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## TURNAROUNDS GET A NEW SPIN

The pandemic is prompting a move to performing less work during a planned shutdown

DECEMBER 2021



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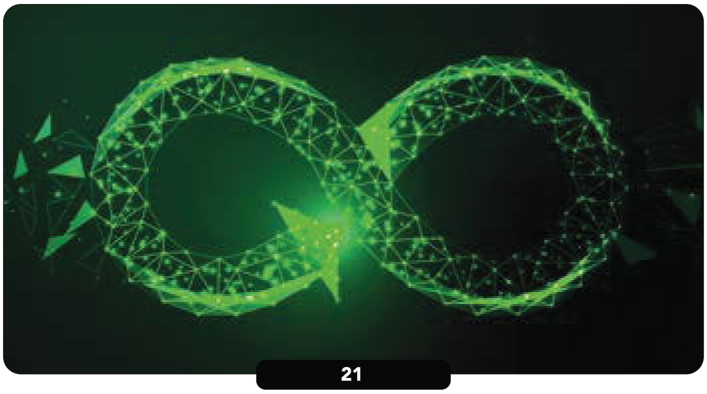
16



21

## COVER STORY



## FEATURES



## COLUMNS



## DEPARTMENTS



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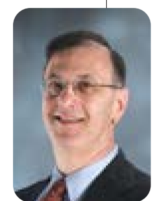
# Process Safety Gaps Persist

Survey shows corporate execution still nowhere near matches intention



**The chemical/petrochemical and oil/gas sectors looked a bit better.**

**THE LATEST** annual report on corporate safety efforts conducted by Sphera, Chicago, points to continuing gaps in companies' efforts to bolster process safety. In addition, the Safety Report 2021, issued in late October, covers an expanded landscape that includes health and safety, unlike the five previous reports. This reflects the structural adjustments necessitated by COVID-19 to keep workers safe.

"The pandemic has highlighted just how quickly safety and risk management processes can be thrown off balance. Safety in all its aspects makes for a resilient and sustainable business model, especially in an era when ESG [environmental, social and governance] goals are of the utmost importance," notes Sphera CEO and president Paul Marushka. "An effective safety culture and efficient safety process helps ensure a healthy workforce and enhanced business performance. However, we are still seeing a gap in how companies link safety and business performance, which highlights a need for a more holistic approach through data, software and expertise."

The report, titled "The Chasm Continues," draws upon responses from 349 risk, process safety, and health and safety professionals from a variety of sectors, including chemicals and petrochemicals, and oil and gas.

One of its key findings is the gulf between intention and execution remains large. While 75% of respondents declared safety is part of their corporate structure and has the support of the highest levels of management, only 40% (55% of those at firms with more than 10,000 employees) said a well-defined roadmap for improving safety performance exists. Moreover, 21% admitted there's a gap between safety intensions and what really happens — a gap the report terms "concerning."

Respondents from the chemical/petrochemical and oil/gas sectors painted a bit better picture, with 86% and 85%, respectively, calling safety a part of corporate culture. The survey found those sectors rely more on leading indicators to enhance safety — with 56% of those respondents reporting that versus 46% of all respondents from large companies.

Among the main drivers to develop a strong safety culture, respondents most frequently cited reducing exposure to operational and major accident hazards (60%), regulatory compliance (48%), and corporate and board priority (37%).

Several obstacles commonly hamper delivering planned safety-critical maintenance and inspection; 51% of respondents pointed to limited resources, while 43% cited conflicting priorities and 31% noted limited budgets.

Deficiencies in incident reporting also undermine many safety-improvement efforts. 27% of respondents said such reports cover only incidents but not near misses, and also lack observations.

The survey showed significant scope and need for companies to take fuller advantage of digital tools.

More than half of respondents (56%) noted their companies still manually track critical safeguards and barriers such as loss of containment and structural integrity; only 19% stated that safeguards are monitored in real time. Moreover, 68% of respondents said their firms rely on paper-based systems or office applications to identify risk. The survey also indicated that higher degrees of siloed data afflict 43% of respondents' companies.

You can download a copy of the report at: https://bit.ly/3CCM5qH. ●

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# What Topics Topped Our Website?

Check out 2021's most popular articles, news stories and columns

**Sustainability, energy efficiency and how-to articles drew the most attention.**

**ONCE AGAIN** it's time to review this past year to see what stood out for readers. Obviously, I am always looking at metrics for how stories and news items perform, but the year-in-review exercise really points out trends. For 2021, I think it's safe to say that sustainability, energy efficiency and how-to articles drew the most attention.

Here, in order of popularity based on page views at presstime, are the top articles, news items and columns from our regular contributors.

## TOP ARTICLES

1. Brightening Outlook Buoys U.S. Chemical Industry. Despite the pandemic, most segments should see moderate growth. https://bit.ly/3EAVm3h
2. Delve Deeper Into Level Overflow Incidents. Simply blaming human error doesn't address the true cause. https://bit.ly/3CQRGtu
3. Control System Modernization Achieves Multiple Goals. Effort addresses technology obsolescence, enhances lifecycle management and paves way for faster digitalization. https://bit.ly/3CJQbgQ

## TOP NEWS

1. Celanese Declares Force Majeure due to Texas Weather. https://bit.ly/3CTxNCt
2. These Five Technologies Will Disrupt the Chemicals Industry. https://bit.ly/2ZQyXQw
3. Teachers Who Sued Monsanto Win $185M Award. https://bit.ly/3bGoWaV

## TOP COLUMNS

### Compliance Advisor

1. EPA Orders Testing for Nine Chemicals. https://bit.ly/3nQnj0j
2. EPA Announces Blockbuster PFAS Actions. https://bit.ly/2ZH0uUi
3. EPA Goes Back to the Drawing Board on Toxic Substances. https://bit.ly/3GMLhSu

### End Point

1. Chemical Engineer Cracks Hindenburg Riddle. https://bit.ly/3bAlcYH
2. Research Questions Bioplastics' Sustainability. https://bit.ly/3CEi6yL
3. Is a Circular Economy Really Sustainable? https://bit.ly/3nQ1IoG

### Energy Saver

1. Consider Chilled Water Thermal Energy Storage. https://bit.ly/3GD15Y2
2. Drive Energy Efficiency with Decarbonization. https://bit.ly/3wbiv9t
3. Behold the Impact of Human Behavior. https://bit.ly/31qYhgD

### Field Notes

1. Concentrate on Critical Thinking. https://bit.ly/3mCMVhw
2. Intelligently Edit P&IDs. https://bit.ly/3BDImrJ
3. Consider the Effects of Global Warming. https://bit.ly/3wbNOkE

### From The Editor

1. Environmental Protection: Don't Call Them Strange Bedfellows. https://bit.ly/3mDVQ2h
2. Recycling: Plastics Require A Rethink. https://bit.ly/3BDYuta
3. It's Not Your Father's Industry. https://bit.ly/3bxE1eT

### Making It Work

1. Control System Modernization Achieves Multiple Goals. https://bit.ly/3CJQbgQ
2. Refinery Reduces Octane Giveaway. https://bit.ly/3nQ2vGa
3. Shift Team Digitalization Enhances Process Operations. https://bit.ly/3wdnK8v

### Plant InSites

1. Distillation: Properly Predict Tray Efficiency. https://bit.ly/2ZRW1i2
2. Corrosion Prevention: Select The Optimum Materials. https://bit.ly/3qfk31p
3. Don't Simply Blame The Piping Designer. https://bit.ly/3nUGxBK

### Solid Advice

1. Profit From Your Bad Experiences. https://bit.ly/30exCna
2. Solids Processing: Don't Fall for Flowability Myths. https://bit.ly/3mCTd0L
3. Why Doesn't Your Mill Work Well? https://bit.ly/3nROvf1 ●

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# Strive To Suppress Short-Sightedness

Ignoring the humdrum to chase after the next shiny thing can stifle success

**We only are limited by our incapacity for imagination.**

**A STEAM** trap jets out periodically, as it has for perhaps a decade, slowly eroding an I-beam that supports pipe from our raw materials tanks. In the last five years, this problem has been written up four times that I know of. When the support finally collapses, it will shut down plant operations for at least two days, likely costing about $400,000. Changing the direction of the steam jet and repairs, as a rough estimate, only would cost $6,500. Yet, the work hasn't gotten done and won't be because it competes with hundreds of other repairs and projects deemed more critical to the plant.

Many companies prefer to spend money on expansions and equipment improvements rather than on such ho-hum repairs. Expansions and improvements look good on resumés — nobody's going to promote you because you kept an old plant running!

Humans don't see cause and effect well — especially if the effect is years in the future, as a column in *Psychology Today* emphasizes (https://bit.ly/3BcCMMR). Reflecting that, our entire economic evaluation process is geared to short-term tangible results. We prefer to invest to get smaller rewards sooner rather than larger ones later. The last capital projects meeting you were in undoubtedly underscores that point! When I worked in oil reservoir analysis, we could show an 85% recovery by implementing a project to maintain the pressure in the sands. However, economic theory favors accepting a 15% oil recovery with a huge cashflow for seven years, while leaving the rest of the oil behind, instead of a smaller cashflow for 30 years. Economics doesn't take into account long-term intangibles like a vanishing resource or greater difficulty doing secondary recovery. This thinking also applies to acute versus chronic toxin exposure, customer product satisfaction, water resources in arid climates where aquifers are drained to irrigate crops, corrosion's impact on reliability, and dozens of other situations.

As instruments have become less expensive, they increasingly are being deployed to monitor processes to reveal spikes in temperature or pressure and variations from norms. (They never will overcome the inherent problems with variabilities in ingredients, equipment and other conditions that occur in batch processes.) Moreover, the growing sophistication of devices gives us capabilities to measure in ways we could only dream about 50 years ago. Of course, some limitations still require human intervention. The classic one is pH control; another is automation of complex laboratory analysis, e.g., titration or liquid/liquid chromatography.

Meanwhile, artificial intelligence (AI) has helped make the intangibles more real. In addition, AI allows us to create remarkable models of chemicals and thermodynamics; we can predict what will happen in ways not imaginable in 1970. We can design equipment such as distillation columns from models where previously we estimated parameters and overdesigned the tower. We can't improve the human thought process, though.

As a propellent-development scientist in the U.S. Air Force in 1980, one of my projects was working with a company creating software to use quantum chemistry to identify useful chemical compounds for rocket research. That firm hoped someday to determine whole chemical processes by quickly establishing the best routes to a particular compound. The dream was to eliminate years of bench-scale development and the expenditure of millions of dollars. A side benefit would be saving lives by reducing laboratory accidents; six people lost their lives in propellent development during my 3½ years in research.

Recently, Pfizer, and other pharmaceutical companies used CRISPR to pinpoint weak points in the SARS-CoV-2 virus. Further, they developed software to identify pathways for making the vaccines. This type of software someday might replace chemical engineers by compiling decades of engineering and scientific knowledge, perhaps learning from and extending that knowledge. Still, decision-making often must remain with humans. As arbitrators, we only are limited by our incapacity for imagination.

AI can't help much with our desire for short-term gains nor our biases. I suppose in a future generation, a computer calmly will chastise a manager for pushing a project just to spend money so that next year's budget isn't reduced. I likely won't live long enough for that but enjoy daydreaming about it.

