towards the achievement of your goals.

Sincerely,

Richard

Richard Lewandowski
CEO



How Technology and Water Converge in the Economics of Oil and Gas Production

by Steve Smith, Analytical Product Business Manager, Endress+Hauser USA

Understand water management in unconventional plays.

Advances in exploration and energy extraction techniques — including horizontal drilling and hydraulic fracturing — are changing the North American energy economy. Horizontal drilling facilitates unconventional access to gas and oil reserves that were unavailable using conventional vertical drilling. Most of the large volume gas and oil reserves are difficult to develop because they are contained in deep, tight sands, shale and other unconventional reserves.

However many of these reserves can be accessed using hydraulic fracturing, which involves the injection of water, sand and chemicals at high pressure across the horizontal well as deep as 10,000 feet below the surface. This fractures the shale and other unconventional formations and allows gas and oil to flow up and out of the well, with significant volumes of water. A well produces three to nine barrels of water, on average, for each barrel of oil produced.[1]

One significant economic benefit from these techniques is the increased production of shale natural gas, which is a precursor to important intermediate chemicals that are used in a wide range of commercial products. Shale gas now accounts for more than one third of the U.S.'s natural gas production and is considered one of the most significant energy developments in the past 50 years.

Hydraulic fracturing and proper water management across the process requires a range of process instruments — including flow meters, level sensors, overflow protection and a range of analytical measurements.

Water Management

The primary fluid used in hydraulic fracturing is water and the completion process can require from 2.75 – 8.25 million gallons per well. For example, the Marcellus Shale uses 80,000 gallons of water per well for drilling and 4,000,000 gallons for hydraulic fracturing, for a total volume of 4 to 8 million gallons per well. With this

requirement, the significant expansion of unconventional oil and gas development requires reliable water resources and effective management to control costs, which are a significant component of upfront capital investment and ongoing lease operating expenses.

Water management can be defined within five major unit-operations: sourcing, transportation, storage, treatment and disposal. Figure 1 illustrates this and shows that water is ultimately injected in disposal wells or recycled within the process.

Three different water management methods exist:
- Once through and disposal
- Treatment and reuse
- Treatment and discharge

1 Argonne National Laboratory, 2009.

Within the "Operation" block of Figure 1, four different types of water-based fluids are associated with hydraulic fracturing—drilling mud, hydraulic fracturing fluid, flowback water and produced water. Different water management requirements and instrumentation are associated with the control and processing of each water type.

Different treatment processes have been developed and new processes are constantly evolving to treat and reuse/recycle as much of this water as possible to conserve and improve operational efficiencies and reduce costs. Treating flowback and produced water is much less expensive than the high cost of water acquisition and the transportation of contaminated water to treatment facilities.

Drilling Mud

Drilling mud cools the drill bit and facilitates the transport of rock cuttings to the surface during drilling operations. Most drilling mud is comprised of water, sand and chemical reagents to regulate mechanical properties and provide environmental protection. Water in drilling mud must be managed to ensure the proper density, viscosity and chemical properties of the mud.

A key analytical measurement in drilling mud is pH. Low pH aggravates corrosion. Online pH monitoring ensures that corrosion is minimized. In this environment, pH measurement is difficult because of abrasion and mineral deposits that have the potential to block a pH probe's reference junction. The use of an ion specific field effect transistor (ISFET) pH probe (see Figure 2) reduces the potential for probe damage and provides longer sensor life.

An ISFET probe is constructed with a solid sensor and is typically made of polyether ether ketone. The pH sensing element is a field effect transistor that responds to the presence of the hydrogen ion, producing a signal proportional to pH. Despite the robust nature of the sensor, it must be removed frequently to clean off mineral deposits. Drilling mud is commonly delivered to the drill bit using progressive cavity pumps. These pumps are able to handle solids and slurries without adverse effects on fluid viscosity.

Hydraulic Fracturing Fluids

Hydraulic fracturing fluids are typically made up of 9 percent sand and 91 percent water in solution. Sand used in fracturing is engineered to be spherical, reducing friction and maintaining a structure in the formation that facilitates fluid flow through the sand matrix. Approximately 99 percent of the liquid used consists of water. The remaining liquid, less than 1 percent, is comprised of additives (see Figure 3). Additives play a key role in hydraulic fracturing fluid dynamics. They reduce friction, fight microbes, control pH and prevent equipment corrosion.

