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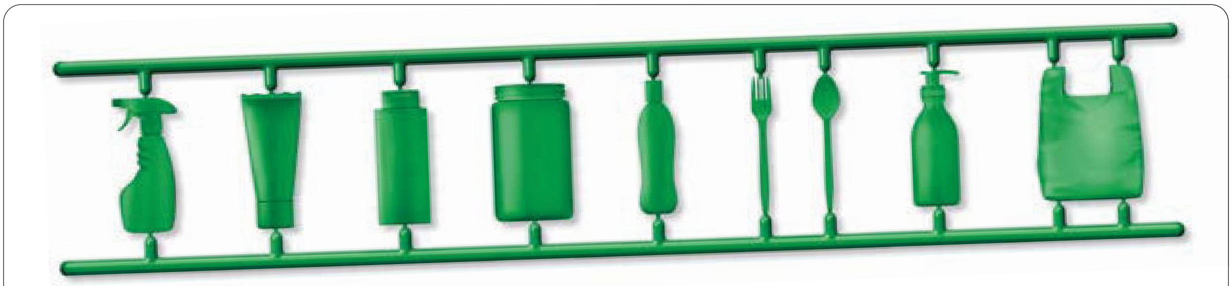

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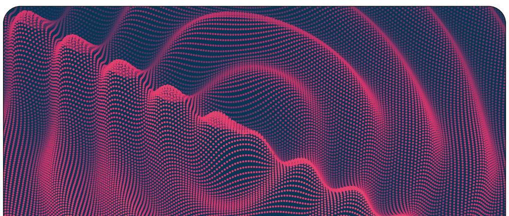

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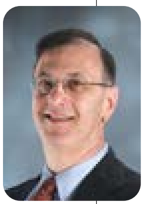
Earth Day Is Golden

Event focused on the environment celebrates 50th anniversary



The problem of discarded plastics has become top-of-mind.

THE FIRST Earth Day took place on April 22, 1970. Twenty million Americans, about 10% of the U.S.'s population then, demonstrated against the prevalent attitude at the time of ignoring or downplaying environmental issues. Now, fifty years later, Earth Day remains an important event to draw attention to necessary actions to protect the planet. Unfortunately, threats to the environment also persist, including at least one that certainly wasn't as apparent in 1970.

In the 1960s, public awareness of environmental issues was increasing, thanks in substantial part to the publication of Rachel Carson's "Silent Spring." That landmark book warned about the harmful impact of pesticides and put the chemical industry in general in a more critical light. (See: "A Milestone Book Turns 50," http://bit.ly/2vCA7jQ.)

However, Earth Day actually emerged as a result of an oil spill in Santa Barbara, Calif., in 1969. That mishap spurred action for an event to call attention to environmental issues.

The Earth Day Network (EDN), Washington, D.C., the guiding force behind ongoing efforts, provides on its website (www.earthday.org) a backgrounder on the genesis of the event.

Gaylord Nelson, a Democratic senator from Wisconsin, came up with the idea for a national day to focus on the environment after witnessing the damage caused by the Santa Barbara oil spill. He raised the idea for a "national teach-in on the environment." He enlisted Pete McCloskey, a Republican congressman from California, to serve as his co-chair. The date — April 22 — was chosen because it fell between spring break and final exams. Rallies took place throughout the U.S. in 1970, with thousands of colleges and universities organizing protests against the deterioration of the environment.

According to EDN, "Groups that had been fighting individually against oil spills, polluting factories and power plants, raw sewage, toxic dumps, pesticides, freeways, the loss of wilderness and the extinction of wildlife united on Earth Day around these shared common values. Earth Day 1970 achieved a rare political alignment, enlisting support from Republicans and Democrats, rich and poor, urban dwellers and farmers, business and labor leaders."

The first Earth Day, notes EDN, triggered a wave of action, including the passage of landmark environmental laws in the United States such as the Clean Air, Clean Water and Endangered Species Acts, as well as the creation of the Environmental Protection Agency (EPA). Many countries soon adopted similar laws, it adds.

Today, EDN works with more than 75,000 partners in over 190 countries. The theme of 2020 Earth Day is climate action.

Thanks to groups like EDN, public awareness and demands for better environmental stewardship have grown dramatically and prompted substantial progress is many areas.

One problem that hadn't surfaced much in 1970 — the scourge of discarded plastics — has become a major environmental issue. It is drawing increasing attention and, as our cover story "Indusrty Breaks the Mold for Discarded Plastics," p. 14, points up, is spurring efforts both to find productive uses for the waste materials and to develop more environmentally friendly alternatives.

So, Earth Day clearly remains resoundingly relevant.

MARK ROSENZWEIG, Editor in Chief
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Profit from Process Safety Tips

Check out our webinar and podcast series for insights on a variety of issues

"If you think safety is expensive, try an accident."
— Trevor Kletz

I'VE GROWN quite fond of the late Trevor Kletz. Not just for being a champion of process safety but also for his extremely quotable adages that drive home the point that safety is an every day, every minute, every step process. One of my favorite quotes is: "There's an old saying that if you think safety is expensive, try an accident. Accidents cost a lot of money. And, not only in damage to plant and in claims for injury, but also in the loss of the company's reputation."

Process safety clearly is paramount. That's why *Chemical Processing* devotes more space to the topic than any other trade magazine in the field, with articles from leading authorities, including Kletz (see "Bhopal Leaves a Lasting Legacy," http://bit.ly/2El0s68).

For the past four years, *CP* has run a Process Safety webinar series (http://bit.ly/CP_ProcessSafetySeries) in partnership with the Mary Kay O'Connor Process Safety Center. This year's series kicked off on April 2 with Trish Kerin, director, IChemE Safety Centre, Institution of Chemical Engineers. The discussion focused on learning from incidents — specifically how to get more insight from the information available after an event. Like all our webinars, it is available on demand.

On June 18 at 2 p.m. ET, the topic turns to preventing human error in the maintenance of instrumented safeguards. Presenter Angela Summers, president of SIS-TECH Solutions, notes that instrumentation and electrical (I&E) maintenance is typically managed using site-wide policies, practices and procedures. Because I&E equipment is part of the control system and nearly every other layer of protection, the cumulative impact of poor I&E performance can significantly contribute to major events. Four elements of causality — organizational processes, workplace practices, personnel traits and enabling conditions — affect the likelihood of human error. Understanding and managing these elements improve maintenance performance, instrument reliability, and process safety.

Come fall, we examine lessons learned from other industries. October 1 at 3 p.m. ET, Kerin will explore incidents in very different sectors — theme parks and finance — to reveal learning parallels applicable to process safety.

Kerin helps us close out the year on December 3 with a webinar on how to leverage Occupational Health and Safety (OHS) for process safety.

CHECK OUT COMBUSTIBLE DUST ROUNDTABLES

Once again in 2020 we are bringing together industry leaders in hazard identification, evaluation and control for combustible dust hazards for two exclusive roundtable discussions. Our moderator, Guy Colonna, senior director of the National Fire Protection Association, will challenge our panelists with tough questions in order to increase awareness of the hazards and the available safeguards of fires and explosions within combustible solids processing and handling industries. Register for these roundtables here: https://info.chemicalprocessing.com/upcoming-webinars

Organizations usually deploy a greater number of personnel on OHS than process safety. She will examine how facilities can leverage the work done in OHS in the past to improve process safety.

In addition to these webinars, Kerin and I host the "Process Safety with Trish & Traci" podcast series. We've dealt with several edgy topics including how a Hurricane Harvey Hangover could be to blame for several safety incidents in and around Texas; how a corroded pipe at the Philadelphia Energy Solutions refinery caused catastrophe; and the need for corporate manslaughter charges when workers are killed at a facility.