All we can do is aim to develop economics to account for the less tangible as well as better contend with our cognitive biases, as highlighted in a column in *BetterUp* (https://bit.ly/3vVoaQY). ●

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# Method Upcycles Two Major Wastes

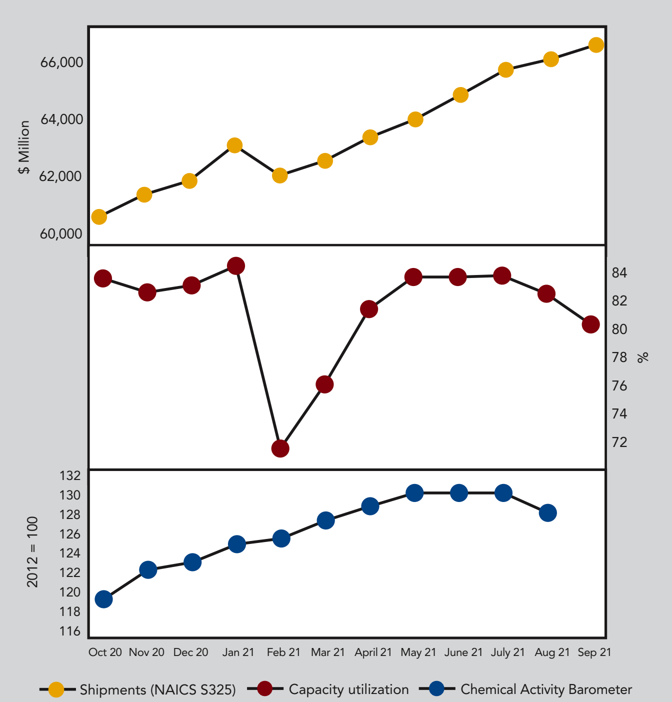
Two-step process produces clean liquid fuel and carbon nanotubes

**RESEARCHERS AT** RMIT University, Melbourne, Australia, say they have developed a method to produce contaminant-free fuel and carbon nanotubes (CNTs) from discarded plastic using organic waste to make the necessary biocatalyst. Upcycling two massive waste streams through one circular economy approach could deliver significant financial and environmental benefits, suggests lead researcher Kalpit Shah. "Our method is clean, cost-effective and readily scaleable," he adds.

CNTs can be used for many applications in a range of sectors including hydrogen storage, composite materials, electronics, fuel cells and biomedical technologies. They also are in growing demand, particularly in aerospace and defense, where they can facilitate the design of lightweight parts.

However, CNTs typically are produced via a thermal chemical vapor deposition (CVD) process that is difficult to scale up. Moreover, the process, which operates at extremely high temperatures, is highly endothermic and, so, requires a significant amount of energy to sustain the necessary temperature.

ECONOMIC SNAPSHOT




Shipments rose but capacity utilization slipped. *Source: American Chemistry Council. Note: The updating of the CAB has been temporarily suspended.*

In the researchers' new two-step CVD process, the team first converts organic waste such as agricultural residue into a carbon-rich and high-value form of charcoal, called biochar, and then uses it as a catalyst to upcycle the plastic.

The biochar nanoparticles significantly reduce the presence of contaminants such as polycyclic aromatic hydrocarbons, as the waste plastic is broken down to become high-quality, clean liquid fuel. At the same time, the carbon in the plastic is converted to CNTs, which coat the biochar.

The nano-sized biochar exhibited higher growth of CNTs with better quality due to their strong gas/solid contact and void fraction, which enhanced the diffusion-precipitation mechanism, say the researchers in an article in the *Journal of Environmental Management*.

The team found the growth rate of CNTs increased with reaction temperature at 900°C as a result of faster carbon diffusion through the catalyst particle, leading to larger CNT production. While the new process would cut the cost to produce CNTs, the resultant CNTs might have a less homogeneous structure than those from conventional CVD production, they caution.

Adding to the circular economy approach, the nano-enhanced biochar can be used directly for environmental remediation and boosting agricultural soils.

The study focused on polypropylene but the approach would be applicable to a range of plastic types, the researchers believe.

"We have already started investigating polyethylene and polyvinyl chloride plastics as well as the mixture of other plastics in our two-stage CVD process for producing carbon nanotube," says Shah.

"While we need to do further research to test different plastics, as the quality of the fuel produced will vary, the method we've developed is generally suitable for upcycling any polymers — the base ingredients for all plastic," he adds.

The researchers believe their method can be replicated in a reactor based on fluidized bed technology, and offers significant improvement in heat and mass transfer compared to traditional CVD processes, reducing overall capital and operating costs.

The team has successfully conducted pilot-trials; the next step is to demonstrate the CVD process in their reactor.

A few multinational companies have contacted Shah's team about possible collaboration for further experimental, modeling and pilot-plant trials.

# Nature Promises to Upend Plastics Recycling

**THE PROTEIN** manufacturing system used in living organisms could provide a model for a radical change in how to deal with waste plastics, hope engineers at the Ecole Polytechnique Fédérale de Lausanne (EPFL), Lausanne, Switzerland. They now have taken the first steps in a proof-of-concept project for such plastics recycling.

Using just 20 amino acids, this natural cycle can produce tens of thousands of proteins — which are polymers — with a vast array of different structures and properties. In turn, biological molecules known as ribosomes can break down these proteins into their constituent amino acids — monomers — and reassemble them into proteins with entirely different properties.

Francesco Stellacci, professor and head of the Supramolecular Nanomaterials and Interfaces Laboratory at the School of Engineering; Sebastian J. Maerkl, professor in the in the Bioengineering Institute; and PhD student Simone Giaveri wondered if a similar strategy eventually could serve to convert waste plastics into other, useful, polymers.

RIBOSOME RESEARCH

Figure 1. Engineers at Swiss technical institute are working to upscale and optimize their original recycling process. *Source: EPFL.*

As a first step in the proof-of-concept, they replicated the natural cycle in a cell-free biological system. In one experiment, for example, they reduced silk to its individual amino acids and reassembled

them back into a different protein used in biomedical engineering. The quality of the new protein matched that produced by living organisms. They dubbed the new process nature inspired circular-economy recycling (NaCRe).

Writing in a recent issue of *Advanced Materials*, the team acknowledges significant technical challenges impede transferring this thinking to industrial waste plastics, and implementation will take decades, if not centuries. However, other researchers already are making significant efforts to create a synthetic equivalent of the ribosome, they note.

For now, the Swiss researchers are focused on their own NaCRe process. "It will take a long time to upscale, although the lab is already working on it [Figure 1]. We are looking to expand it to other biopolymers and to do the process with synthetic polymers. We are also working on process optimization," says Stellacci.

The current timescale for such a concept is so long that researchers are not now seeking industrial funding, he notes. Main support comes from the European Research Council (ERC) advanced grant system for projects with ground-breaking potential.

"The ERC has been very generous in its funding, but the time horizon is not for industry yet — although hopefully that will change." Stellacci concludes.

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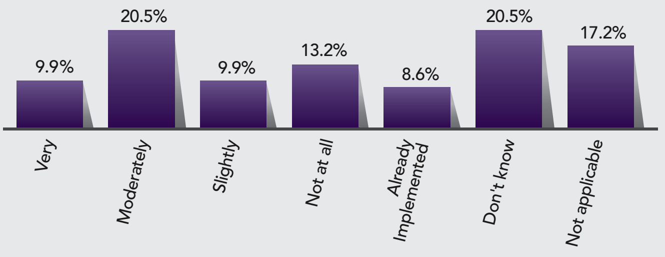
**How interested is your site in cloud-based storage of applications or data?**




Nearly 50% of respondents indicate interest In or use already of the cloud by their sites.

# Get Fired Up

Three main factors impact the efficiency of furnaces and boilers

**It's important to indicate which heating value is being used.**

**SOME CLASSES** of equipment have a disproportionate effect on overall energy efficiency. Foremost among these is fired equipment, which includes furnaces and boilers.

Furnaces and boilers are an integral part of most sites in the process industries. Furnaces are commonly used to heat and vaporize hydrocarbon feeds. Boilers, in contrast, produce only steam. However, the classification isn't always clear-cut, as many furnaces incorporate convection banks that produce steam, in addition to their hydrocarbon heating duty. An important example of this is the pyrolysis furnace used in ethylene plants, where the furnace steam production is an important part of the overall process.

Energy efficiency (η) can be defined by a simple equation: $\eta = (\textit{Useful energy})/(\textit{Energy supplied})$

The *useful energy* is the amount of heat delivered by the fired equipment for "useful" purposes, such as heating process streams or making steam. The *energy supplied* is the heat content of fuel that is burned. However, this can be defined in two different ways. The higher heating value (HHV) is the thermodynamic heat of combustion, or the enthalpy difference between all combustion products, including condensed water, and the fuel and oxygen before combustion, at a standard temperature (commonly 77°F). The lower heating value (LHV) subtracts the heat needed to condense the water vapor component of the combustion product — basically implying that energy can't be recovered by condensing water in the stack gas. When discussing the efficiency of fired equipment, it's important to indicate which heating value is being used. In the United States, boiler efficiencies usually are calculated using HHV, whereas Europe uses LHV, which yields a higher numerical value for the efficiency. Many modern furnaces have a net LHV efficiency above 94%, with a stack temperature of about 230°F for furnaces that burn clean fuel gas. Boiler efficiencies typically are lower.

Three main factors impact the efficiency of furnaces and boilers, although the largest inefficiencies are usually due to the first two: temperature losses and combustion losses.

1. Temperature losses. How hot is the stack gas?

Low stack temperatures result in high efficiency. However, the absorption of heat from stack gases is limited by two main factors:

i. There is a tradeoff between the cost of the convection bank (heat exchanger) and the value of the energy savings as the stack temperature is reduced. For example, if the feed comes into the convection section of a large furnace at 230°F, the minimum economical stack temperature is typically between 260°F and 270°F.

ii. The stack temperature must generally remain above the condensation temperature of the acid components of the combustion products — the acid gas dew point. The acid dewpoint is very sensitive to the amount of sulfur in the feed; it typically lies between 220°F and 340°F. If the acids condense, they are very corrosive, and can rapidly damage the equipment.

2. Combustion losses. Is too much air used (excess oxygen), or too little air (excess fuel)?

Both too much and too little air reduce efficiency. If too much air goes to the firebox, the stack gas flow increases, so at any given stack temperature, the stack gas carries more heat out of the stack. Conversely, if too little air goes to the firebox, incomplete combustion will occur, wasting fuel. Furthermore, incomplete combustion can lead to fires in other parts of the furnace or boiler and also can result in high emissions of toxic carbon monoxide from the stack.

3. Shell losses. How much is lost through the shell or casing of the fired equipment?

These losses are a function of the equipment's insulation and sealing. For modern furnaces and boilers, the shell losses are generally small (0.5–1.0%).

In boilers, and in furnaces that produce steam, there is a fourth type of loss to consider — blowdown loss. Typically, between 2% and 5% of the water supplied for steam production is discarded in blowdown streams to remove dissolved solids and other contaminants. The heat content of the blowdown typically is about 1% of the heat from fired fuel. ●

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**ADDITIONAL INFORMATION**

Alan Rossiter & Beth Jones, "Energy Management and Efficiency for the Process Industries," AIChE/John Wiley & Sons, Inc., Hoboken, New Jersey, 2015, Chapter 9.