Hydraulic fracturing fluid is blended and combines sand, water and additives in exacting combinations. It is then injected at high pressure deep into the well. Precise blending of the additives is achieved using Coriolis mass flow meters. Coriolis mass flow meters measure fluid flow in mass rather than in volume. Mass flow allows for precise control of the additives relative to the mass of the water and sand.

In addition to mass flow blending, control of the additive blend's pH can be accomplished with digital pH measurement. Digital pH sensor technology allows for the remote calibration of the sensor under controlled conditions and simple replacement onsite, using a sealed, inductively coupled connection that protects the sensor signal under harsh environmental conditions.

Pumps used to send fracturing fluid down the wellbore are critical to the success of the hydraulic fracturing process. Reciprocating plunger pumps have been used for

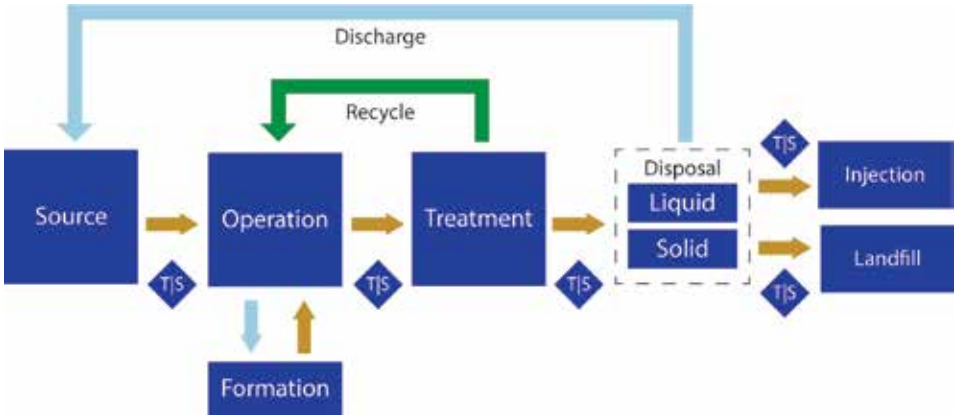


Figure 1. Water flow in hydraulic fracturing and production. Source: HIS and Cap Resource: The Future of Water in Unconventionals—Water Management Strategies in the Continental U.S.