The latest episode, "Is Inherently Safer Design Really Safer," unearthed another anecdote that reinforced my adoration for Trevor Kletz: "There's a story about Trevor," says Kerin. "He actually used to live in a single-story bungalow because you couldn't fall down a set of stairs if you didn't have any. In theory, it's an inherently safer design. But if you're in a floodplain area, you've got nowhere to go. So you see, there's a tradeoff here — do you give away something for the benefit of something else? You need to determine what risk is the more acceptable one or tolerable one to you."

You can access that podcast via chemicalprocessing.com/podcasts. The series is available for download on several podcast apps including Apple (formerly iTunes), Google Play, Stitcher and Spotify. Don't worry if none of those sound familiar to you — you can also listen right from the ChemicalProcessing.com website.

TRACI PURDUM, Senior Digital Editor
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Protect Your Centrifugal Pumps

Check if crucial ones lack sufficient safeguards

One of four culprits commonly kill a pump.

AN IMPORTANT question dawned upon me: "How is the caustic pump protected if the expansion joint at its suction port splits open?" That pump was the only one capable of keeping the plant running at full capacity. Thinking about this issue a bit more, I realized that many pumps in lots of plants I'd been to had little or no protection.

One of four culprits usually kill a pump:

1) a loss of flow from the feed tank caused by a suction line failure or a drop in tank level;
2) a blocked suction or discharge line;
3) a mechanical failure such as a broken shaft due to debris fed to pump, change in pumping fluid, corrosion, etc., or running a pump with a variable-speed drive (VSD) too fast or too slow; and
4) mis-application, e.g., using a centrifugal pump to move a viscous, corrosive, bubbly or high density liquid.

Now, let's consider some options for protecting centrifugal pumps. These involve monitoring of level, pressure, flow, temperature or power.

By far the cheapest method is level control. Plants usually monitor the level in feed tanks. Take advantage of this measurement to program a trip to turn off the pump when the level nears the point at which gas enters the pump instead of liquid. As a rule of thumb, I use 1 ft above the top of the suction line but you can calculate this by looking into "submergence" online; I suggest checking "Cameron Hydraulic Data." If your pump seal is rugged, you might set a lower level for the trip. Also, you certainly will want to confirm that the net positive suction head available ($NPSH_A$) suffices at the trip point. Cheapest isn't best, though. Level control only thwarts running the pump dry (culprit 1).

An option that's a little more expensive is a high-pressure switch (PSH) at the pump discharge. This approach catches (1) and (2) successfully but (3) and (4) only sometimes. Set the PSH to match the deadhead pressure but put a 15-sec. delay on the trip. Changes in liquid specific gravity affect the setting because pump discharge head remains the same but pressure varies with density. The PSH is a robust instrument; that's why it's typically used to protect pumps where local instrument support is minimal. (A low-pressure switch (PSL) could be used to detect an open discharge line.)

Flow measurement is the best approach. However, it's not foolproof because flow is inferred from another parameter — usually, velocity or pressure drop. Fluids affect these measurements. Ideally, you should measure downstream flows that can be used to trip a pump if sufficient flow isn't headed its way. If that's not feasible, install flow switches on suction lines. Flow monitoring protects against (1), (2) and (3) to a large degree and even (4) in most situations. An alternative approach for timer-controlled pumps relies on on/off feedback from automatic valves. In critical pump applications, you could use this feedback as an additional layer of protection even where flow measurement is available. Set the flow at the temperature limit where liquid vaporizes; vendors generally provide minimum flow in data sheets.

Then, there's temperature measurement, an option available in vendors' pump monitoring packages. However, temperature always suffers from lag. By the time the system reports a temperature high enough to cause damage, it's already done. Set the trip high but to respond instantly.

Don't rely on power monitoring to gauge pump condition. It can detect altered power draw from a change in fluid viscosity and density but won't alert you to a broken impeller. Unless it's completely destroyed, which is rare, the impeller still turns and the pump draws power. Power monitoring is useful to tell you if a motor is running at a high speed or, worse, a low speed. Totally enclosed fan-cooled (TEFC) motors rely on shaft speed to avoid burning the motor coil insulation. A power monitor represents an inexpensive approach to protect motors; include it whenever you use a VFD.

Consider using multiple approaches. Level and power are cheap options while flow and power may provide the most protection. Perhaps opt for level, flow and power for some overlap. Regardless, realize a spare pump isn't really a long-term solution if you can't prevent the first pump's failure.

CHECK OUT PAST FIELD NOTES

More than a decade's worth of real-world tips are available online at www.ChemicalProcessing.com/field-notes/. For additional practical pointers, check out the online roster of Plant InSites columns at www.ChemicalProcessing.com/plant-insites/

DIRK WILLARD, Contributing Editor
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Fluidization Foils Electrocatalyst Fatigue

Circulating catalyst in electrolyte promises to boost its efficiency and durability

FLUIDIZING CATALYST particles in electrolyte instead of attaching them to electrodes provides a more efficient and stable method to conduct electrocatalytic reactions, say researchers at Northwestern University, Evanston, Ill. The approach could improve production processes for electrolysis and electrochemical energy conversion and storage, they add.

With the conventional approach of catalysts attached to electrodes, voltage continuously applied through the electrode causes electrochemical stress on the material. Over time, the catalytic performance can decay due to accumulated structural damage in the electrode as a whole or on individual particles.

The team's approach avoids the continuous stress by fluidizing the particles in the electrolyte. The rotating particles experience electrochemical stress only momentarily when colliding with the electrode. Collectively, the output from the individual collision events merge into a continuous and stable electrochemical current.

"Fluidized electrocatalysis breaks the spatial and temporal continuum of electrochemical reactions, making the catalysts more efficient," says Jiaxing Huang, professor of materials science and engineering at the university's McCormick School of Engineering, who led the research. "Fluidization also reduces the mass transport limit of the reactants to the catalyst, since the particles are swimming in the electrolyte."

Using a commercially available Pt/C catalyst, which is susceptible to severe performance decay, to catalyze oxygen evolution, hydrogen evolution and methanol oxidation reactions, the team found their fluidization method resulted in higher efficiency and stability. Their findings appear in the journal *CCS Chemistry*.

Huang believes his method could be applied to a variety of different types of materials and drastically extend runtime for low-cost, more-abundant but otherwise unstable electrocatalysts.

"Fluidized electrocatalysis basically collects a lot of transient current from particle-electrode collision to yield a continuous overall current output, which is generic to all reactions using particle catalyst. We found they're particularly useful for reactions suffering from unstable catalysts such as Pt and MOF [metal organic framework] materials for oxygen reduction reactions, or reactions where the electrode kinetics is limited by inefficient mass transport, or those involving gas evolution that may cause catalysts pulverization and detachment from the electrode surface, such as hydrogen evolution reactions and oxygen evolution reaction," he explains.

"Such materials tend to aggregate and sinter when exposed to continuous and long-term electrochemical voltage. Such fatigue problems should be well addressed by fluidizing the corresponding catalytic particles," he says. The team hasn't yet completed this project, but is looking into these reactions.

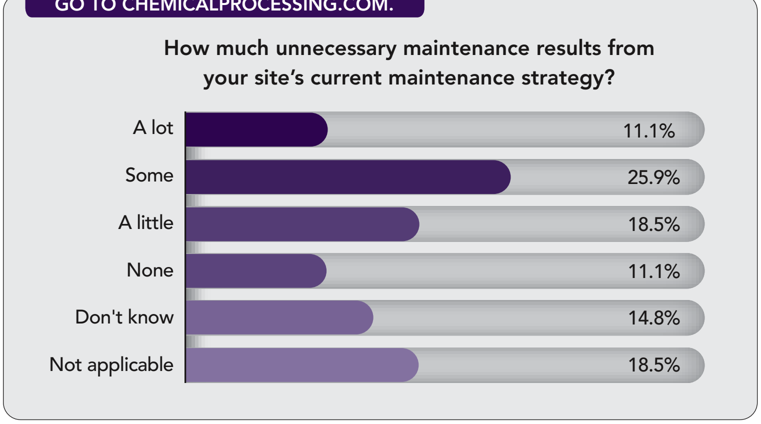
"This work stands to bring a new concept and provide three model reactions for proof-of-concept demonstration. The three model reactions already represent most common mechanisms of catalyst fatigue. We need funding to continue to explore other systems," he adds.