# EPA Proposes PIP 3:1 Compliance Extension

The agency plans to push deadline to October 31, 2024

**THE U.S.** Environmental Protection Agency (EPA) announced on October 21 that it intends to move further back the compliance dates related to articles containing phenol, isopropylated phosphate (3:1) (PIP (3:1)) to ensure supply chains for key consumer and commercial goods are not disrupted. The agency proposed extending the compliance date until October 31, 2024, along with the associated recordkeeping requirements for manufacturers, processors and distributors of PIP (3:1)-containing articles. This article discusses this important development.

The January 2021 final rule regulating PIP (3:1) (and four other chemicals) in articles caught industry by surprise. PIP (3:1)'s uncelebrated profile may have contributed to the 2019 proposed rule's general lack of recognition as a potential showstopper. A final rule issued January 6, 2021, prohibited the processing and distribution in commerce of PIP (3:1), and the products or articles containing the chemical substance, for all uses, except for a handful of specific exemptions or prohibition phase-ins. The final rule also requires manufacturers, processors and distributors of PIP (3:1) to notify their customers of these restrictions. The rule contains other prohibitions, which were to be effective as of March 8, 2021.

Industry advocacy eventually persuaded the EPA to issue a rare "No Action Assurance." These administrative expedients advise regulated entities that the EPA will not pursue legal action for a specified duration to allow affected parties to get their act together, in this case until September 5, 2021. On September 17, 2021, the EPA provided a short-term extension of the deadline for compliance with the PIP (3:1) restrictions to March 8, 2022.

On October 28, 2021, the EPA suggested extending the deadline again to October 31, 2024. Importantly, the agency's proposal provides a description of the specific kinds of information it will require to support any additional extensions to the compliance dates. According to the prepublication version of the proposed rule, the EPA will review requests for extensions beyond October 2024 by evaluating the level of detail and documentation provided by commenters on:

- The specific uses of PIP (3:1) in articles throughout their supply chains;
- Concrete steps taken to identify, test, and qualify substitutes for those uses, including details on the substitutes tested and the specific certifications that would require updating;
- Estimates of the time required to identify, test, and qualify substitutes with supporting documentation; and
- Documentation of the specific need for replacement parts, which may include the documented service life of the equipment and specific identification of any applicable regulatory requirements for the assurance of replacement parts.

The EPA also requested comment on whether these are the appropriate types of information for use in evaluating compliance date extensions and whether other considerations should apply. Without more specific information, the agency states it "will be unlikely to extend the compliance dates again."

The EPA also intends to issue a proposal for a new separate rulemaking on PIP (3:1) and the other four persistent, bioaccumulative, and toxic (PBT) chemicals — 2,4,6-tris(tert-butyl)phenol (2,4,6-TTBP); decabromodiphenyl ether (decaBDE); hexachlorobutadiene (HCBD); and pentachlorothiophenol (PCTP) — in spring 2023.

The recent proposed rule provides considerable comfort to importers, processors and distributors, including retailers of electric and electronic devices, of products containing PIP (3:1). What the final rule will include remains to be seen, but the extension was greeted with a collective sigh of relief. Potentially impacted entities should carefully consider the implications of the proposed rule, as the final is expected to look similar.

At least two points are clear. First, the EPA has regulated articles more frequently in the recent past and is expected to continue to do so. This will further press commercial entities to know exactly what chemicals are included in products sourced to them and demand transparency in requiring supplier certifications of one form or another.

Second, expect the EPA to be tough when it reviews the PBT final rule of January 2021 and proposes a new rule in 2023. The PBT rule was issued under the prior Administration, and the EPA has stated it intends to "further reduce exposures" and "promote environmental justice." There will be much more to follow in the New Year as this already complicated administrative saga continues.

**LYNN L. BERGESON**, Regulatory Editor
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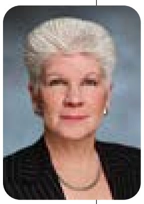

**The January 2021 final rule caught industry by surprise.**

# Confidently Convey Difficult Materials

Efficient conveying solutions can protect workers from hazardous dust, fumes and odors

ERIC SMITH
Technical Director,
Hapman

**The more hazardous the material, the more you're going to want to keep it enclosed. A tubular drag conveyor is a great technology to do that in.**

**SELECTING THE** right conveyor for a particular need is an important decision. Pneumatic conveying is often considered the standard solution for transferring materials in bulk solids plants. In many applications, however, a type of mechanical conveying using a tubular drag conveyor can be a more cost-effective solution. It also proves to be a top choice for difficult-to-handle and explosive materials.

The tubular drag conveyor consists of a tubular housing that encloses a continuous chain mounted with circular discs called flights. The flights are attached to the chain at regular intervals. The housing forms conveying and return legs that can be arranged in many configurations to suit specific applications similar to pneumatics.

*Chemical Processing* sat down with Eric Smith, Technical Director for Hapman, a global manufacturer of standard and custom bulk material handling equipment, to discuss best practices when moving hazardous and temperamental materials.

***Q: Can you give a quick breakdown of the various conveying types that are suitable for challenging solids?***

***A:*** When we look at the material, we need to determine the best solution — can a flexible screw conveyor move it or could a pneumatic conveyor move it? But oftentimes with difficult materials, we have to use a tubular drag conveyor. And this type of conveyer operates in a low-speed, high-torqued operation. The low-speed operation of the conveyor greatly reduces the material degradation so it doesn't break down as it's being conveyed from the inlet to the outlet.

***Q: What are considered difficult-to-handle materials?***

***A:*** Well, in general, materials are difficult when they are cohesive, they degrade easily, they can be highly abrasive or aerate. For example, one that has several of these characteristics is resin flakes.

Resin flakes become hard to handle in overheated conditions, whether by temperature or frictions, due to a low melting point. When this happens, the resin becomes adhesive, cohesive, and can pack and smear. A recent customer had pneumatic conveyors that created multiple issues with significant impact to profitability and efficiency of the system, and created an expensive explosion prevention issue. The high conveyance speed of pneumatics degraded materials, elevated temperature that caused plugging, and created multiple dusting issues. Due to the physics of the explosive material and how pneumatic systems work, expensive explosion suppression systems would have had to be installed and regularly maintained. The tubular drag solution implemented solved all the above issues and significantly reduced operating costs through reduced maintenance, lower power consumption, while improving efficiency and up-time.

***Q: Do you help facilities pick the proper conveyors?***

***A:*** Yes, we team up with customers and look at the materials they need to convey. A lot of other conveyors, they can tumble the material as it's conveying, such as a screw conveyor. With pneumatic conveyors, there is high velocity — those speeds and that tumbling action break down the materials and the material can stick within those components. On a tubular drag conveyor, the material will come into the inlet and it sits between two plastic flights, typically made of UHMW [ultra-high-molecular-weight polyethylene] and the material sits static between those flights and it moves through the system to the discharge point. Product captured between flights is moved *en masse* exposing it to very little turbulence during its transfer. Only a small percentage is ever in contact with the pipe wall minimizing the potential for abrasive degradation.

**PODCAST ACCESS:**
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***Q: Are there other special design considerations?***

***A:*** Many times when you get into a difficult-to-handle material and if it is explosive, you want to be dust-tight and odor-free. In the tubular drag, it's totally enclosed, and it offers those things. With it being fully enclosed, we protect the workers from the hazardous dust, fumes and odors. Not to mention, the high torque operation of a tubular drag gives it the ability to stop and start under full load removing the need to handle the material once loaded into the conveyor.

Another great feature of the tubular drag is it can navigate around different objects. What has traditionally required two or three conveyors can often be accomplished with just one tubular drag conveyor. The ability to convey through bended pipe makes it possible to route conveyors through layouts requiring changes of direction. Additionally, tubular drag conveys vertically. In crowded plant environments, the ability to convey vertically is a game changer. Suddenly retrofitting a vital new process into the middle of the plant is made possible by a conveyor that can receive material and immediately turn upward, conserving valuable floor space.

***Q: What about NFPA guidelines?***

***A:*** Because we are moving the material at a low speed inside the conveyor and it's sitting static between those flights, it generates very little dust. And with that, the dust is not explosive because it's not present. With the NFPA guidelines, that is usually based on a volume calculation of how much material is sitting in a static place. And with the tubular drag, that calculation is done between flight pockets and that volume is a half a cubic foot or less per flight pocket.

***Q: Is that measured all the time to make certain you are within the NFPA guidelines?***

***A:*** That is a calculation determined going into the application. That's something we can define right up front. We can offer that volume calculation per flight and we can also tell customers how much material is in the entire conveyor.

***Q: What mistakes can be made when selecting a conveyor system and what questions should customers be asking themselves?***

***A:*** A lot of it comes down to how does the material handle being moved? Can it break easily? Is it sticky? Can it stick to a conveyor flighting? What do we need for inlet agitation and devices to get it into the conveyor and how do we need to get it out of the conveyor?

With some of these hard-to-move materials, we do what's called a snowball test. For the snowball test, you take a handful of material and you make a snowball with it. And if you open your hand and it free-flows back through your fingers, that's a good application for a tubular drag. You won't need any inlet agitation or discharge devices to get it off the chain. Now, if you open your hand and it sticks together but you can take another finger and poke at it and that starts to break apart, that tells us we probably need a vibrator on the discharge but still a good application for a tubular drag. But if you open your hand, you poke it and you leave an indent around it or it's kind of like peanut butter and it's stuck to your fingers, that's not going to be a good application. At that point, you are going to want to look at a conveyor technology that can carry the material, such as a belt conveyor. Alternatively, if you can get that material dryer or wetter, sometimes that helps.

***Q: And what about other materials? Can these same principles be applied?***

***A:*** The snowball test can be applied on any material. We work with sand, crystallines and powders — things that aerate. What's great is we can test materials at our in-house lab in Kalamazoo, Mich., to determine the best solutions.

SUITABLE FOR CHALLENGING MATERIALS

Figure 1. This 8-inch tubular drag conveyor elevates product into hopper for packaging.

***Q: What suggestions do you have for those struggling to move their materials?***

***A:*** I suggest you get in contact with us and we'd be happy either to come out to your site and review the application or send material in and we can test it here. Start by providing information about your material's characteristics, especially particle size, bulk density and flow properties. As a supplier, we will also need to know application details such as your plant's available floor space and headroom, how your material will be stored prior to conveying, the distance your material will be conveyed, the available energy source, and similar information. A key part of this process is to have your material tested in a tubular drag conveyor in our lab. Based on the test results, we can help you determine which conveyor components and options are right for your application.

***Q: Do you have anything you'd like to add?***

***A:*** The more hazardous the material, the more you're going to want to keep it enclosed. A tubular drag conveyor is a great technology to do that in. Tubular drag technology is also very energy-efficient in comparison to pneumatic conveying, especially when the motive is an expensive utility, such as Nitrogen. The design options with the tubular drag conveyor allow for integration into a new or existing material handling system and provide for long, reliable conveying operation.

*For more information, visit: https://solutions.hapman.com/cp*

# TURNAROUNDS GET A NEW SPIN

**The pandemic is prompting a move to performing less work during a planned shutdown**

By Seán Ottewell, Editor at Large

**TURNAROUNDS ARE** becoming even trickier due to the impact of supply chain problems, staff shortages, lack of contractors and other COVID-19-related issues.

Software and consulting company KBC, and Emerson counsel that effectively tackling these issues requires working hard to limit the scope of turnarounds and better managing their associated risks.