Figure 2. ISFET pH probe

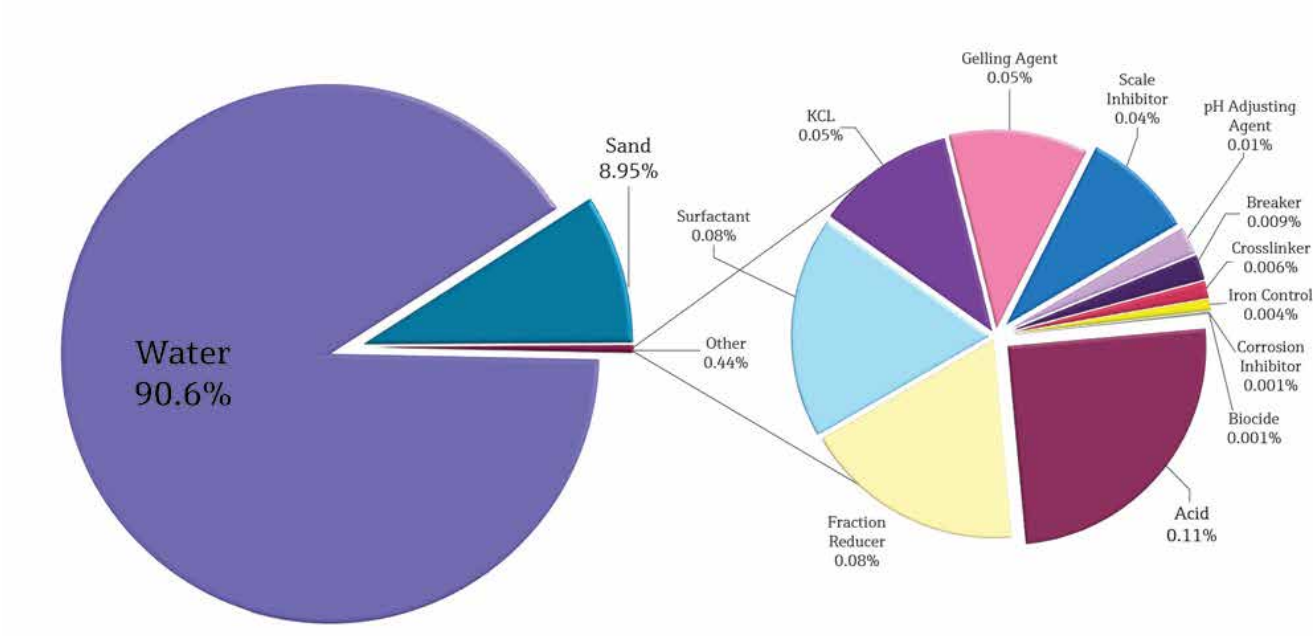


Figure 3. Typical makeup of hydraulic fracturing fluid. Source: Modified from Bohm et al., All Consulting, 2008