However, the approach may encounter volume-related constraints in volume-sensitive applications. "This refers to the need for fluidized reactions to have an electrochemical cell allowing electrolytes to flow, regardless of how small it is. The need for flowing and liquid electrolytes limits the lower end of the reactor sizes, in comparison to other systems using solid state electrolyte or just a very thin layer of electrolyte gels," notes Huang.

While the team used magnetic stirrers to achieve fluidization in the lab, Huang points out there are many ways to induce flow on an industrial scale, including by a pump and gravity, or by rotating the electrochemical cell or a rotating electrode to stir up the reactions.

"I hope other researchers consider our method to re-evaluate their catalysts. It would be exciting to see previously deemed unusable catalysts become usable. We welcome suggestions and input about catalyst fatigue problems in your electrochemical reactions. This helps us to identify new problems to address," concludes Huang.

TO PARTICIPATE IN THIS MONTH'S POLL, GO TO CHEMICALPROCESSING.COM.



The largest number of respondents reported some or a little unnecessary maintenance.

Catalyst Pushes the Edge

A NEW catalyst for dry reforming of methane could provide an economically feasible route for large-scale use of carbon dioxide as a feedstock and, thus, an important tool for dealing with greenhouse gas emissions, hope researchers in Korea. Their catalyst, by concentrating nickel nanoparticles on the support's edges, overcomes cost and technical problems posed by current catalysts for dry reforming. Those catalysts contain rare and expensive metals such as platinum and rhodium and are prone to deactivation through a combination of coking and sintering.

The attraction of nickel as a more economical catalyst isn't new. However, build-up of byproducts on its surface have caused problems.

"The difficulty arises from the lack of control on scores of active sites over the bulky catalysts surfaces because any refinement procedures attempted also change the nature of the catalyst itself," says Cafer T. Yavuz, associate professor of chemical and biomolecular engineering and of chemistry at Korea Advanced Institute of Science and Technology (KAIST), Daejeon, Korea.

Yavuz and his co-workers have developed a technique they believe overcomes all these problems. Details on their method, dubbed nanocatalysts on single crystal edges (NOSCE), appear in a recent issue of *Science*.

NOSCE involves using highly crystalline fumed magnesium oxide to support molybdenum-doped nickel nanoparticle catalysts (NiMoCats). On heating, the nanoparticles migrate to form larger, highly stable nanoparticles on the oxide surfaces' edges (Figure 1).

REFORMING CATALYST

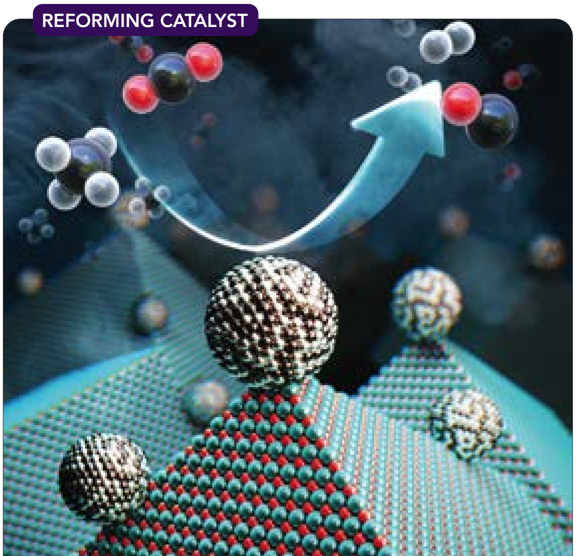
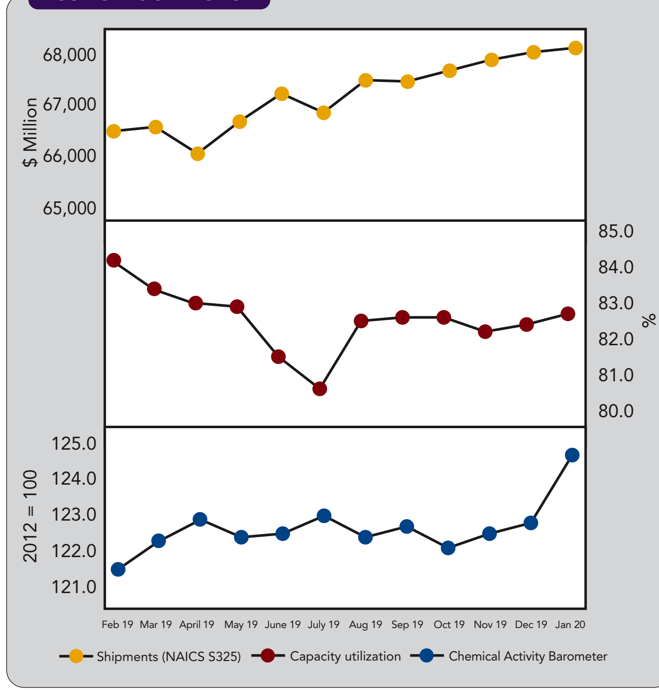


Figure 1. Unique structure overcomes coking and sintering problems that have afflicted other catalysts. *Source: Cafer T. Yavuz, KAIST.*

ECONOMIC SNAPSHOT



Data for January 2020 show that all three metrics rose, with the CAB up most. *Source: American Chemistry Council.*

In tests, the catalyst has operated continuously for more than 850 hours with a reactive gas flow of 60 L/mass of catalyst/hr with no detectable coking.

Synchrotron studies showed that sintering did not occur and also revealed the complex movement of nanoparticles and magnesium oxide crystals during catalyst activation.

"It took us almost a year to understand the underlying mechanism," notes Youngdong Song, a graduate student at KAIST. "Once we studied all the chemical events in detail, we were shocked."

The next phase in the work involves pilot plant testing with stable catalyst pellets, states Yavuz. "The main challenge at the moment is pellet stability. Our initial runs with commercial binders showed great activity but low mechanical stability. We're now improving the procedures for better pelletization," he explains.

The group also looks to expand the application of NiMoCat to other reactions. "As anyone would guess, we're already into higher hydrocarbons and mixed (steam and dry) reforming procedures. But, in principle, any nickel-catalyzed reaction could benefit from our design," he adds.

Saudi Aramco has been funding the work so far through the Saudi Aramco-KAIST CO_2 management center.

"Now, we'll work with known catalyst companies to make the process plant scale," concludes Yavuz.

Is it Too Good to Be True?

Question the validity of vendor claims that tout extraordinary energy efficiency

Remarkable claims demand remarkable evidence.

OF ALL my consulting assignments, none has been so strange as "The Case of the Magic Burner." My client asked me to evaluate this new technology, with the objective of upgrading some boilers.

The vendor claims were interesting, to say the least. The burner requires virtually no excess air, and produces essentially no carbon monoxide or NO_x. Furthermore, because of high flame speed, it delivers excellent heat transfer. However, what really caught my attention was the claim that the burner would reduce fuel use in the boilers by 30–40%. The nameplate efficiency of the boilers was over 90% (lower heating value (LHV)), equivalent to about 81% (higher heating value (HHV)). If the burners could reduce the fuel use by even 30%, while still delivering the same amount of useful heat, the energy efficiency would significantly exceed 100%, thus violating the first law of thermodynamics (conservation of energy).

Remarkable claims demand remarkable evidence. I told the vendor CEO that if he could prove his claims, I would personally recommend the burner's inventor to the Nobel committee.