In the face of these pressures, compounded by clients reporting contractor availability being less than 10% of that needed, KBC believes that, before planning any work, an operating company must answer one crucial question: "Is the underlying premise of the turnaround still valid?"

"It's the golden rule for turnaround success. Get the scope right: i.e., can you defer individual elements and do them at another time?," notes Jim Watt, global product manager, reliability, availability and maintenance, for KBC, Walton, U.K.

"Furthermore, can you even postpone the whole project? We are asking that fundamental question of businesses," adds Mark Hudson, senior leader in KBC's consulting business, also based in Walton, U.K.

To help answer these questions, KBC uses its five-step turnaround optimization program (TOP), a customizable set of reviews to gain specific value and drive cost out of turnarounds. These focused workshops use cross-functional client teams, including representatives from operations, maintenance, reliability and inspection, to identify costs, a suitable risk-management approach, and improvements in turnaround performance and long-term sustainability.

The first step in TOP is a full review of a client's turnaround strategy; the program ultimately progresses to a final, lessons-learned step.

Part of the challenge for many chemical processing, oil-and-gas and refining companies is not treating turnaround in the traditional way, Watt emphasizes. Lots of companies historically view turnarounds, he says, as periodic shutdowns that provide an opportunity to perform a large number of projects identified beforehand.

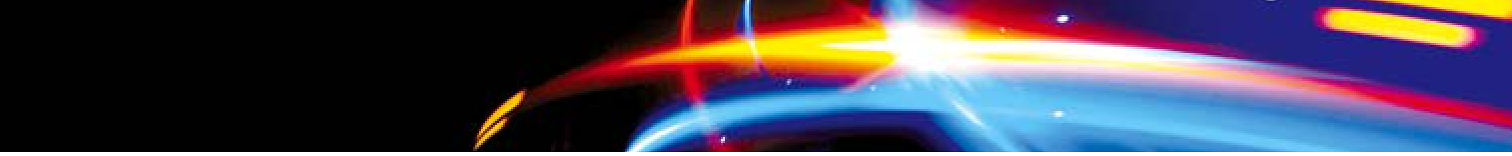
"In reality, you end up with a bunch of work that doesn't need to be done during a turnaround. So the scope grows and, with this, the risk and associated costs. Every additional job adds risk. Also, due to high overheads and labor rates, the cost to do certain jobs during turnarounds can be more than twice what it would be to do it as routine maintenance. So minimizing scope minimizes both risks and costs [Figure 1]," he stresses.

**SCRUTINIZING SCOPE**

Figure 1. Identifying and eliminating non-essential work during turnarounds minimizes risks and costs. *Source: KBC.*

## WINNOWING WORK

To minimize scope, KBC takes a rigorous risk-based approach, typically using tools including risk-based work selection, to go through the initial work scope and ask, for example, what's the risk if you don't do this particular piece of work during turnaround? If the risk is



low and deemed acceptable, that work doesn't occur during the turnaround but instead takes place at the optimum appropriate opportunity.

But how does this add value when most clients have their own risk-based turnaround processes to begin with? Watt explains: "Of course, they could do it for themselves, but they don't have 'cold eyes' and the ability to challenge the status quo. Sometimes clients have difficulty in challenging themselves and, at the same time, may not be fully aware of [the] latest international practices and norms. Companies are doing the things they have always done in the way they have always done them — but without understanding the real, true risk to their businesses."

However, he adds, this approach depends on client management support, which particularly is needed to emphasize to staff that the risk assessments and reviews KBC is facilitating differ markedly in rigor and focus from those they might have experienced before.

The potential savings with this approach are enormous. For example, KBC reviewed the scope of a turnaround at a European refinery and found that 80% of the work could be deferred.

"Following our review, the company looked at its entire strategy and cancelled that turnaround completely. It's an extreme case, but even so we usually find that 20–30% of any scope can come out," says Watt.

He cites several other examples that highlight the benefits of KBC's "get the scope right" philosophy.

First, is the implementation of a full TOP for a major oil company in the Asia Pacific region. It covered three refineries with a combined capacity of 425,000 bbl/d, plus the firm's head office. The company's problem was the high costs and long duration of turnarounds posed a serious risk of loss of refinery availability.

Among the key recommendations of the TOP program were: optimization of work scope through rigorous work selection, reduction of the turnaround critical path schedule, and minimizing the budget through monitoring and control strategy on contractor performance.

Benefits for the client included ongoing savings of over $50 million/yr, a 10–15% reduction in work scope, $10 million of savings during the assessment stage, plus identification and mitigation of high risks before the turnaround execution.

The second example involves a Middle Eastern petrochemicals company which found the cost for the first turnaround after initial refinery start-up significantly exceeded the budget estimate.

Here, KBC used the second step of the TOP strategy — risk-based work-scope optimization — to identify the "right" optimal scope, and to understand and manage the risk for work items not included.

This led to a 21.4% decrease in the number of scope items, with an associated cost reduction of roughly $7.9 million. Identification of reduced scope on 84 turnaround work items cut another $1.1 million from turnaround costs.

The third example is of a European olefins complex that experienced a 13-day delay on a major turnaround. This, in turn, jeopardized supply of high-purity ethylene to neighboring manufacturing sites. For the client, this came as major shock because it had carried out detailed, timely planning and scheduling beforehand. Also, it had secured the contractors it wanted and alerted spare parts manufacturers more than 12 months prior to the shutdown.

Here, KBC conducted a three-month turnaround close-out review — the final step of the TOP. This included a thorough assessment by a client/KBC team of the challenges experienced from turnaround definition through execution to understand why the planned results so differed from the actual ones.

The review identified a number of contributory factors for the overrun. Among these were: late approval and poor definition of some projects that did not allow for detailed planning; poorer contractor performance before and during turnaround phases than previously experienced, including late delivery of pre-fabricated piping spools; and an initial 20% weld-rejection rate that wasn't reported by the inspection contractor for two weeks.

Among KBC's final recommendations was a continued turnaround interval of 84 months — instead of a move to 96 months the client was considering — and improved management of causal factors that had impacted turnaround performance.

### ELIMINATING SURPRISES

The last two years have seen a dramatic change in the way that organizations plan and execute turnarounds, says John

CONTINUOUS MONITORING


Figure 2. Small, easy-to-install sensors like this vibration monitor can warn if an asset needs attention well before a turnaround. *Source: Emerson.*

Sanders, Eden Prairie, Minn.-based director for global shutdowns, turnarounds, and outages for Emerson. The many and varied implications of COVID-19 and endemic shortages in experienced personnel have left plants operating with crews far smaller than optimal to perform a safe, effective and timely turnaround, he adds.

"Moreover, economic uncertainty during the last two years has made organizations wary of spending capital, and even those plants willing to spend are seeing supply chain issues that make executing large projects more difficult."

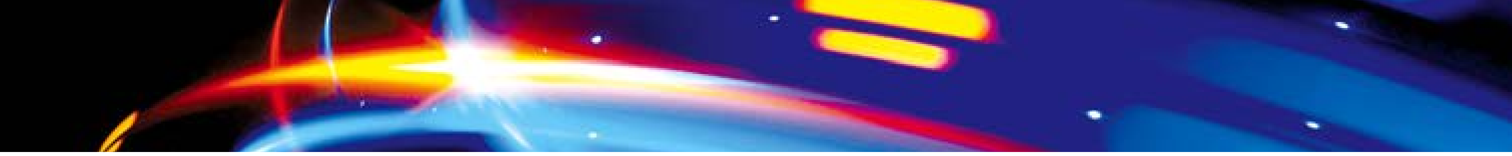
At the same time, keeping processes running at peak performance requires performing some work. "In the chemical manufacturing industry in particular, unplanned outages can exacerbate existing supply-chain issues, so organizations are focused on finding new ways to plan and complete turnarounds on time and on budget," he explains.

The most successful of these companies use digital vibration-analysis and condition-monitoring technologies in tandem with digital walkdown and workflow tools to collect and trend critical data, and identify root causes, notes Sanders.

However, just because an asset is non-essential enough to allow deferring its maintenance doesn't mean its issues won't affect production. Consider a non-critical valve with servicing left out of a turnaround to save time. If this lack of maintenance results in missing a small leak causing 5% less efficiency, a significant impact on production would result over the weeks, months or years until it is discovered.

"The solution comes down to risk management, which itself is about eliminating surprises," says Aaron Crews, director for modernization solutions and consulting, Emerson, Round Rock, Texas. "Instead of scheduling based solely on criticality, plants performing the most-successful turnarounds use knowledge gained from predictive maintenance technologies that have been collecting and analyzing asset health data since well before the turnaround date."

Crews points to the importance not only of detecting asset defects but also of clearly identifying their severity and finding the root causes. He suggests small, easy-to-install and cost-effective sensors such as Emerson's PeakVue family (Figure 2) that provide an intuitive analysis of an asset's current health.



"Armed with more knowledge about the severity and causes of defects affecting their equipment, turnaround teams can make better decisions about what needs to be repaired immediately and what can wait, making it far easier to accurately schedule turnarounds. They can also rely on that same analytical data to feel more confident deferring maintenance for some assets, knowing they will be notified immediately if a pending problem is detected," he adds.

Success also depends on experienced personnel, either internal or external to the organization, carrying out essential tasks such as detailed walkdowns.

However, with fewer experts on staff or because of the need to stagger personnel on site to meet social distancing guidelines, most organizations face difficulties in assembling enough company experts to guide these walkdowns and generate the workflows needed to provide sufficient data for turnaround planning.

In fact, says Crews, even before the pandemic, organizations were having to contract workers six months or more in advance of a turnaround to ensure they had the best available personnel. Today, with an increasing worker shortage compounded by social distancing requirements, along with a rapid return to business after a long period of downtime, teams looking to hire expert personnel often discover the people they need are locked into long-term contracts. Moreover, even when organizations can find the experts required, restrictions on travel or quarantines can mean delays of days or weeks before an expert is available.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Part of the answer here lies with automation vendors who have developed digital walkdown and workflow tools to help offset a shortage of expertise in the field (Figure 3).

"These digital tools rely on mobile devices to help new and experienced workers become more efficient by accurately navigating the walkdown process. Guided workflows provide procedural tools to take pictures and videos, along with voice and text notes, as personnel perform walkdowns. Many of these walkdown tools are created with specific assets in mind, automatically prompting users to check and record the most important and relevant data at every step," explains Sanders.

Similarly, mobile video and augmented reality tools allow expert technicians to monitor walkdowns, and to offer live advice and guidance in real time to less-experienced personnel. Even in the face of travel restrictions or quarantines, these technologies ensure access by turnaround teams to the expert advice needed.

"Using predictive maintenance knowledge coupled with thorough pre-turnaround walkdowns, teams can identify which assets truly need maintenance and, thus, avoid inadvertently introducing issues where none existed. Moreover, they are likely overhauling fewer pieces of equipment, reducing plant outages and making it easier to ensure — before work begins — they have fast access to any required spare parts," he adds.

Organizations seeing the most improvement in performance and stability will be those that embrace the digital technologies available today to streamline turnarounds, Sanders strongly believes.