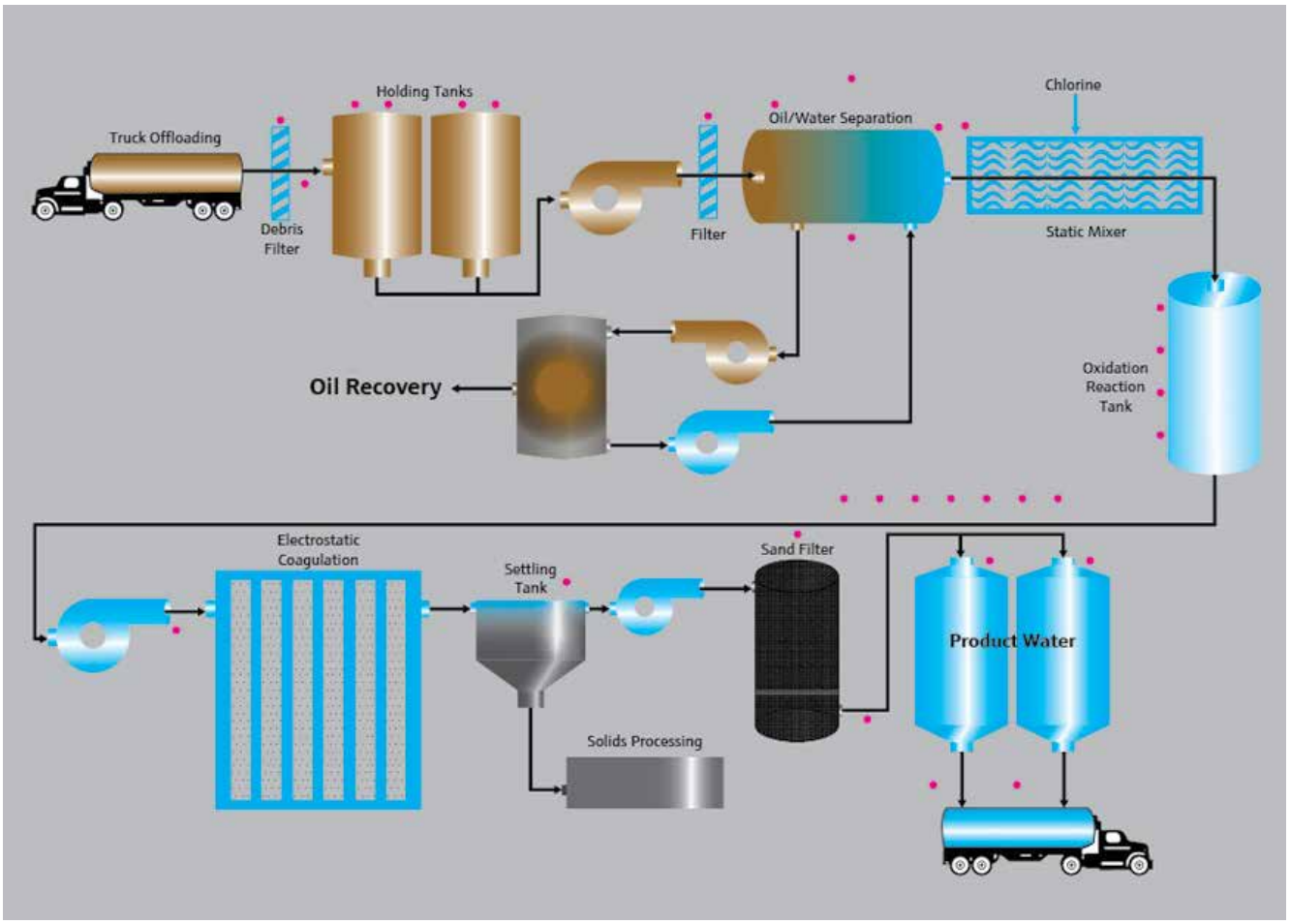


Figure 4. Typical flowback/produced water process

decades to propel the water, sand and chemicals into a well at pressures as high as 15,000 psi and flow rates above 100 barrels per minute. These pumps are evolving with increases in size, horsepower ratings and pressure capabilities to meet the increasing demands as drilling migrates into more complex geological formations.[2]

Flowback Water

Water used to fracture the well recycles back to the surface and is referred to as flowback water. During the completion process, volumes can range from 0.5 to 1.2 million gallons per well per week. As a well achieves completion, flowback water slowly transitions to produced water.[3]

Flowback water may contain hydrocarbons, fracturing sand and pieces of plastic/metal/cement from drilling. As the well comes online, the water can be difficult to manage because of the varying flow rates and composition. With proper instrumentation, both flowback and produced water can be treated in close proximity to well sites for reuse, reducing costs and decreasing the dependency on fresh water sources.

Produced Water

Produced water is collected along with hydrocarbons during the well's production life. Produced water includes a mixture of the following:

- Liquid or gaseous hydrocarbons
- Dissolved or suspended solids
- Produced solids, such as sand or silt
- Recently injected fluids and additives that may be in the formation as a result of exploration activities

Typically the volume, chemistry and suspended solids are stable throughout the well's life. Produced water flows can range from 30 to 500 gallons per day for each well. Given the limited availability of water, hydraulic fracturing operations are now reusing produced water to decrease the demands on local water sources and reduce the overall cost and challenges of disposal. Of the costs associated with produced water management, transferring water from a well site to a processing facility or a disposal well is the greatest component. Costs for transporting water can be more than $3 per barrel. The development of onsite produced water processing facilities can dramatically reduce these costs.

Produced water handling and treatment represents an $18 billion cost to the oil and gas industry in the U.S. alone, and is the single largest waste stream challenge facing the industry. The cost of disposing produced water ranges from a low of $0.08 per barrel to a high of $12 per barrel. By contrast, water for agricultural irrigation can be as low as $0.004 per barrel and municipal drinking water costs in the range of $0.04 per barrel. The price of cleaning produced water is up to 300 times greater than treating municipal water and 3,000 times greater than agricultural irrigation water.[4]

Coriolis mass flow meter

Produced and flowback water can be processed onsite or transported to a central processing site. While a central processing site can be leveraged across multiple well sites, a portion of the transportation costs still exist.

A typical produced/flowback water process (see Figure 4) employs four basic steps.

Pre-treatment This step includes the removal of large particles and oil/water separation. At a central processing facility, water is delivered by truck and is pumped into storage tanks using centrifugal pumps. Tank levels are monitored using guided wave radar and are protected with overflow sensors. This stage incorporates filters with differential pressure measurement to monitor filter status. Conductivity sensors are employed to monitor the oil content and the effectiveness of the requisite oil/water separation process.

Main treatment Using a range of processes–including biocide addition and different coagulation and flocculation steps–total suspended solids and total dissolved solids are reduced, including iron. Once the compounds begin to coagulate, a sludge thickening process is employed to remove the solids.

2 Matt Trieda, "The Evolution of Hydraulic Fracturing and Its Effect on Frac Pump Technology," Pumps & Systems, April 2010.

3 Water Environment Federation – Fracking Fact Sheet, 2013.

4 www.altelainc.com/applications/detail/oil-and-gas-industry-produc...

Polishing Using filters, ultra-small and dispersed hydrocarbons are removed. In this process, differential pressure is again used to monitor filter status.

Tertiary treatment This final, optional step can produce a high-quality effluent stream. Evaporation technology is being employed to produce a higher quality distillate that can meet or exceed secondary drinking water quality standards.

Throughout this process, analytical instruments are employed to control this process. Level sensors are used in holding tanks and settling tanks with high-level overflow protection sensors. Where oil and water coexist in a tank, radar level is used to detect the actual interface.

Flow measurement technologies in produced water processing include magnetic and ultrasonic. Magnetic flow meters are not suited for flow streams with high oil content because oil is not conductive. In these applications, ultrasonic flow meters are the technology of choice.