The efficiency of boilers and furnaces is defined as: efficiency (%) = (useful heat delivered)/(total heat supplied)×100. This is deceptively simple. First, "heat supplied" can be based on either higher heating value, which includes the latent heat of condensation of water vapor in the exhaust gases, or lower heating value, which omits the latent heat. As water condenses, so also do the acid gases (especially SO_x) in the exhaust stream. This "acid condensation" is extremely corrosive, and damages most heat transfer surfaces and casings. Consequently, except in specialized equipment made with exotic materials, LHV represents the maximum amount of recoverable heat. For this reason, many practitioners prefer efficiencies based on LHV. For natural gas and most other gaseous fuels, HHV is about 10% higher than LHV. For liquid and solid fuels, the difference is generally less.

Efficiencies can be calculated either by the direct or indirect method. The direct method requires a measurement of the heat supplied (typically from the flow rate of the fuel and its heating value) and also the heat delivered. These measurements are difficult to make and often are inaccurate.

The indirect method starts from 100%, then subtracts individual inefficiencies. For most boilers and furnaces, the main inefficiency is the heat that leaves in the stack gas. This loss can be estimated from two simple parameters — stack temperature and excess oxygen. A typical design temperature for stack gas in a natural-gas-fired industrial boiler with an economizer is around 160°C (320°F).

One of our most common fuels is natural gas, which consists mostly of methane. Its combustion can be represented as: $CH_4+2O_2 \rightarrow CO_2+2H_2O$; $\Delta H = -891$ kJ/mol. However, this process is imperfect, and excess oxygen is required to drive the reaction to completion. Furthermore, in almost all cases we support combustion with air, not pure oxygen; so, a great deal of nitrogen, and smaller amounts of other gases, enter the burner with the fuel and oxygen, diluting the mix. All these gases eventually leave through the stack, carrying heat with them. The more excess air we supply, the more excess oxygen (plus nitrogen and other gases) goes to the stack, and the greater the heat loss becomes. Modern gas-fired industrial boilers are typically designed for 2.0–2.5% excess oxygen. With a stack temperature of 320°F and 2% excess oxygen, and an ambient temperature of 90°F, the stack loss (excluding latent heat) would be around 6%.

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Smaller losses (typically <1% in good, modern designs) exist through the wall, or "shell" of the equipment. Furthermore, for boilers, and also for furnaces that incorporate steam generating equipment, additional heat loss (typically 1–3%) happens due to blowdown water. This is a withdrawn hot water stream to remove dissolved solids and other impurities that would otherwise build up and damage the equipment. Thus, a good boiler efficiency would be around 100-6-1-1 = 92% (LHV).

The vendor never validated the performance of the magic burner, so the laws of thermodynamics remain stubbornly fixed, and the inventor won't get nominated for a Nobel Prize. Have you ever encountered outrageous vendor claims that seemed too good to be true? ●

ALAN ROSSITER, Energy Columnist
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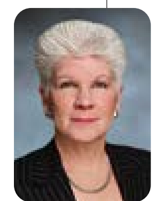
TSCA Fee Controversy Continues

Notice set off a backlash among industry expected to pay a portion of the EPA's fees



The EPA could elect not to enforce action under certain circumstances.

IN LAST month's column, we reported on the January 27, 2020, notice from the U.S. Environmental Protection Agency (EPA) identifying the preliminary lists of manufacturers, including importers, of the 20 chemical substances the EPA designated as high-priority for risk evaluation and for which fees will be charged. The notice created a firestorm of criticism over the lack of any exemptions from being considered potentially responsible for paying a share of the EPA's $1,350,000 fee for conducting a risk evaluation of a high-priority chemical. This column updates the status of this fast-changing matter.

BACKGROUND

As noted, companies that manufactured or imported any of the 20 high-priority chemical substances prior to January 27, 2020, are required to submit a notice to the EPA admitting that fact, even if the agency didn't identify them in the preliminary lists published in January. Companies on the list and not removed, and companies that "self-identify" are deemed potentially responsible for paying a share of the $1,350,000 administrative fee the EPA will charge to conduct a risk evaluation under Toxic Substances Control Act (TSCA) Section 6. Other charges, including industry consortia fees and related expenses, may also apply.

Companies can certify to the EPA that they have not manufactured the chemical substance in the five-year period preceding publication of the preliminary lists, or certify that they had ceased producing or importing the substance prior to the March 20, 2019, deadline and will not do so in the five years following that date. Either certification action will avoid the fee obligations.

The EPA developed the preliminary lists of manufacturers and importers subject to fees using data submitted via the Chemical Data Reporting (CDR) Rule (2012 and 2016 reporting years) and the Toxics Release Inventory (TRI) (2012–2018 reporting years); some entities not expecting to be included on the list, in fact, are. The EPA admits it may have incorrectly identified companies that had ceased manufacture prior to the defined cutoff dates or as a result of processing or use activities reported under TRI.

The absence of exemptions and the wide scope of potentially liable entities inspired confusion and concern in industry, and many are annoyed about this state of affairs. Some are especially irritated with having to master the EPA Central Data Exchange (CDX) merely to advise the EPA they aren't a responsible entity. As stakeholders know, CDX is manageable if you know it, but a bit daunting if you don't.

EPA CLARIFICATION

Given industry stakeholder confusion, EPA leadership said the agency is considering options to alleviate these concerns. With this in mind, potentially impacted industry stakeholders may wish to consider suspending ongoing internal deliberations on self-reporting obligations until the EPA provides the additional guidance promised. The EPA plans to extend the response period to April 27, 2020. During this period, manufacturers, including importers, must self-identify as manufacturers of a high-priority substance irrespective of whether they are included on the EPA's preliminary identification lists.

Self-notifying is a required action under the TSCA and failure to do so is a violation of TSCA Section 16. Whether and when the EPA would actually pursue such an action is another matter, and the EPA is likely also considering enforcement discretion options.

This means the EPA could indicate that while violations of TSCA in this regard are actionable offenses, the EPA could elect not to enforce them under certain circumstances. Chances are, this would go a long way in providing the comfort stakeholders seek. Stay tuned.

The preliminary lists are available in Docket EPA-HQ-OPPT-2019-0677 and on the EPA's website at www.epa.gov/TSCA-fees. Entities are urged to review the lists now and then take the appropriate action. ●

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Lynn is managing director of Bergeson & Campbell, P.C., a Washington, D.C.-based law firm that concentrates on chemical industry issues. The views expressed herein are solely those of the author. This column is not intended to provide, nor should be construed as, legal advice.

INDUSTRY BREAKS THE MOLD FOR DISCARDED PLASTICS

Efforts aim to bolster recovery and effective processing

By Seán Ottewell, Editor at Large

SIGNIFICANT ADVANCES are taking place in chemical recycling technologies for dealing with discarded plastics. In addition, waste collection collaborations needed to underpin the eventual commercialization of such technologies are progressing.

Various chemical processes under development aim to convert specific polymers back into monomers. For example, BP, London, is targeting polyethylene terephthalate (PET) with its Infinia depolymerization chemical recycling technology. Infinia breaks down PET waste into its constituent monomers. After contaminant removal and purification, the recycled terephthalic acid (PTA) and monoethylene glycol (MEG) are interchangeable with monomers produced from a traditional hydrocarbon feedstock.

More will be known about the future of the process following the commissioning of a $25-million Infinia pilot later in the year at the company's research and development center in Naperville, Ill. If the technology can operate on a commercial and continuous basis, the company says deployment at a number of full-scale plants operating at different locations around the world is likely.

"BP Infinia technology is based on proven chemical processes which BP aims to economically operate at large scale; we believe BP's expertise in chemical process technology development, particularly in the area of PTA production, provides us with advantages for the successful development and implementation of the BP Infinia technology," notes a company spokeswoman.