"A maintenance foundation built on pre-turnaround predictive maintenance and collaborative walkdown and workflow tools will prepare plants for more-successful turnarounds — and, by extension, more-efficient production. In the long term, such a strategy will also ready the organization for future uncertainties and market fluctuations," he concludes. ●


Figure 3. Digital tools foster more-efficient walkdowns and better preparation for turnarounds. *Source: Emerson.*

# IMPROVE YOUR CONTINUOUS EMISSIONS MONITORING

New gas analyzer technologies enhance ease of use and reduce operating costs

By David McMillen and Katherine Williams, Emerson

**INDUSTRIAL-SCALE COMBUSTION** processes invariably fall under some form of air-quality environmental regulation, which can take a variety of forms depending on the application and pollutants involved. For instance, the European Union's Industrial Emissions Directive and U.S. Environmental Protection Agency (EPA) regulations mandate continuous measurement of the relevant pollutants at the point of release to the atmosphere. The EPA notes:

"A continuous emission monitoring system (CEMS) is the total equipment necessary for the determination of a gas or particulate matter concentration or emission rate using pollutant analyzer measurements and a conversion equation, graph, or computer program to produce results in units of the applicable emission limitation or standard.

"CEMS are required under some of the EPA regulations for either continual compliance determinations or determination of exceedances of the standards. The individual subparts of the EPA rules specify the reference methods that are used to substantiate the accuracy and precision of the CEMS."

A CEMS serves the single purpose of monitoring emissions for regulatory compliance and is not connected to any process control mechanism, although its data may be used to help evaluate combustion processes.

Here, we will focus on the types of installations frequently found in chemical plants and refineries: fired heaters, boilers and some heat-intensive processes. For the most part, these burn natural gas, oil or a combination of plant byproducts. Each generates a list of pollutants connected with these fuels, primarily:

- nitrogen oxides ($NO_x$);
- sulfur dioxide ($SO_2$);
- carbon monoxide (CO);
- carbon dioxide ($CO_2$);
- unburned hydrocarbons;
- ammonia ($NH_3$), usually residue from a $NO_x$ suppression system; and
- particulates.

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Other applications and fuels may result in a longer list of pollutants requiring monitoring — but these tend to be more specialized.

Common to all applications is the need to analyze the flue gas after it has received any treatment and as it is

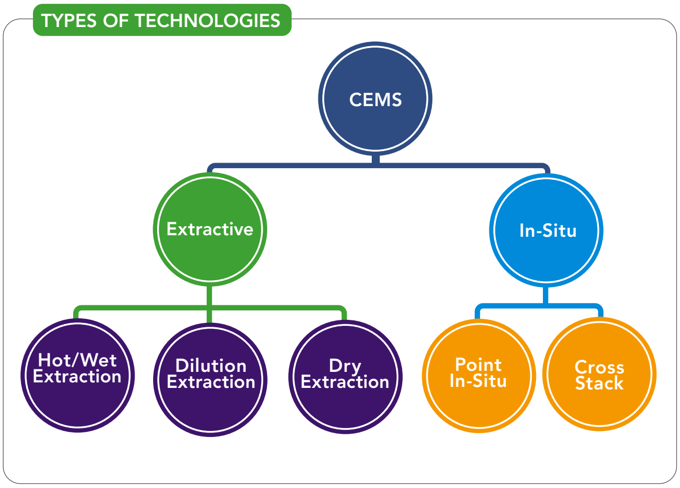



Figure 1. Extractive and in-situ methods can provide continuous emissions monitoring but in-situ approaches suit only a small segment of applications.

leaving the stack. Two main groups of analyzer techniques (Figure 1) suit this task:

1. *in-situ*, where the analyzer is incorporated into the stack; and
2. extractive, where sample gas is drawn from the stack and sent to the analyzer.

*In-situ* approaches represent a very small segment; so, this article focuses on extractive methods, which differ in the type of analyzer technology and sample gas treatment. In particular, we concentrate on high-performing newer methods that are much simpler than older technologies and address operational and maintenance problems they pose.

## CHALLENGES WITH EXTRACTIVE METHODS

As it leaves the stack, flue gas primarily comprises nitrogen, residual oxygen, various pollutants, and a lot of water vapor (8–20%). Because the gas is hot, typically >95°C (>200°F), its ability to carry water vapor is greater than air at the ambient temperature. Therefore, the dew point of the flue gas generally is below its exit temperature but higher than the ambient temperature, so water condenses as it reaches the atmosphere.

If sample flue gas being sent to the analyzer is allowed to cool, two things happen. First, water vapor condenses. Second, some of the pollutants of interest, such as $SO_2$, dissolve into the water, which reduces their level in the gas reaching the analyzer and causes understating of their content. (The condensate also becomes acidic and, therefore, corrosive, which can pose issues.)

As a result, to ensure an accurate measurement by the analyzer, extractive methods must have a strategy and mechanism for handling the sample gas in a way that preserves the actual pollutant content. Moreover, the sampling system must present the sample in a way the analyzer can handle.

Let's now look at the three options.

*Dilution extraction*. This mixes untreated air with the flue gas to increase its volume and provide cooling. The underlying idea is that the higher volume supplies enough air to avoid condensation, even at a lower temperature. The additional air volume is measured and pollutant levels adjusted accordingly. However, maintaining consistency is difficult because it requires very accurate measurement of sample and dilution air flows, and impurities in the dilution gas affect the readings. This approach mainly finds use for coal-fired applications where water vapor content is low.

*Cold/dry CEMS*. The most common extraction method for applications at chemical plants and refineries, it has been utilized for many years, so regulations frequently specify this approach or at least assume its use.

Cold/dry methodology (Figure 2A) passes the sample stream through a thermoelectric chiller to reduce the temperature to about 4°C (39°F), so most moisture condenses and drops out. This approach is mechanically complex but well-suited to an application such as a boiler fired with pipeline natural gas, where the primary pollutant is $NO_x$. Unfortunately, it has problematic side effects, particularly with more-complex fuel situations and longer lists of monitored pollutants.

Some pollutants, particularly particulates and some acids, are water miscible and dissolve or get captured with the condensate — and, thus, are effectively washed from the sample. This drastically reduces their concentration and makes the readings for those analytes ineffective. Therefore, in situations that require monitoring of water-miscible pollutants ($NH_3$, HCl, HF), this approach is not suitable. Other analytes ($NO_2$, $SO_2$) are somewhat water miscible, so water removal can affect them; however, the error usually is quite small and regulatory bodies often are willing to accept a compensated reading from the dry gas sample.

*Hot/wet CEMS*. As analyzer technologies have evolved, some have become more tolerant of higher operating temperatures, making the need for chilled gas samples less important. This has helped launch a simple and effective sampling technique that is becoming more widely used: a hot/wet system.

Figure 2B shows a single sample stream flowing directly from the tap point to the analyzer without passing through a chiller. The sample stream is maintained as hot as necessary to keep all components above their dew point, so no condensation occurs. Where high concentrations of $SO_2$

exist, the required temperature can be held at 160–190°C (320–375°F) to stay above the acid dew point.

All chemical components remain in their gas phase, just as they are in the flue-gas stream, during and after passing through the analyzer. When finished, the sample is vented, still as a gas, so there is no liquid at all in the system. The data processing system for the analyzer converts the wet readings to a dry basis as necessary (more on that point later). This approach is less complex mechanically than an equivalent cold/dry system, and calls for different analyzer technologies for some pollutants.

## ANALYZER TYPES

Traditional cold/dry systems generally use a combination of established analyzer technologies suited to specific pollutants, including:

- non-dispersive infrared (NDIR) spectroscopy (CO, $CH_4$, $SO_2$, NO, $NH_3$);
- non-dispersive ultraviolet (NDUV) spectroscopy ($NO_2$, $SO_2$);
- gas chromatographic (GC) analyzer ($H_2S$, sulfur species);
- paramagnetic analyzer ($O_2$); and
- chemiluminescent analyzer ($NO_x$).

Some of their capabilities overlap, so individual situations determine the selection of the specific technologies. In certain cases, the regulatory agency may drive the choice in one direction or another. For example, chemiluminescent analyzers long have served as the standard reference method (SRM) for $NO_x$ monitoring by the U.S. EPA (Method 7E Procedure) and are cited in standards, e.g., the European Standard EN 14792:2017, used by other regulatory agencies. The SRM is not necessarily the only permissible technology — however, regulatory bodies will insist that any proposed alternative must perform as well as the standard. Therefore, when considering a different technology to measure $NO_x$,

USUAL EXTRACTIVE METHODS

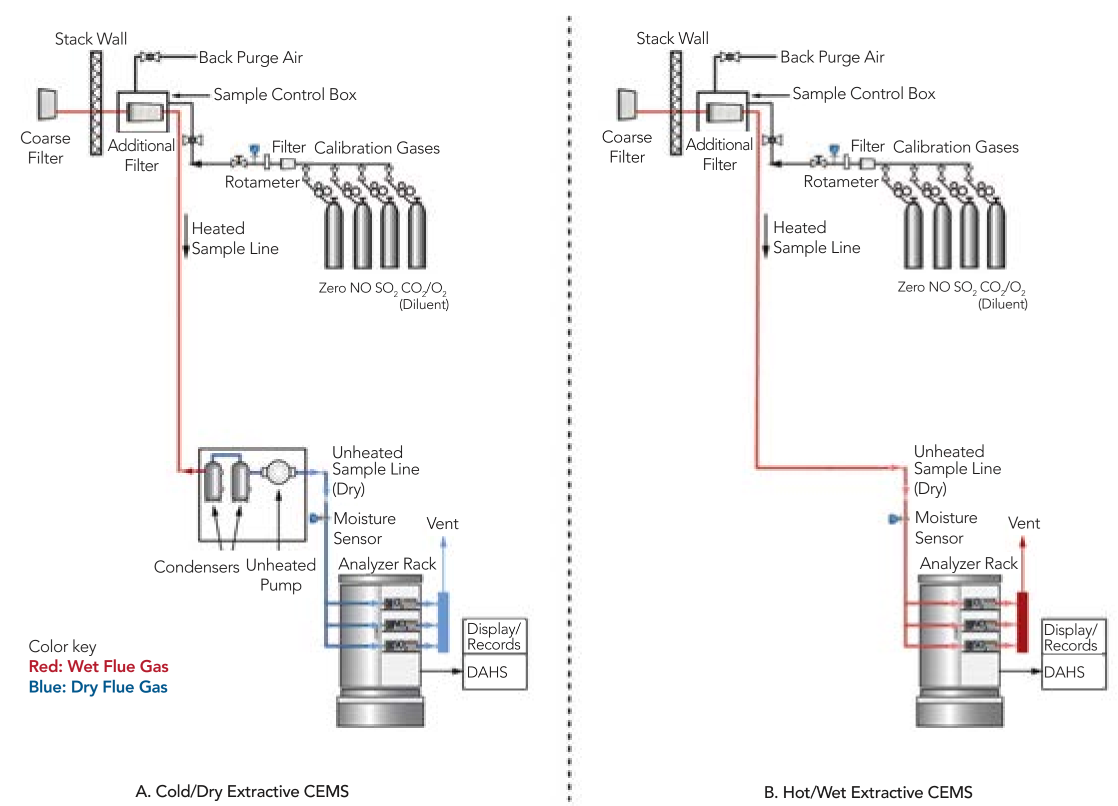



Figure 2. These diagrams from an U.S. EPA field audit manual illustrate the two most common extractive approaches. A cold/dry system (A) cools the sample gas but doesn't suit all pollutants. A hot/wet system (B) eliminates the need for cooling the sample gas. *Source: U.S. EPA.*

it is important to determine if it can cover the necessary range, particularly at the low end, and if the regulations require measurement of all $NO_x$ components separately or if they can be lumped together.