Conclusion

Horizontal drilling and hydraulic fracturing are making significant impacts on the availability of energy resources, including natural gas and oil, but are also adding significantly to the demands of water in the production process. Improvements in operational efficiencies and reductions in the use of fresh water resources can be achieved by applying recycling technologies for all water associated with the production process.

Drilling, completion and production can employ water management solutions that incorporate state-of-the-art technologies including flow, level, pressure and analytics. In addition to reducing water consumption, applying these technologies can create a sustained competitive advantage by reducing capital investment and operating expenses.

Trade Shows 2015

January 12–13	MWWA, Brandon Manitoba
March 9–10	AWWOA
March 17–18	CsHM Telus Convention Centre, Calgary
March 17–19	Americana, Montreal
March 24	ISA Hamilton
March 24–26	World Heavy Oil Congress, Edmonton
April 14	ISA Sarnia, Holiday Inn
April 19–21	OPCEA - WEAO Toronto Congress Centre
April 19–22	MPWWA (Maritime Provinces WWA) Charlottetown, PEI
April 22–23	ISA Calgary
April 29–30	RAOTM Kitchener Ontario
May 27–30	BCWWA Kelowna
May 10–12	CIM Montreal
June 9–11	Global Petroleum Show (Calgary)
June 17–18	Atlantic Canada Petroleum Show, St. John's, NFL
September 15–18	Western Canada Water Winnipeg, Manitoba
September 26–30	WEFTEC, Chicago
October 22–23	NWOWWA, Thunder Bay
November 4–5	SWWA Conference and Trade show

TBD

Process & Automation Shows
Foundation Fieldbus, Calgary (April/May)

A Rock-Solid Solution

Endress+Hauser Gammapilot radiometric technology for low-density applications

When an international rock insulation manufacturer decided to replace an out-of-date density measurement system in its manufacturing line, it faced a number of challenges. The project involved limited physical space, allowed a limited amount of down-time, and the unique properties of its products made conventional measurement systems ineffective. Endress+Hauser helped the company install an innovative density measurement system that fit the space, time and measurement tolerances of the job.

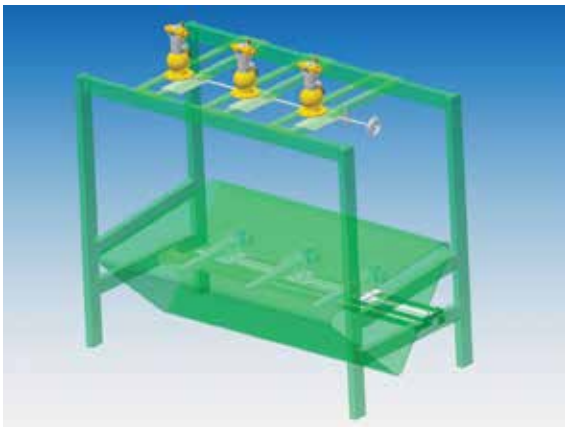
Manufacturers of stone wool products traditionally employ production processes involving high temperatures, limited space and precise measurements. It begins by heating a mixture of volcanic rock, slag and coke to temperatures, approaching 1500C until it liquefies. The melt is then spun into wool in a spinning machine, with binders and additives introduced before it travels along a conveyor to be cured. The structure and density of the wool are adjusted before it is delivered to a curing oven, at which point its properties are set.

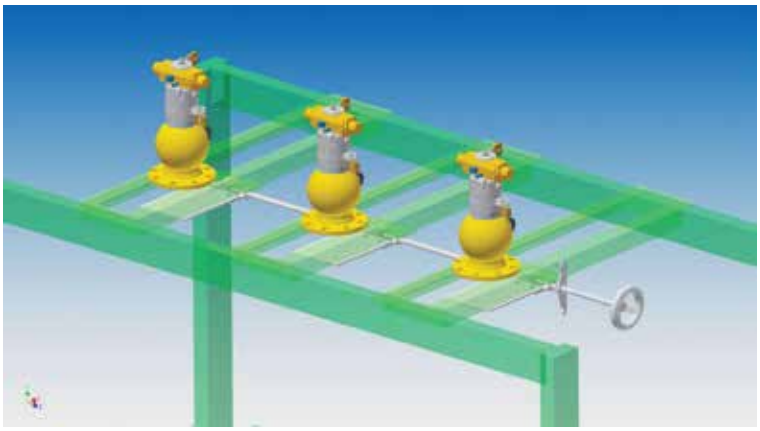
Endress+Hauser was contracted to replace an aging density measurement system that was used to measure the area weight of a continuous insulation bat between a spinning chamber and a curing oven. The accuracy and reliability of the application was crucial, as the measurements provided are used to adjust the speed of the downstream conveyor through the curing oven.