As part of its recycling strategy, BP also is working with other companies in the polyester value chain, including Britvic, Danone and Unilever, to address setting up recycling streams and to better understand the technical implications of end-user requirements and carry out product testing.

POLYSTYRENE FOCUS

Meanwhile, INEOS Styrolution, Aurora, Ill., and Agilyx, Portland, Ore., are developing a 100-t/d chemical recycling facility for polystyrene (PS) in Channahon, Ill. The plant, now at the engineering design stage, will use Agilyx's proprietary chemical recycling technology that breaks down PS to base monomers suitable for manufacturing new styrenic polymers.

The decision to move ahead with the plant follows a successful development program with INEOS Styrolution that qualified the styrene product to the company's specifications and identified post-consumer polystyrene feedstock for the process.

Agilyx itself has successfully concluded a year-long collaboration in artificial intelligence (AI) with GE Research, Niskayuna, N.Y. This involved assessing GE's advanced modeling technology and its applicability to Agilyx's database of chemical conversion of post-use plastics.

The two companies have concluded that AI, machine learning, predictive modeling technologies and other optimization tools can enable an increase in the chemical recyclability of all post-use plastics to over 95% from the current 10%.

Agilyx now is working with others in the PS supply chain to optimize the findings and expects to announce further collaborations later in 2020.

POLYMETHYLMETHACRYLATE

According to "Plastics Europe," a 2017 report published by Deloitte, London, the total demand for plastics in Europe was 51 million t/y then (and growing). That generated 27 million t/y of post-consumer plastic waste, with 17 m t/y of this from packaging. Currently, collection programs in the European Union (EU) retrieve 8.5 million t/y of packaging waste, half of which is recycled. The bloc aims to recycle 50% of such waste by 2025, and reach 55% by 2030.

This has spawned several projects supported by the EU to convert polymers back into monomers. One, called MMAtwo, started in October 2018 and runs until the end of September 2022. The EU is contributing €6.66 million ($7.43 million) to the total budget of €8.93 million ($9.96 million). The project's main objective is to construct a novel and fast-growing polymethylmethacrylate (PMMA) recycling value chain through depolymerization and recovery of a monomer grade that can be sold at 90% of virgin methylmethacrylate (MMA) price.

The small amount of PMMA currently recycled comes from production scraps recovered by mechanical recycling and then sent through a depolymerization process that relies on a molten-lead-based process.

"This works well when there is a small amount of contaminants in the PMMA to be recycled to the monomer," says Jean-Luc Dubois, scientific director, catalysis, processes, renewables and recycling, Arkema, Colombes, France, who chairs the executive board for the project. "However, with other PMMA grades, a high amount of contaminated residues would be produced and would have to be disposed of. So, an alternative process that would avoid this issue is needed. We selected a process using a high-temperature twin-screw extruder process (Figure 1), partly because the recycling companies that would adopt the technology are more familiar with that type of process."

The process itself faces a number of chemical and engineering challenges, he notes. For example, the MMA monomers could easily repolymerize in the unit; there are flammability risks because the depolymerization occurs at conditions close to the self-ignition temperature of the monomer; and impurities generated in the process may compromise the polymerization process.

One of the project's partners currently is carrying out the conceptual design for a downstream purification sequence that can handle difficult impurities. "This is important because the final recovered MMA monomer will have two types of applications — one that demands optical quality is the same as virgin monomer and others where transparency is not needed," adds Dubois.

The pilot demonstration of the depolymerization process is installed at project partner Japan Steel Works Europe's facility in Dusseldorf, Germany, while pilot-scale purification will be carried out by distillation specialist Speichim, Lyon, France. The quality of the recycled MMA monomer then will be validated both by Arkema and sheet manufacturer, Delta Glass, Tholen, The Netherlands.

HIGH-TEMPERATURE TWIN SCREW EXTRUDER

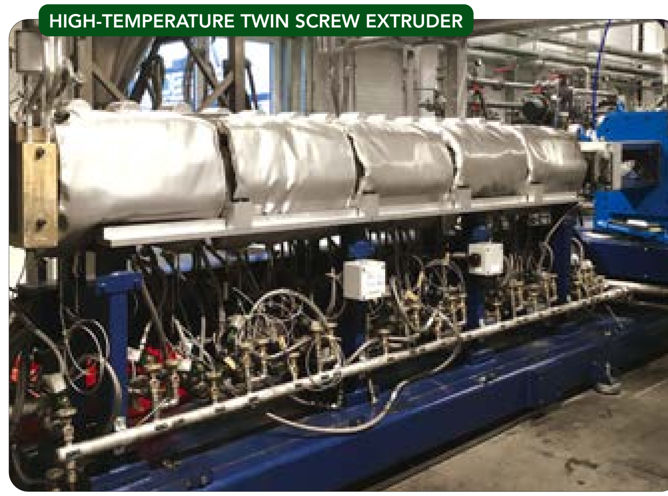
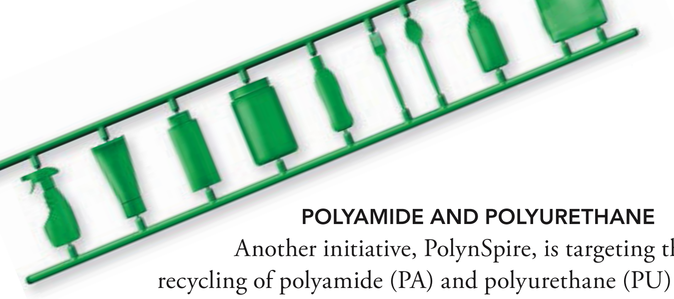


Figure 1. Effort to recover polymethylmethacrylate focuses on use of equipment familiar to recycling companies. *Source: MMAtwo.*



POLYAMIDE AND POLYURETHANE

Another initiative, PolynSpire, is targeting the recycling of polyamide (PA) and polyurethane (PU) using depolymerization reactions. The 48-month project started in September 2018 with a budget of €9.95 million ($11.10 million), with the EU providing €7.94 million ($8.85 million).

The 21 partners involved include five chemical companies — Repsol Quimica, Arkema, Novamont, Nurel and Kordsa — with consortium coordination provided by sustainable technology development group CIRCE, Zaragoza, Spain.

The goal of the project is developing a system prototype ready for demonstration in an industrial environment. This involves work on two novel approaches for the total depolymerization of PA and PU.

One is chemical recycling assisted by microwaves. Here, 2.45-GHz and 915-MHz sources bombard a reactor vessel containing solvent and PA or PU.

Second is chemical recycling assisted by smart magnetic materials. This involves heating catalyst, PA or PU and solvent in a reactor. The resulting monomer-containing mixture then goes through a vessel where several magnetic zones enable capture of the catalyst. Ioniqa, Eindhoven, The Netherlands, developed the technology.

"Our initial lab-scale analyses have brought very promising results for all the technologies in terms of efficiency and quality," says project coordinator Tatiana García Armingol, director of CIRCE's energy and environment group. "Regarding scaling up, the main challenges include: process economics; the quality of sample material used — in terms of additives, pollutants and size — and their pre-treatment requirements; and isolation of PA and PU monomers," she adds.

Work soon will progress from the laboratory scale to the first steps of technology demonstration, García Armingol notes.

COMPLEX MATERIALS

The EU also is supporting a third initiative, called Multi-Cycle. The three-year €9.7-million ($10.82-million) — including €7.7 million ($8.35 million) from the EU — project started in 2018 and aims to deliver an industrial recycling pilot plant for fossil- and bio-based thermoplastic multilayer packaging and fiber-reinforced composites. The process uses a novel solvent-based selective extraction process that allows recovering pure plastics and additives in mixed wastes for their later reprocessing into value-added applications. It is based on

CreaSolv technology from CreaCycle, Grevenbroich, Germany, which can use a solvent tailored to specific plastics.