A mix of technologies needed to cover multiple pollutants can create operational and maintenance headaches because each may have different consumables, range limitations and calibration requirements. Of course, analyzer technology is not static; established techniques receive improvements, often built upon better data processing and simplified operation. In some cases, preferences for measuring a given pollutant change as less-complex and more-economical technologies emerge.

For example, quantum cascade laser (QCL) and tunable diode laser (TDL) analyzers are growing in popularity thanks to their ease of operation and ability to measure a wide variety of analytes. Generally, QCL covers the mid-infrared spectra while TDL handles near-infrared spectra. Both apply properties of the Beer-Lambert Law for absorption spectroscopy. These two technologies, working together, can cover the full range of the other technologies just mentioned, and provide measurements of all the pollutants common to CEMS applications.

Analyzer selection will depend on the complexity of the particular application. For example, a fired heater fueled exclusively by natural gas only may need to monitor $NO_x$, so a single dedicated chemiluminescent analyzer might suffice. On the other hand, the same fired heater, if supplied with a range of fuels, including raw refinery fuel gas, may require monitoring of a wider range of pollutants. A single analyzer able to handle a longer list of analytes might be the better choice for this type of application rather than two or three separate analyzers using different technologies.

### HYBRID ANALYZERS

Laser-based analyzers using a hybrid approach can be modular, with the QCL and TDL measuring cells configured as insertable units into an analyzer. An enclosure (Figure 3) can house a mix of up to six laser modules selected to cover the relevant analytes. Some lasers can measure more than one analyte, so one unit can deal with up to nine analytes; this covers the full range of CEMS applications in a typical chemical plant or refinery application. Laser measuring cells can handle sample gas temperatures up to 190°C (375°F), making them well suited for hot/wet sampling systems.

**MULTIPLE ANALYTE MONITORING**

Figure 3. A hybrid QCL/TDL analyzer, such as Emerson's Rosemount CT5100 Continuous Gas Analyzer, can contain up to six laser modules, some of which can measure two analytes.

The use of these laser-based analyzers is increasing for several key reasons:

- Lasers are very stable; there is little need for calibration, although some regulations require periodic verification.
- Absorption characteristics do not change; lifetime sensor drift stays less than 2% of full scale.
- There are no moving parts.
- Laser modules are field replaceable.
- Sophisticated electronics provide extensive diagnostics and remote access.

### A SUCCESS STORY

A refinery in the U.S. Midwest had a tail-gas stream with particularly heavy sulfur content. Rather than simply neutralizing the pollutant, the refinery decided to use a Claus scrubber with an ammonium thiosulfate process to create agricultural fertilizer as a separate product stream. Based on typical production, the refinery anticipated it could manufacture 100,000 tons of fertilizer annually from the pollutant. As part of the installation, the EPA called for a CEMS at the stack to measure residual amounts of $SO_2$ and $NO_x$ not captured by the scrubber.

The facility's environmental engineering team selected Emerson's Rosemount CT5100 Continuous Gas Analyzer, a hybrid QCL/TDL analyzer working with a hot/wet gas sampling system.

Sample gas is delivered to the analyzer at 125°C (260°F), safely above the water and acid dew points for the flue gas.

(Scrupulous heat tracing and insulation avoid any cold spots where condensates could form.) The analyzer contains six laser modules (one TDL, five QCL) configured to measure $O_2$, CO, NO, $NO_2$, $SO_2$ and $H_2O$.

The analyzer converts the wet-basis measurement to dry-basis using an integral water-compensation algorithm. All measurements, including water, are continually checked and corrected during normal operation. After three years of operation, the facility's environmental team evaluated the system's performance and found the calibration remained within 1% of the factory settings, with no unplanned outages and required servicing. This fulfilled one key company objective — reducing the amount of maintenance attention required with previous approaches.

It also fulfilled larger corporate objectives to improve energy efficiency and decrease emissions by investing in new technologies and equipment upgrades. Thanks to this and other similar projects, the refinery has reduced emissions over the last 15 years, with its emissions per barrel approximately 20% lower than other refineries in the U.S.

## PRACTICAL CONSIDERATIONS

Any facility thinking about installing a hot/wet sample-handling system should keep two key aspects in mind.

First, the sample gas must not be allowed to cool. All the tubing, valves, eductors, pumps and other parts of the sample train must remain above the relevant dew point (which mainly depends upon the specific flue-gas composition). Streams with high acid content have a high dew point and, so, are particularly critical. Also, the temperature at the stack where the sample is extracted can vary widely based on a variety of factors but the equipment must be able to withstand the highest potential temperature.

Equipment installers must take particular care with insulation and heat tracing because the sample stream has a very low thermal mass, so its temperature can drop very quickly when passing through even a few inches of unprotected tubing. Heat tracing often requires closed-loop control to keep the sample temperature stable during changing ambient conditions. Any condensation is harmful to virtually all types of gas analyzers, so this is a very critical part of any installation.

Second, a hot/wet measurement usually will result in different values for critical analytes than a cold/dry measurement. This stems from removing the water from the stream, which affects analyte content. It is a quantifiable and predictable change and, therefore, convertible while retaining the necessary degree of precision. However, users must ensure the analyzer includes this capability.

Because cold/dry systems have been the default for so long, most regulations call for dry measurement. Consequently, when a hot/wet application is commissioned, it is necessary to build in a correction factor based on water content of the stream, which requires including a water measurement from the analyzer. Fortunately, many analyzers can make the correction in real time and provide critical analyte measurements on a wet and dry basis.

## AVOIDING COMPLEXITY

All things being equal, chemical plants and refineries understandably choose the simplest and most-reliable approach to solving any application challenge. Historically, analyzers and sample handling systems have been complex and fussy, calling for lots of maintenance attention and consumables. Fortunately, technologies have advanced, becoming simpler and easier to operate than their predecessors. In particular, the combination of hot/wet sampling systems and QCL/TDL analyzers has improved performance and stability for CEMS installations.

To the EPA and other regulatory bodies around the world, the key word in CEMS is continuous. These systems must do their job any time the process is running. If fuel is burning, the CEMS must be working or the facility will be liable to fines, shutdowns and possibly exposure to litigation and other penalties. Worse, a production stoppage due to an unscheduled analyzer outage will mean lost revenue. To address the mandated availability and data quality, a hot/wet system with QCL/TDL analyzers is reliable, simple and often the most maintenance-friendly option. ●

**DAVID MCMILLEN** is a Fullerton, Calif.-based business development manager for Emerson's Rosemount process gas analyzers. **KATHERINE WILLIAMS** is Sterling, U.K.-based product manager for Emerson's Rosemount quantum cascade laser gas analyzers. Email them at David.McMillen@emerson.com and Katherine.Williams@emerson.com.

## REFERENCES

1. "About Quantum Cascade Laser Analyzers," www.emerson.com/en-us/automation/measurement-instrumentation/gas-analysis/about-quantum-cascade-laser-analyzers.
2. "Continuous Gas Analyzers," www.emerson.com/en-us/automation/measurement-instrumentation/gas-analysis/continuous-gas-analyzers.
3. "Rosemount CT4400 Continuous Gas Analyzer," www.emerson.com/en-us/catalog/rosemount-sku-ct4400-continuous-gas-analyzer.
4. "Rosemount CT5100 Continuous Gas Analyzer," www.emerson.com/en-us/catalog/rosemount-ct5100-continuous-gas-analyzer.

# Conquer a Centrifuge Control Challenge

Multiple issues need addressing to come up with a suitable instrument package

## THIS MONTH'S PUZZLER

I'm fresh out of college and have been handed a project for which I need help. I'm installing a centrifuge for concentrating a pharmaceutical product from a reactor's mother liquor. This is an expansion plant, designed by corporate engineering, for handling a new process.

The mother liquor is fairly sticky. I only have two data points: 31 cP at 108°F and 72 cP at 72°F. With the product, in a concentration of 13% by mass, the viscosity is 52 cP, and 101 cP, respectively. I am told the product starts to degrade above 115°F.

The density ratio between the product and the liquor is 1.3:1 for the batch stack centrifuge. I read that upstream factors could affect this ratio.

I still haven't figured out how I'm going to do the cleaning-in-place, given the sensitivity of the product to low pH and high pH. I'm worried about residual materials.

My problem primarily is instrumentation because we are under orders to reduce the labor costs per batch. I'm kind of on my own here. I have some ideas on what controls are critical versus just nice to have. What do you suggest as far as instrumentation?

### ASSESS MULTIPLE ISSUES

Consider the following points:

1. There are various types of centrifuges based on speed, processing capacity and other specific requirements such as temperature control, particle size control, etc. For selecting a centrifuge suitable for your application, seek help from your company experience and experience of vendors. Of course, you need to have relevant data such as viscosity and density profiles, cleaning requirements, and processing rates.

2. In terms of instrumentation, aspects to keep in mind include:

- speed measurement (tachometers) and control;
- vibration alarms and interlocks;
- instruments with appropriate vibration pads or isolators because some vibration is to be expected at/near the centrifuge;
- temperature control and high temperature alarms because of concerns about high temperature degradation;
- appropriate mitigation systems, alarms, and interlocks if high temperature degradation is likely to cause a runaway exotherm;
- gas monitors at strategic locations (e.g., seals, flanges, gears) if flammable species are involved;
- cable routing that provides protection to the cable, actuator and associated equipment in the event of a fire;
- low temperature alarms if low temperature is anticipated to increase viscosity substantially; and
- interlocks to prevent opening the centrifuge while it is in motion.

3. Provide a strong foundation for the expected centrifugal forces.

4. Ensure effective access for maintenance ingress/egress.

*GC Shah, Consultant*
*Houston*

### TREAT CENTRIFUGE WITH RESPECT

Ah, the old sink-or-swim treatment. Such situations happen many times during a career. In retrospect, I would say it builds character but it didn't seem that way when I went through it the first time at a remote Anheuser-Busch plant where I faced two plant expansions simultaneously.

A lack of physical properties is a common problem. A lot can happen to fluids with a change in temperature.

I suggest ordering Zahn cups to measure samples of all the fluids you can get: feed, heavy and light. Zahn cups should be part of every engineer's tool kit; they measure viscosity based on the capillary flow of liquid through a known hole diameter. Take measurements to fill in and expand the temperature range.

You can estimate density using a graduated cylinder and a weigh scale.

Most manufacturers can provide automatic control of their centrifuges. As a basic shopping list, consider my recommendations shown in the provided figure (Figure 1).

There are two categories of measurement: those for reliability and those for performance. For reliability, you should watch oil pressure, vibration, speed, bearing performance and, certainly, the oil temperature. For performance, measure the mass flow rates of the feed and the mother liquor. You can determine the flow rates of the concentrate, i.e., the heavy stream, if enough liquid is left in it. Otherwise, the flow meter may foul too much to be useful. It is better to measure the two liquid streams and do a material balance for the heavies. One approach might be to put the heavies in a tank with a weigh cell and have the software do the material balance. This all can be automated in your control system.

One of the greatest risks to a centrifuge is ramping up and ramping down. In particular, the machine is most at risk during a sudden power failure. It's a good idea to put the centrifuge controls on a separate controller with a dedicated uninterruptible power supply (UPS) as noted on the figure.