This could not be a conventional density measurement application.

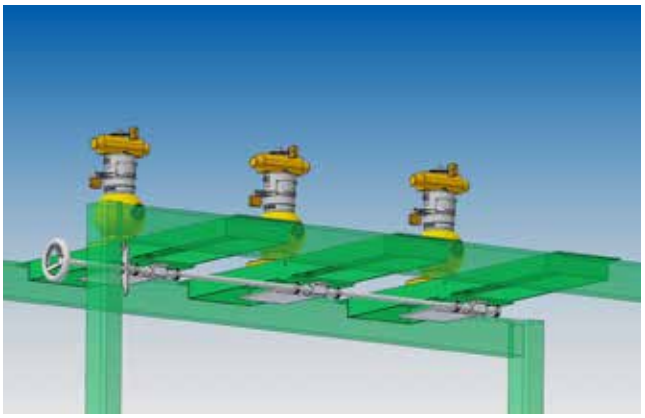
"The company had an old custom gamma measuring system with analog electronic components for which spare parts were non-existent and little engineering documentation existed," explains Ian Notley, Endress+Hauser's project manager for the job. "They were looking for a low-cost replacement solution with same or better performance, using modern off-the-shelf components."

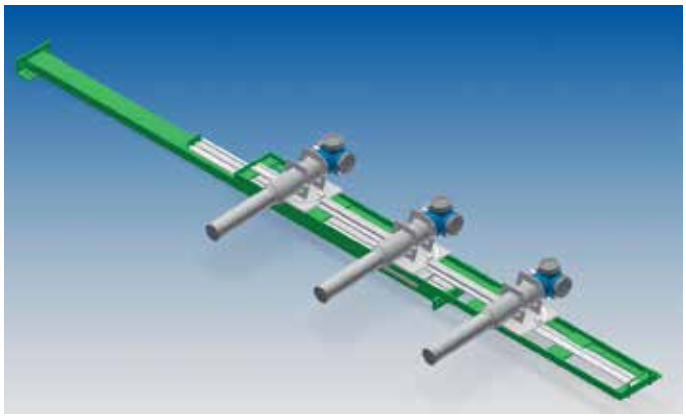
Endress+Hauser had just the solution The Gammapilot FMG60 is a compact radiometric level and density transmitter made for non-contact, constant measurement in a wide variety of extreme environments. Endress+Hauser paired the FMG60 with a PVT scintillator and gamma source FSG60 (Cs137 20 mCi) along with a FQG61 source container and FHX40 display units. This solution provided a cost-effective state-of-the-art measurement system. The





Gamma density measurement technology is a non-intrusive, non-contact measurement technology that is appropriate for online continuous measurements





instrumentation installed has a much lower nuclear activity level than the previous system, providing a smaller hazardous area around the equipment and greater safety for workers. As well, the system is completely digital—the PVT scintillator detectors replaced outdated Geiger-Müller type tubes.

"Gamma density measurement technology is a non-intrusive, non-contact measurement technology that is appropriate for online continuous measurements like the situation we faced," says Notley. "A conventional weighbridge solution would have required substantially more horizontal length along the belt conveyor and would not have been possible to install within the small space available. A weighbridge would also not have been able to provide different profile measurements across the insulation bat as done by the gamma system."

Though it was easy to identify the best technology for the project, limited space in the area between the spinner and the curing oven demanded customization of elements for easy access and the new system needed to be largely pre-assembled to permit installation within a 48-hour period in order to reduce downtime. The detectors were mounted on rotating cradle baseplates, which were in turn mounted on a sliding frame assembly, enabling a technician to withdraw and service all three detectors from one side of the belt. The calibration plates were mounted beneath the sources and connected by a single shaft that is easily rotated into place by an operator hand wheel from one side of the belt.