"A 25-kg/hr MultiCycle pilot plant [Figure 2] will be set up at industrial solvent handling technology firm Lömi, Grossostheim, Germany, at the end of Q2/2020," says Elodie Bugnicourt, innovation unit leader and MultiCycle project coordinator, Iris Technology Solutions, Barcelona.

"The main challenge for the plant is the need for high versatility in order to recover different polymers from packaging and automotive origins, as well as glass and carbon fibres. In consequence, advanced monitoring techniques are being used by Iris Technology Solutions to identify the composition of each incoming batch of end-of-life material to ensure the process is set up optimally for the fractions to be recovered," she adds.

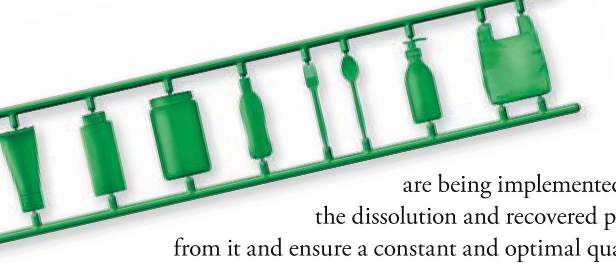
Several project partners will evaluate the recycled raw materials for a range of packaging and automotive applications.

Experience with the pilot plant has solved most of the basic engineering and process challenges that would arise on scale up to commercial operation, Bugnicourt believes.

"However, it would, of course, bring challenges familiar to those involved in industrial process design. In terms of process monitoring, additional inline analytical technologies

PILOT PLANT

Figure 2. Work is progressing on 25-kg/hr unit in Germany. *Source: MultiCycle.*



are being implemented to monitor the dissolution and recovered polymers from it and ensure a constant and optimal quality. Further automation may also be introduced in the future," she notes.

SYNTHETIC CRUDE

Meanwhile, Neste, Espoo, Finland, has set itself the target of recycling more than one million t/y of post-consumer waste from 2030 onwards. To achieve this, the company is working on projects with polymer recycler and distributor Ravago, Luxembourg, and recycling specialist Remondis, Lünen, Germany. Process details and investment in the two facilities remain guarded.

Both involve construction of 200,000-t/y plants that will use Neste's thermochemical liquefaction process to convert the plastic waste into a material similar to crude oil. Following refining and upgrading in Neste's existing refineries, this synthetic crude then can be converted into raw materials for new plastics, chemicals and fuels.

"The key challenge related to developing chemical recycling capacity is that we need to develop value-chain partnerships, business models, technologies and eventually also facilities — but without fully confirmed financial and regulative frameworks to support investments into this area," notes Heikki Färkkilä, Neste's vice president, chemical recycling.

The main technical hurdle is to develop a capability to process as broad a range of low-quality plastics as possible (Figure 3) to complement mechanical recycling technologies and still produce suitable feedstocks for high-quality chemical products, he adds.

However, Färkkilä stresses that the regulatory framework around chemical recycling still is being formed both at the EU level and in many member states. So, Neste and other players are helping the regulators more thoroughly understand the concept of chemical recycling.

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"We highlight how chemical recycling is not replacing mechanical recycling; instead, it can complement mechanical recycling by enabling recycling of those plastics that currently cannot be recycled mechanically. Being able to efficiently recycle, for example, multi-material, multi-layer and colored plastics with chemical recycling could significantly contribute to increasing plastic recycling rates and reaching ambitious EU level recycling targets," he explains.

CIRCULAR FOCUS

Sabic, Sittard, The Netherlands, is committed to increasing the amount of plastic it processes in Europe to 200,000 t/y by 2025. Its Trucircle strategy, announced in late 2019, spans design for recyclability, mechanically recycled products, certified circular products from feedstock recycling of plastic waste streams and certified renewables products from bio-based feedstock. The company says that it has made significant advancements in closing the loop this year via alliances with partners, customers and collaborators across the value chain.

At the heart of its strategy is Tacoil — a patented product from Plastic Energy, London — produced from recycled low-quality mixed-plastic waste otherwise destined for incineration or landfill. The process uses pyrolysis-based thermal anaerobic conversion technology to achieve this.

Figure 3. Chemical recycling may enable handling discarded materials including multi-material ones not suitable for mechanical recycling. *Source: Neste.*

Sabic says that a semi-commercial plant to produce pyrolysis oil from plastic waste at its Geleen site in The Netherlands should be operational next year. Its output initially will provide materials for Sabic's downstream collaborators but the long-term intention is to rapidly scale-up the supply of its certified circular polymers for all global customers. ●

Don't Let Vibration Shake Up Operations

Understand the causes of dynamic problems and how to address them

By Amin Almasi, mechanical consultant

THE RELIABILITY and integrity of equipment, structures and piping can suffer because of vibration and dynamic responses. These depend mainly on excitation forces, stiffness, mass distribution and damping.

Modal analysis, which focuses on natural frequencies and associated modal shapes, provides an important tool in understanding potential issues. Indeed, usually the first step in checking for or troubleshooting vibration issues is to use it to find the natural frequencies and associated modes of machinery or systems. It can show if a specific excitation arrangement can excite a nearby natural mode. Such information then informs adjustments such as stiffening to ensure the natural frequencies lie outside the range of excitation frequencies. Sometimes, a natural frequency and an excitation frequency being close may be acceptable if the situation won't cause a resonance and subsequent high vibration or damage.

Here, we'll look at modal analysis and its application at processing facilities as well as practical pointers for avoiding problems.

VIBRATIONAL MODES

The first vibrational mode usually is related to the weakest part in a structure or piping or the most flexible component in a piece of equipment. For example, many machinery mechanisms rely on a small diameter shaft that carries a lot of weight or is under considerable loading. The deformation of this shaft typically indicates the first mode at work. With equipment having a long beam taking the main loading, the first mode is the bending mode of this beam. Many important modes are related to deformations under bending, torsion or a combination of the two. Often, an important mode is a combined one of deformation of two or three different components or parts such as two shafts or a shaft and an arm. In piping systems, a combined mode may involve two or three connected piping lines. The same is true for structures and frames.

Some modes, particularly first or second ones, can be easily excited. On the other hand, some modes need high energy for excitation. For instance, in a machine with a vertical cylinder in its base, the third mode is the slight bending of the vertical cylinder when the entire body of the unit oscillates. It is not easy to excite the machine at this mode. Many times, different local modes of oscillation occur for various components and subsystems. In such cases, the main elements of the machinery or structure stay stationary but some parts deform locally.

Certain high-order modes could be complex ones composed of bending and torsion of many or all the components in a piece of equipment, a piping system or a structure. On the other hand, some high-order modes could be second and third bending modes of different parts and components such as beams, arms, shafts, rotors, piping, etc. These high-order modes need specific (usually high energy) excitation arrangements — and, therefore, their excitation is unlikely. In other words, except in very rare cases, high-order modes don't pose dangers. In addition, higher modes are quite damped in practice.

All-in-all, you should carefully check any equipment or structure for the first three modes.

EXCITATION MECHANISMS

Forces resulting from operation, e.g., due to unbalance, misalignment, reciprocating motion, etc., can generate an excitation frequency close to a natural frequency. The relationship between generated forces and the speed in different pieces of equipment can be complex. There could be different harmonics of operating speed acting as excitation forces. So, check the harmonics of operational frequency and compare them with natural frequencies. The integer number of the fundamental operational frequency might come close to a natural frequency; this may lead to resonance, high vibration or even some damage if the excitation forces can excite a natural mode that's close.

For instance, in one machine the rotor speed was around 11 Hz and the first natural frequency was 22.7 Hz. Two times the operational speed (2×11 Hz) was very close to the natural frequency and misalignment at that speed could be enough to excite the natural first mode, which was in the transversal direction. So, the machine was modified to elevate the first natural frequency to a higher value.