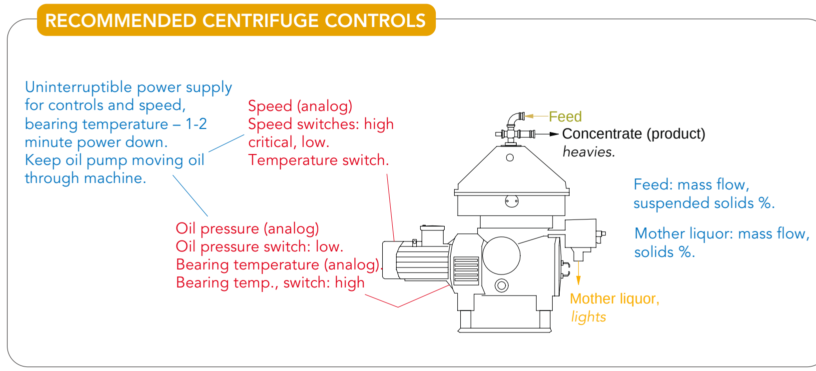


Figure 1. Reader suggests considering these "must have" (red) and "nice-to-have" (blue) controls for disk-stack centrifuge.

You also should set up supervisor-level security on the programming to prevent tampering. Because a whirling piece of steel could leave a Tasmanian-devil-size disaster if an accident occurred, I recommend putting the centrifuge under the strictest control: rigorous management of change (MOC) procedure; lock out/tag out (LOTO); and annual inspections of mechanical, foundation and electrical.

As for machine performance, I suggest Coriolis mass flow meters because they can provide density, mass flow rate, and volumetric flow rate and are built for pharmaceutical service. Just be careful how you install the meters! Put them in vertical lines that can drain; keep the transmitters remote so they aren't affected by temperature when you clean-in-place (CIP) the tube.

Although not commonly done, you may want to automatically calculate the material balance using a process controller. Don't count on cost savings from reducing labor with controls; the downtime alone will kill your budget while your expensive instrument techs figure out what's wrong.

As for CIP, make sure you keep the first flush below the temperature of concern for product quality; burnt material tends to find its way into the product. This concern also is important regarding pH.

Your mention of "upstream factors" has me concerned. You may need to adjust feed stream density on-the-fly. If you haven't already, install a feed tank upstream of the centrifuge where you can sample the density or even measure it directly and then, if needed, adjust the density of the feed with water. Take care that the feed tank is well-mixed for good sampling.

*Dirk Willard, consultant*
*Wooster, Ohio*

# FEBRUARY'S **PUZZLER**

We are re-tasking a batch fluid-bed dryer we had used for a different pharmaceutical product that has become a generic. I have several concerns: 1) the old particle size was larger than that of the new one which has a slightly higher density; 2) the new powder could be a fire risk — we don't have safety data but still are pushing ahead with the project; 3) we only have incomplete maintenance data on the blower; 4) the screen and baghouse are severely corroded; 5) the electric heater leaks tramp air; and 6) the exhaust fan has been upsized twice and also is corroded.

If this dryer were a fish, I'd throw it back. Instead, I am tasked with getting this dryer up and running in three months. Because of the pandemic bottleneck, I'm not sure there's anything I can do to make it run better.

In the future, I want to get a handle on these problems. The corrosion has me concerned. Another problem I notice is vibration in the corroded ductwork and poorly supported conduit — it jerks about an inch every time the blower starts and stops. I want to check out the fluidization against a Clark chart because I have heard of clumping complaints about the previous product.

What can I do to ensure this product campaign goes well? What do you think causes the corrosion? Why do you think the exhaust fan size was increased? Should I be concerned about preparing this dryer for use before the safety data are in?

Send us your comments, suggestions or solutions for this question by January 7, 2022. We'll include as many of them as possible in the February 2022 issue and all on ChemicalProcessing.com. Send visuals — a sketch is fine. E-mail us at ProcessPuzzler@putman.net or mail to Process Puzzler, *Chemical Processing*, 1501 E. Woodfield Rd., Suite 400N, Schaumburg, IL 60173. Fax: (630) 467-1120. Please include your name, title, location and company affiliation in the response.

# Don't Rely on Hydraulic Capacity Calculations

Real plant conditions may vary markedly from assumptions

**Simple checks and instruments can give you the information you need.**

**INCREASES IN** plant capacity often call for fitting more flow volume through existing lines. A conventional desk-based approach to estimating hydraulic capacity starts with the line geometry, calculates an effective line length, and then uses estimated physical properties to calculate a line pressure drop for the new flow rate.

Too often this approach fails because of significant differences between calculations and reality. Actual plant hydraulic performance usually doesn't match calculated expectations because at least one of three factors — supply pressure, pressure drop and destination pressure — isn't what you think it should be. Here, we will focus on supply pressure and pressure drop.

Multiple standards include different acceptance tests for centrifugal pumps. However, testing pumps costs money. Did your pumps get tested before delivery? Next, what are the acceptance levels? The most commonly used standards, those of the Hydraulic Institute and the American Petroleum Institute, offer a choice of acceptance classes. Most often, the values used are ±8% on flow and ±5% on head for most chemical industry pumps and ±5% on flow ±3% on head for oil and gas industry pumps. Other limits apply to power and efficiency.

Wear on pumps always decreases pump head available. Based on my experience, in service you should expect up to 10% less pump total dynamic head than that shown on the pump performance curve. (Achieving more than that requires a higher level of performance and maintenance than the typical plant can consistently provide.) So, the supply pressure may be far less than what you anticipate. Lower supply pressure results in lower flow rates.

Pressure drop depends upon the geometry of the flow channel, which includes factors such as size, surface roughness, shape, obstructions and length. Tables and graphs of friction factors and equivalent lengths are available for all these but sometimes the line isn't what you assume. Situations I and others have encountered include pipe schedule differences with segments of thicker pipe in lines, items dropped into pipes and fittings, welding blanket fragments in pipes, plastic trapped in pipes, damaged and pinned check valves, pipe blocked by deposits (see: "Scale Back on Heat Tracing," https://bit.ly/3qSw9gV), temperature solidification deposits, sedimentation deposits, and other factors.

In these cases, the tables and figures of friction factors and equivalent length have no value. The real hydraulic performance differs so much that the calculated possible flow rate never can be achieved.

The solution is simple for many applications. Straightforward checks and instruments can give you the information you need to make a valid estimate of possible capacity.

First, walk down the line. Look for partially closed isolation valves or open bypasses around control valve stations. Operators often use isolation valves to throttle flow to prevent operating problems. If an isolation valve is partially closed, find out why. You may have bigger challenges in increasing plant capacity than just a hydraulic limit. Open control valves or other bypasses signal you already have flow hydraulic problems. Understand why every bypass is being used and what the implications are.

Second, check control valve positions. A valve that's fully open or close to it shows a flow line is already at or near its capacity. Work on understanding why the valve is so open and how to deal with that.

After those two steps, get an accurate pressure gauge. Run a pressure survey down the line. Use the demonstrated system pressures and flow rates to calibrate plant performance. A pressure reading coupled with the simple relationship that pressure drop goes up with the square of flow rate in turbulent flow will give a better answer for system capacity than the most-complicated flow calculations.

Of course, complex flow patterns such as phase change, partially full pipes, multiple-phase flow, compressible flow, laminar/turbulent transition and non-Newtonian fluids don't have such simple flow relationships. Physical property changes also can affect this relationship. One example is temperature loss and viscosity changes in long lines.

Nevertheless, the pressure gauge, when correctly used (as explained in "Do Simple Things Right!" http://bit.ly/2Nvy3xs), is a tremendous tool for understanding the flow capacity of systems. I suggest you intensely question any proposed plant capacity increase that doesn't come along with a hydraulic analysis backed up with pressure surveys. Too many plant expansions have failed due to a disconnect between actual conditions and desk-bound calculation. ●

**ANDREW SLOLEY**, Contributing Editor
ASloley@putman.net

## Metering System Simplifies Installation

The Bravo H pre-engineered, chemical-feed skid system provides low pulsation and metering of chemicals via progressive cavity pumps. It is used in a variety of industries for disinfection, pH control, flocculation, corrosion inhibitors, oxygen scavengers and containment elimination. The H model improves on the company's original, vertically mounted design by mounting the

pumps horizontally, implementing a new pipework design, and providing enhanced skid bases to simplify installation and extend longevity of the system. Progressive cavity pumps are integrated into the plug-and-play skid-mounted system which includes piping, drives, system control, and calibration and optional equipment adders in one compact unit.

**Seepex, Inc.**
937-864-7150
www.seepex.com

## Smart Glasses Assist Remote Support

Visor-Ex 01 smart glasses for use in hazardous areas combine high camera quality and reliable communication features in an ergonomic design, with a weight of just 180 g. The glasses allow mobile workers to complete tasks

that require hands-free use as well as continuous communication. This can include many digital workflows like maintenance procedures under the guidance of a remote support expert. A total of three integrated cameras act as a remote worker's bionic eye. Two 16-megapixel cameras centrally positioned to map the wearer's natural field of vision enable the remote support sees exactly what the mobile worker sees.

**Pepperl+Fuchs**
330-425-3555
www.pepperl-fuchs.com

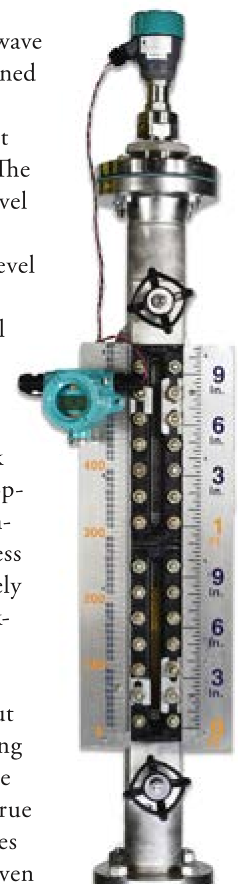
## Ultrasonic Technology Prolongs Screen Life

The Titanium Series Vibrasonic deblinding system is designed for any fine powder screening application, eliminating mesh blinding and blockages and increasing the longevity of the sieving system's mesh screen. An ultrasonic frequency is

applied to the sieve mesh using an acoustically developed transducer. The frequency of the vibration breaks down surface tension, effectively making the stainless-steel wires friction-free and preventing particles that are slightly greater or smaller than the apertures from blinding or blocking the screen mesh. This preserves mesh life, improves product quality and increases throughput, the company says.

**Russell Finex**
800-849-9808
www.russellfinex.com

## Gauge Suits Steam Applications



The Acurage auto-calibrating guided wave radar gauge is designed for true level reading and instant spot smart calibration. The ASME-approved level measuring instrument displays the level of process fluids in real-time via digital display and built-in sight glass tube. An integrated safety ball check valve protects the operator from accidental spillage of process liquid in the unlikely event of glass breakage. It also enables instant glass field replacement without complicated isolating procedures from the process fluid. The true redundancy provides full functionality even in a power failure mode which is inevitable in critical level monitoring applications.