The most time-consuming challenge, however, was posed by the characteristics of the insulation itself. "Gamma technology is typically applied to measure high-density liquids and solids," Notley explains. "The insulation bats have a very low density, meaning the change in gamma attenuation seen at the detector when an insulation bat was present was very small. Consequently, small measurement errors would produce a large output error.

"This could not be a conventional density measurement application since both product density and bed height varied depending on the product type selected."

After extensive trouble shooting, the Endress+Hauser team revised the initial system architecture to create a simple one source-one detector configuration, aligning the beam paths directly with the detectors. This provided reliable profile measurements across the insulation bats, ensuring the consistent density required for effective production.

Endress+Hauser provided a low-cost replacement solution with same or better performance, using modern off-the-shelf components.

"This solution has performed reliably throughout testing and implementation, even for the lowest density insulation products," says Notley. The project was ultimately a success and allowed Endress+Hauser to explore new areas of application for its gamma density instrumentation. "The project has proven the concept of area weight measurement of low-density solids using standard Endress+Hauser gamma components for future applications."

Equally important, the client received a safe, reliable world-class measurement system that can provide accurate measurements in its insulation production line for years to come.

Proline Promass 80E Coriolis Flowmeter

Just the ticket for locomotive refueling station

Endress+Hauser Canada recently provided a refueling solution that has helped keep one of the world's largest iron ore operations on track.

An international iron ore producer was recently looking to replace the aging positive displacement meters in a refueling station in its rail yard. The company relies on more than 20 locomotives and close to 1000 cars to transport nearly 75,000 tonnes of iron ore concentrate along its 420 km private railway every day. An additional 300-plus utility cars are also scheduled on the rail line to transport commodities and timber back and forth from the interior mining area to a port complex.

Turnkey Solution On average, five full trains (with two locomotives per train) return from the mining site to the port every day. Accurate and efficient refueling of those trains is critical to continuous processing and fulfillment of orders.

Endress+Hauser was contracted to provide a turnkey solution for diesel mass flow measurement and data transmission through a Profibus network. The contract involved provision and installation of two Coriolis flowmeters, a Profibus network, electrical panel and wiring for the new fueling system, starting the system up and complete commissioning.

Benefits of Proline Promass 80E Coriolis flowmeter

- Modular device and operating concept resulting in a higher degree of efficiency
- Software options for batching and concentration measurement for an extended range of application
- Diagnostic ability and data back-up for increased process quality
- Multivariable flow measurement in compact design
- Insensitivity to vibrations thanks to balanced dual-tube measuring system
- Immune to external piping forces due to robust design
- Easy installation without the need for inlet and outlet runs

Challenges The project provided a number of challenges for the Endress+Hauser team.

- The new system had to be installed and functional within 10 weeks.
- There could be no prolonged interruption of the logistics and production schedule in the company's industrial complex.
- The team had to manage employees from mechanical and electrical contractors, supplier shipping and Endress+Hauser specialists, as well as provide IT support related to the installation and operation of a new Profibus network.

Proline Promass 80E Coriolis flowmeter After initial consultation, it was determined that the new metering system should be built with Endress+Hauser's Proline Promass 80E Coriolis flowmeter. The 80E provides the accuracy demanded by the refueling environment with exacting accuracy at a reasonable cost. Coriolis measurement technology works independent of physical fluid properties, such as viscosity and density, meaning there is no need for temperature or pressure compensation.

The Proline Promass 80E offers the versatility required to operate the system with one device rather than requiring multiple devices and a calculation at the end of refueling. The 80E provides greater accuracy of the quantity of fuel dispensed (±0.20%), offers more diagnostic information than had been previously experienced, and does so with little-to-no maintenance. By installing the Coriolis flowmeter in a Profibus network, the device will work with any Profibus-certified components within the network in the future, regardless of manufacturer.

The project team prepared the new system to the job specifications on budget, meeting the "no-down-time" demands of the company. After commissioning, the company reviewed the performance and execution of the new system and indicated they are satisfied with the instrumentation and the commissioning process. They now have a reliable state-of-the-art metering system in their refueling station, providing an accurate understanding of its diesel fuel inventory as they keep their locomotive stock rolling.