In some cases, you must modify the operating speed to avoid any resonance and achieve better operation with minimum vibration. To reduce the vibration, the excitation frequencies should be far from the modal natural frequency of the whole machinery system (including the associated structure, connected piping, etc.).

Reliable and high-performance operation also requires careful evaluation of overall and local vibrations and deformations. You must assess the deformation of equipment, structures or piping at each critical point where there is a limitation. For instance, if the gap between a moving part and stationary components is tight, you should check the vibration and deformation at that location to avoid any operational problems.

CALCULATION CAVEATS

Theoretical models nearly always exhibit stiffer behavior than actual machinery, piping or structures. Therefore, calculated natural frequencies usually are higher than the actual ones. This mismatch is lower than that between actual/measured modes and calculated ones. For a vibrating mode, the calculated natural frequency may be accurate but the theoretical predicated mode shape might not be. You should consider this in operational observations, reliability studies and maintenance.

Nonlinearities are a major reason for incorrect mode shapes. However, inaccuracies also stem from other sources such as damping. Because the values of damping aren't accurately known, it's difficult to theoretically predict the

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behavior of the machinery, piping or structure at or near resonance. Too often, this is where accurate simulations are needed to make important decisions on operation, modification and improvement. Prestressing can change the modal behavior of a structure, piping, frame and other elements.

CASE STUDIES

Now, let's look at two examples of the use of modal analysis.

Drive frame for belt conveyor. This very large belt conveyor for transferring raw material to a chemical plant has a speed of 5 m/s, a width of 2 m, and capacity of 6,000 t/h. The length of conveyor is 1,450 m. The drive frame has two pulleys, each driven by a 750-kW drive unit. This is a long, high-power system; there was concern about different dynamic and vibrational behaviors of such a conveyor and drive frame.

During the commissioning and initial period of operation, complaints arose about high vibration of the drive frame. A modal analysis conducted for the drive frame indicated the lowest modal frequency (first natural frequency) to be just above 3 Hz (somewhere between 3.1 Hz and 3.4 Hz in different simulations). The movement was in the transversal direction (in the axial direction of pulley shaft). Because the actual drive frame was softer (less stiff) than the finite element model, the actual natural frequency for this mode would be around 3 Hz. On the other hand, the rotational speed of the pulley was calculated as around 1.5 Hz. The excitation frequency caused by misalignment was two times the rotational speed, equivalent to around 3 Hz. This excitation acted in the same direction as the first mode — in the transversal direction, the axial direction of pulley shaft. This resonance was the reason for high vibration.

To solve the problem, the drive frame was stiffened to make the natural frequency more than five times higher than the excitation frequency. This required a very strong bracing configuration in the transversal direction (in the axial direction of pulley shaft) to elevate the first modal frequency to the targeted level.

The original design of the frame offered very little stiffness in the transversal direction because it was believed that the main loading was in the longitudinal direction. This was proved wrong.

One or two ordinary transversal braces or supports wouldn't suffice. The fix required four strong box-type transversal supports, two at the top and two at the middle. Each was fabricated from 16-mm plate, placed inside an existing I-beam column and then fully welded all around. This solved the problem and eliminated the resonance and high vibration.

250-MW high-speed machinery package. This unit was mounted on a massive reinforced-concrete foundation supported on 15-m concrete piles that extend down to bedrock. The total weight of the machinery and foundation is around 2,000 tons. To satisfy operational and seismic requirements, a modal test and finite element analysis was carried out to obtain the natural frequencies and mode shapes of the machinery unit. Some assessments showed that the concrete columns were elastic for 5 m under the concrete floor and were assumed rigidly secured below this depth. Tests and calculations identified 20 modes between 3.8 Hz (fundamental, longitudinal–horizontal [x] direction) and 230 Hz (complex platform bending torsion). The first mode was 3.8-Hz, translational [x], in-phase, rigid platform. The second mode was 4.1-Hz, y-lateral, in-phase, rigid platform. The third mode was 5.1-Hz, y torsional, platform warping. The fourth mode was 9.5-Hz, y-lateral, platform bending. Higher modes showed further platform warping and column-versus-column bending. First operational excitations were considered; it was confirmed there was no resonance. Because this is a high-speed unit, the machinery's contribution should be minor below 25 Hz, at which frequency any excessive rotating unbalance may couple with mode 7.

For seismic considerations, a considerable amount of the excitation energy is in the 1–10-Hz frequency range. The most significant vibration responses are expected to occur in modes 1 and 2, because these modes most readily can couple with the strongest earthquake spectral components in the 1.5–6-Hz domain (which is the major excitation frequency range of historical earthquake data for the region). Above 7 Hz, the earthquake excitation strength is less, and the modal forms also are less likely to couple with the ground motions. For instance, column-versus-column modes are improbable with ground vibration as are platform warping and vertical modes. Further simulations for this structure showed that stresses and deformations as the result of an assumed "0.25×g" seismic load are below the allowable limits. ●

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Are You Adequately Testing Automated Valves?

Updated technical report provides important insights about partial stroke testing

By Stan Hale, consultant, Loyd Hilliard, Puffer-Sweiven, and Vince Mezzano, Fluor Corp.

THE INTERNATIONAL Society of Automation (ISA) working group responsible for ISA TR 96.05.01 2008 edition on partial stroke testing of automated valves published an update to the original technical report (TR) in late 2017. This latest edition resulted from a lengthy process that included input from end users, valve and actuator original equipment manufacturers, process safety engineers, valve maintenance providers, engineering service companies and consultants. Feedback from end users around the industry has been positive.

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Although not containing mandatory requirements, the updated TR is very informative and a must-read for engineers responsible for automated-valve test programs.

The update introduces concepts that were not widely deployed when the 2008 version was issued. These reflect the evolution of more stringent process safety standards and effective proof-testing schemes for critical automated valves, testing and analysis methods. Experience gained from initial partial stroke testing (PST) implementations and automated online valve testing programs revealed key concepts that should be factored into PST and other valve proof-testing programs designed to support process safety objectives.

The most important addition is the concept of margin. Margin is a term familiar to valve and actuator manufacturers as well as valve test engineers; it is a critical performance parameter when assessing any valve's ability to perform as designed. Simply put, margin is the difference between the force that must be exerted to move the valve closure member to its required position and the capacity of the installed actuator to provide the force needed to make that happen, i.e., capacity – requirement = margin.

The concept of margin is similar to the concept of safety factor that often is specified for new automated valves. However, safety factor is the design objective while margin is the actual result. Theoretically, margin should equal safety factor when the automated valve is brand new. After some time in service, the expected degradation mechanisms, which provided the basis for the target safety factor, will start to affect valve performance and margin will decrease.

An automated valve normally will be considered capable of performing its intended function as long as margin remains equal to or greater than zero. Both actuator capacity and valve operating requirements change due to service conditions and, as a consequence, functional margin degrades. Therefore, PST and other proof-test approaches for demonstrating that automated valves remain capable of performing critical functions on the next cycle or at some point in the future must be capable of assessing the margin condition.

FOUR APPROACHES

Operating companies routinely conduct periodic tests to ensure automated valves will perform when needed. The 96.05 working group identified four different measurement, analysis and acceptance criteria approaches now used in the industry during partial stroke testing and designed a process to help end users determine the level of proof-test coverage provided by each.

The four test and evaluations levels are:

Level 1 — partial-stroke test without instrumentation;

Level 2 — partial-stroke test with event timing;

Level 3 — partial- and full-stroke test with actuator-based instrumentation (e.g., control signal, pressure and position feedback); and

Level 4 — partial- and full-stroke test with an external condition monitoring system, including Level 3 parameters and incorporating process system and valve-based measurements (e.g., torque/thrust and acoustic leak detection).