**Hawk Measurement Systems**
888-429-5538
www.hawkmeasurement.com

### Mixer Maximizes Vacuum Technology

Ross VersaMix multi-shaft mixers with solids/liquid injection manifold (SLIM) technology enable fast and efficient large-scale powder dispersion into low-viscosity liquids including resins, oils, melted waxes, emulsions and aqueous solutions. Model VM-600 is a 600-gal-capacity high-shear dual-shaft mixer designed for deep vacuum levels. Its rotor/stator assembly creates a powerful suction that draws solids sub-surface, directly into the high-shear zone. This accelerates powder wet-out and minimizes issues like

agglomeration (fisheyes), floating powders and dusting. The second agitator is a two-wing anchor equipped with hinged Teflon scrapers for consistent heat transfer across the vessel sidewalls and bottom, which could be jacketed for temperature control.

**Charles Ross & Son Company**
800-243-7677
www.mixers.com

### Flow Meter Minimizes Condensation

The ST80 Series thermal mass flow meter measures methane and provides emissions data to meet government environmental regulations and reporting

requirements. A robust, open and cleanable, no-moving parts sensor design suits demanding processes. The meter features Adaptive Sensor Technology, a measuring drive that combines constant power and constant temperature thermal dispersion sensing technologies in the same instrument. Four different precision flow-sensor-element designs help ensure performance, including a new wet gas option. The Wet Gas MASSter sensor optimizes the sensor head design and installation to prevent condensation droplets, entrained moisture or rain from contacting the thermowells, which ensures steady, reliable measurement.

**Fluid Components International**
800-854-1993
www.fluidcomponents.com

### Actuators Meet CSA Standards

Designed for use in hazardous locations, the HXY/Z series are CSA Class/Zone certified, expanding the range of applications the company's quarter-turn electric actuators can service. The units cover torque outputs from 310 in./lbs


(35 Nm) to 20,350 in./lbs (23,00 Nm) and a variety of voltages. All units are available with on/off or proportional control (2–10-VDC/ 4–20-mA inputs and outputs). The units are based on the mechanical and electronic components of the company's HRS Series, with the external housings cast and machined for compliance with Class 3228.02 and 3228.82 standards, and compliant with CSA 60079-0-11, CSA 60079-1-11, CSA 60079-31-12, UL60079-0-09, UL 60079-1-09 & ISA 60079-31-13 requirements.

**Hayward Flow Control**
888-429-4635
www.haywardflowcontrol.com


### Vacuum Transforms Pipe into Conveyer

The 3-NPT heavy-duty threaded Line Vac transports high volumes of material through ordinary pipe. The in-line conveyor is made of a hardened alloy to prevent premature wear when transporting abrasive or heavy materials. Large throat diameters enable conveying more material over long vertical and horizontal lengths. The conveying rate is typically twice that of ordinary air-powered conveyors. The conveyors eject a small amount of compressed air through directed nozzles to produce a vacuum on one end and high output flows on the other with instantaneous response. Utilizing a pressure regulator, conveyance rate can be finely tuned to suit the application.

**EXAIR**
800-903-9247
https://exair.co/108-3hdtlv

### Detectors Monitor Toxic and Combustible Gases

Rosemount 935 and 936 open-path gas detectors help increase safety and reduce downtime in extreme environments with an easier, faster installation and commissioning process. The units withstand both heavy vibration conditions and operating temperatures ranging from -55°C (-67°F) up to 65°C (149°F). The 935 uses infrared technology to detect highly combustible hydrocarbon gases including, methane, propane and ethylene. The 936 uses ultraviolet technology to detect hydrogen sulfide and ammonia. Its Xenon flash technology enables greater installation flexibility versus tunable diode laser technology which needs perfect alignment between beam and receiver for high reliability, the company says.

**Emerson**
888-889-9170
https:// Emerson.com/RosemountFlameAndGas

### Software Helps Extend Equipment Life

The Genix asset performance management suite is designed for condition monitoring, predictive maintenance and asset performance insights. The system reportedly eases adding asset condition monitoring to existing operational technology landscapes, enables prioritization of maintenance activities based on AI-informed predictions, and provides a comprehensive overview of asset performance. It also allows for significant improvements in operational sustainability. By assessing the remaining useful life of industrial assets, the system generates a plan for preventive maintenance, which can extend equipment uptime by as much as 50% and increase asset life by up to 40%, says the company.

**ABB**
800-435-7365
www.abb.com

## Flow Measuring System Eases Pipe Requirements

The Prosonic Flow P 500 measuring system with its FlowDC function reduces the need for long lengths of inlet run and undisturbed flows. The device requires only minimal straight inlet runs and can be installed directly onto the exterior of the pipe, so there is no need to interrupt operations. Planners and operators of process plants can stay flexible and install the unit in just about any location, independent of the pipeline design. This non-intrusive device enables safe measurement of corrosive, abrasive and toxic fluids regardless of their properties, such as conductivity and pressure.

**Endress+Hauser**
888-363-7377
https://eh.digital/FlowP500_us

## Controller Manages Multiple Feeders

Developed to streamline powder processing, the GUC-F universal feeder controller automatically controls weighing, dosing and feeding from up to four different feeders simultaneously, eliminating the need for separate controllers for each feeder. The feeder control system operates in gravimetric and volumetric feeding applications in both batch and continuous processes and may be set up to manage these different applications at the same time from a single, human-machine interface. Access, monitoring, and adjustments may be performed on-site or via remote operation. The controller is pre-configured for fast, easy installation yet may be customized for each process to control actuators, sensors, and additional machinery.

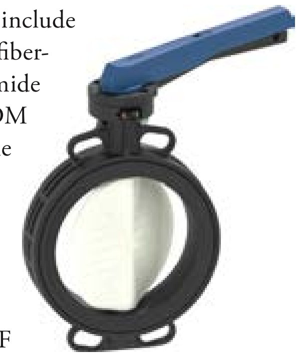
**Gericke USA, Inc.**
855-888-0088
www.GerickeGroup.com


## Feedwater Systems Reduce Thermal Shock Risk

Frontline feedwater systems expand the company's line of firetube boiler systems. The design reportedly provides optimum performance to meet a plant's boiler feedwater needs. The unit's steam dispersion system optimizes heat transfer to evenly and effectively preheat makeup water and reduce the risk of boiler thermal shock. The result is far longer boiler life, according to the company. The line includes a complete offering of sizes and configurations to meet any application requirement.

**Victory Energy**
918-274-0023
https://victoryenergy.com/

## Thermoplastic Valve Supports Safer Installation



The 565 butterfly valve consists of durable high-performance plastic components that include PVDF disc with fiber-reinforced polyamide housing and EPDM or FKM seals. The valve is designed for pressures up to 232 psi (16 bar) and temperatures ranging from 14°F to 176°F (-10°C to +80°C). Available in sizes from NPS 2 through 12 (DN50-300), the valve is 60% lighter than a comparable metal valve, allowing a single technician to safely and easily install it. It comes in the same installation length as metal valves (ISO 5752 Row 20, API 609 Table 2), so retrofitting requires no additional work on the pipes or new designs.

**GF Piping Systems**
800-854-4090
www.gfps.com/us

## Software Executes Alarm Rationalization

The aeAlarm alarm rationalization tool is control system platform-agnostic. The software is effective for projects of all types and sizes, including small project rationalizations and large site-wide efforts. The system provides rationalization teams easy access to customized templates and dropdowns for severities and maximum time to respond, along with automatic population of alarm priority. The tool also helps to compile process safety information and generate customized reports and tables to expedite data tracking for site-specific key performance indicators. Users can fill in consequences, causes and operator actions as tags are processed. User-defined data fields can be added to incorporate site-specific requirements while maintaining compliance.

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# A Mobile Reactor on the Moon?

## Solar-powered unit could produce fine chemicals in remote locations

"Our dream is to see our system used at a base on the Moon or on Mars."

**DUTCH CHEMICAL** engineers and chemists have developed a stand-alone solar-powered mini flow reactor capable of producing fine chemicals in remote locations on earth — and, possibly, further afield.

"Our dream is to see our system used at a base on the Moon or on Mars, where self-sustaining systems are needed to provide energy, food and medicine. Our mini-plant could contribute to this in a fully autonomous, independent way," says Timothy Noël, professor in the flow chemistry group of the Van't Hoff Institute for Molecular Sciences at the University of Amsterdam, the Netherlands.

The prototype reactor consists of a scaled-up luminescent solar concentrator photo-microreactor (LSC-PM) which converts direct and diffuse sunlight energy to a wavelength range that matches the absorption spectrum of a photocatalyst and, subsequently, guides this fluorescent light towards embedded reaction channels to drive photochemical transformations.

The reactor itself is based on a 15-mL LSC-PM module that started life as two 4-mm-thick polymethylmethacrylate (PMMA) plates each with an area of 470 $mm^2$. Both plates were first doped with BASF's commercial fluorescent dye Lumogen F Red 305 — chosen for its high fluorescent yields and excellent photostability. Then 16, 3.2-mm-diameter grooves were drilled along each plate. After gluing perfluoroalkoxy (PFA) tubing of the same external and internal diameter into each one of the grooves, the two halves were sandwiched together.

A pump introduces the reaction mixture into the reactor channels while an LSC guides light towards them. The incoming liquid flow is merged with a flow of oxygen governed by a mass flow controller.

A light sensor attached to the edge of the LSC-PM is monitored in real time, with a control system tweaking the flow rates of both oxygen and reagents to match the current light intensity. An experimentally established conversion correlation maintains production quality, no matter the weather.

For longer periods of poor light, or even darkness — a Lunar night lasts 14 days, for example — a solar-panel charged battery acts as a power buffer.

"Field tests confirmed that it is able to churn out chemicals at a constant rate even on days that are a mixture of sunny and cloudy," notes Noël.

While these tests were carried out in the Netherlands, the team used solar data from the North Cape of Norway, Spain and Australia to check on global deployment possibilities.

"Even at the North Cape, with relatively little sun power, we estimate satisfactory production figures," Noël states.

The researchers then compared the performance of their prototype system with production figures for the industrial photochemical synthesis of rose oxide.

A monoterperene, rose oxide is responsible for the typical floral fragrance found in roses and rose oil, plus the flavor in some fruits, and wines such as Gewürztraminer. It can be produced industrially by photooxygenation of citronellol to give the allyl hydroperoxide, followed by reduction and ring-closure.

The annual production of rose oxide is 60–100 tons. Using the solar data from Townsville, Australia, the team calculated that a mini-plant based there could produce almost 180 tons/yr. To match the current worldwide production, would call for approximately 150 $m^2$ of solar coverage.

In contrast, found the team, actual industrial solar setups would require around 1,900 $m^2$ of space deploying parabolic mirrors costing up to €196/$m^2$ (U.S. \$222.71/$m^2$). LSC panels needed to build the reactor are sold for €99/$m^2$ (U.S. \$112.49/$m^2$). Because two are needed per reactor, the price of the light concentrating material reaches €198/$m^2$ (U.S. \$224.98/$m^2$).

Writing in a recent issue of *ChemSusChem*, Noël points out this shows the LSC-PM mini-plant actually is a more promising alternative, and with more flexible deployment options than industrial photochemical plants. Moreover, he adds, as the entire plant is run on solar energy, no energy cost is present in the operating expenditures, making it a sustainable strategy for future chemical production.

Commenting on the area of solar panels needed to meet current annual demand, Noël added, "That's just one factory roof full of our mini-plants. So, this really could be a sustainable strategy for future production of chemicals such as rose oxide or pharmaceuticals.

You could even cover the facade of a building. Of course, the output would then be smaller than when the system is placed at an optimal angle to the sun, but it certainly is possible — and how cool would it be to have the walls make chemicals," he concludes. ●

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