Products Spotlight

Cleanfit CPA875

Hygienic and sterile retractable assembly for pH, ORP, DO

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- High-pressure operation with either manual or pneumatic actuation

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- Non-liquid verification and calibration for low range turbidity
- Direct pipe insertion design eliminates product loss
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Products Spotlight

Memosens

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- Sensor traceability with automated storage of process and sensor data

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Memobase Plus CYZ71D

Calibrate, measure and document

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- Create true sensor life-cycle management with complete calibration records, standards management and service history

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- Highest reliability with new Multi-Echo Tracking evaluation
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- Heartbeat technology™: continuous self-diagnostics and device verification
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- Life-time calibration eliminates errors caused by sensor drift

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Proline Promag 400

Flowmeter

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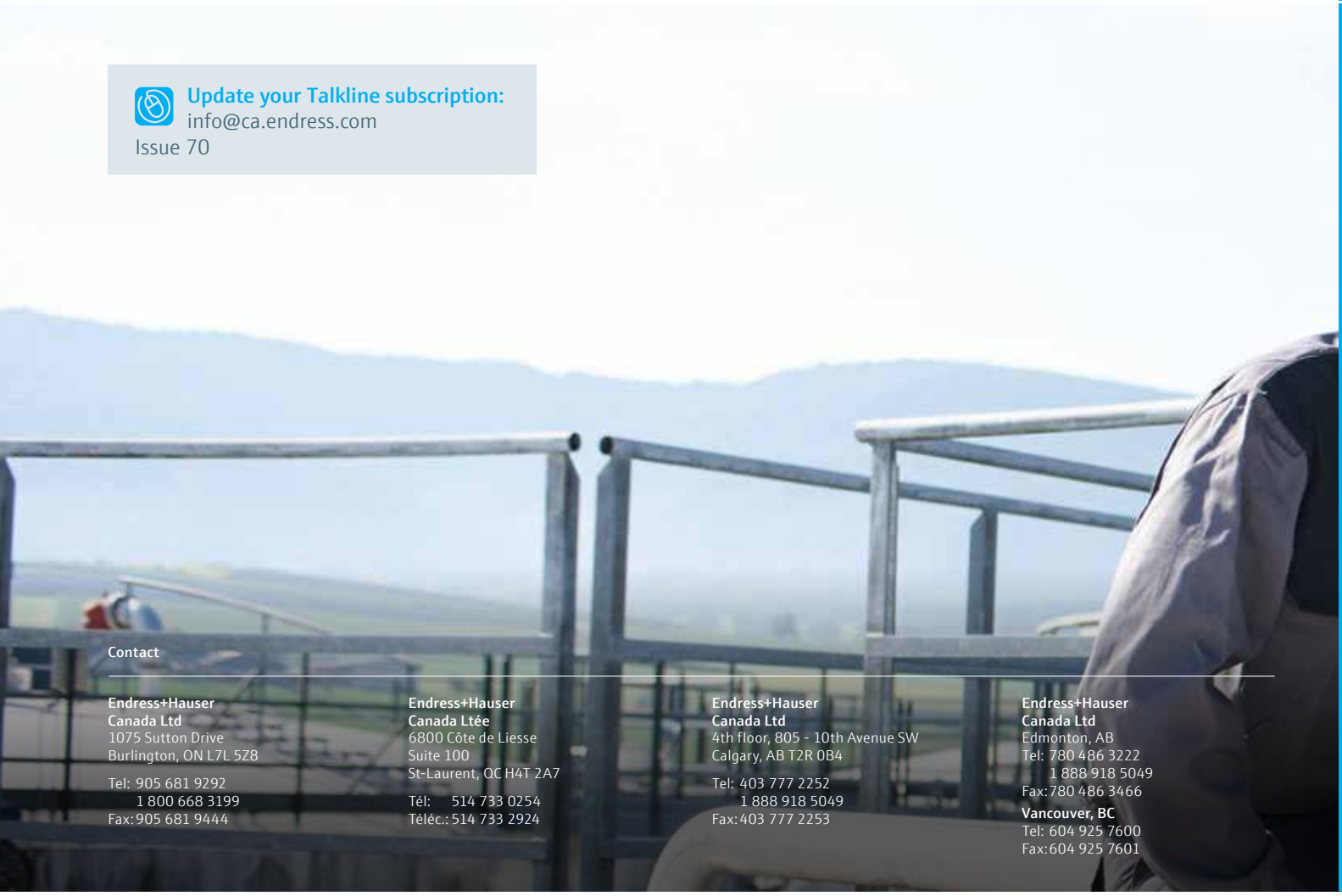

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