The analyses conducted during development of the 2017 update revealed that proof-test coverage increases significantly with each higher level of implementation. The discussions that led to the current update indicated that Level 1 likely is the most widely used automated-valve testing approach. However, it is the least effective. During a Level 1 test, the valve simply is cycled some partial stroke distance; the only measurement recorded is whether the valve moved. Various papers, technical reports and input from subcommittee participants demonstrate Level 1 implementations provide the lowest level of proof-test coverage.

A Level 2 approach uses instrumentation to measure the time required for the valve to travel between two known positions. With all things kept constant (e.g., system pressure, actuator pressure, solenoid response, etc.), changes in the time required for the valve to travel a known distance and return can serve to detect changes in margin. This additional information increases the test coverage by revealing certain margin-related degradations. It is important to note that the end user must develop meaningful acceptance criteria for changes in cycle time to ensure this approach is as effective as possible.

A Level 3 approach is a built-in feature of certain valve controllers (e.g., position transmitters and positioners). The end user looks for changes in the relationship between control signal, pressure and position supplied by the actuator instrumentation to assess altered performance indicative of margin degradation. A Level 3 approach is straightforward for double-acting actuation but subject to additional uncertainties for single-acting, spring-return actuation. The extra uncertainty stems from the actuator spring providing the closing force and not a measurable pressure.

Level 4 incorporates sensors and data acquisition devices that are installed on the valve and actuator but kept separate from the control system. This often includes torque or thrust gauges, pressure transducers, position transmitters and acoustic devices to detect leakage or flow when the valve is closed. A Level 4 approach, although more costly than the others, delivers the highest level of proof-test coverage, lowest probability of failure on demand (PFD) and makes safety targets easier to obtain.

TYPES OF FAILURES

The working group also identified 48 different categories of causes of automated-valve failure and force-ranked the list to identify which ones occur most often and which PST implementation level can effectively detect each. Guidance contained in the new TR recommends that end users perform a similar analysis and employ either statistical data or an expert panel process to identify and rank the causes of valve failures at their facilities.

The forced ranking also was used to identify which degradations or causes of failure were most likely, less likely and least likely to occur. The working group developed rudimentary statistical classifications to set the three categories. Five categories of failure, as shown in Figure 1, were estimated to cause failure 68% of the time. The next 20 degradation categories are expected to cause failure 27% of the time with the last 23 degradations only contributing to failure 5% of the time. Consequently, any proof-test approach expected

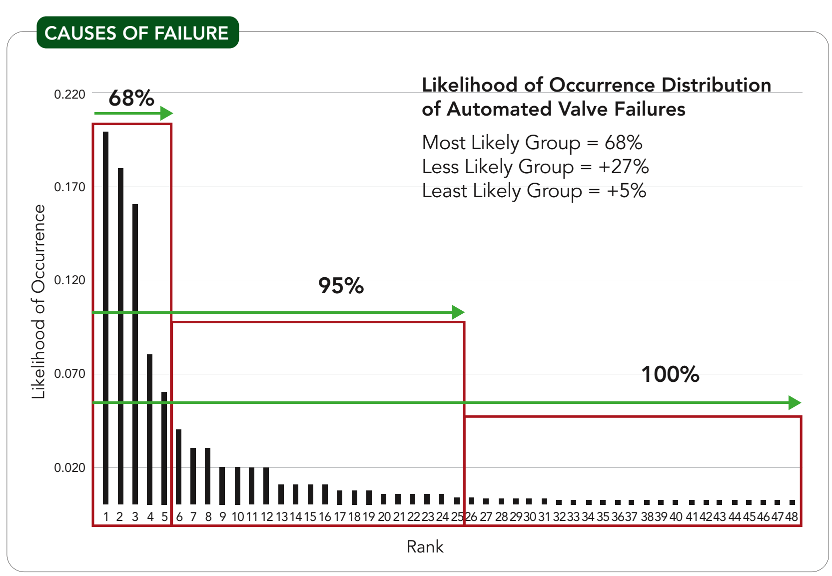

Figure 1. Five categories of causes should account for more than two-thirds of failures.

to achieve 95% coverage must detect all causes of failure listed in the most likely and less likely groups.

Table 1 provides more details on the five most likely causes of failure. Based on the experience of the working group participants and those surveyed, the most likely cause of automated valve failure actually does not involve the valve or actuator. Instead, failure of solenoids, pilots and other control components lead to more failures than any of the other causes. Issues with control components are expected to cause failure 20% of the time and result in various failure modes including loss of functional margin (LFM), slow to open (STO) and slow to close (STC). Functional margin is affected when less than adequate pressure is available to the actuator for generating the force required to reposition the valve. LFM failures are typically hidden unless detailed measurements are made during the proof-testing process. While automated valves will change position and appear operable during cycle tests under zero- or low-pressure conditions, they may not fully close under more-challenging conditions present when the automated valve must operate during an emergency or upset producing a more-taxing process environment. This deficiency remains hidden when the test approach is not capable of assessing margin.

The second most likely degradation simply increases the torque required to reposition the valve. Hydrocarbon byproducts, debris or other contaminants that collect on the valve obturator or seat can cause this. In extreme cases, manufacturing tolerances combined with minor damage or hydrocarbon deposits raise loads beyond the actuator capability and the automated valve appears stuck. However, the most likely effect is higher than originally assumed torque loads. In those cases, the actuator will reposition the valve under zero or low operating pressures but not have the margin needed to reposition the valve under worst case or process upset conditions; this normally remains a hidden failure unless Level 3 or 4 measurements are used to quantify margin changes.

The third most likely cause of automated valve failure is degradation of pressure sealing components within the actuator. When the actuator is new, the internal piston surfaces that react to pressure and create the force needed to reposition the valve can rely on the full pressure assumed in the sizing calculations. When seal degradation or failure reduces the pressure available, the actuator cannot generate the force assumed in the sizing process. Pressure versus position or pressure versus torque measurements available from Level 3 and 4 approaches are needed to identify this normally hidden failure.

The fourth most likely degradation and cause of failure often is a progression of the second culprit. As the debris or buildup on the seat continues to increase, the seat eventually is lifted or deformed in such a way that the valve leaks when closed. This particular degradation requires the valve to be closed and, thus, is not detected by PST. Even when the valve is closed under pressure, leakage can remain hidden unless sensors or test methods capable of identifying and quantifying leakage are used.

The fifth most likely degradation is when the valve will not move and appears stuck. All test levels can identify a failure to open (FTO) or failure to close (FTC).

It is important to note that the four most likely degradations expected to be the cause of failure 62% of the time cannot be detected by the most common Level 1 PST approach.

Automated valves used in safety instrumented systems require periodic proof-testing to ensure the necessary safety integrity level (SIL) is maintained. Two key variables in establishing the SIL for valves used in safety systems are proof-test coverage (sometimes referred to as diagnostic coverage) and probability of failure on demand. Each progressively higher test level discussed above provides an increasing degree of diagnostic coverage that makes SIL objectives easier to obtain — provided the end user employs the data and responds when the data indicate risk of failure is increasing.

HOW GOOD IS YOUR TESTING?

It is critically important that end users understand how their selected test strategy identifies and quantifies the degradations known to cause failure of automated valves. The ISA TR 96.05.01 2017 update provides an example of the process end users should employ to determine what level of coverage to expect based on the practices and experience of each facility or operating company.

MOST LIKELY CAUSES

	Known Degradations/Root Causes	Typical Effect	Failure Mode	Detection Method (Test Level 1–4)	Likelihood of Occurrence
1	Partial or intermittent sticking of hydraulic or pneumatic system components such as solenoids, pilots, speed controller, etc., due to moisture, debris or alignment	Reduced capacity to perform — loss of functional margin	LFM, STO, STC	2–4	0.200
2	Binding, galling or other degradation of valve seats or related flow control trim that only restricts or resists valve movement	Increased operating loads beyond assumed safety factor — loss of functional margin	LFM, STO, STC	4	0.180
3	Actuator seal degradation caused by compression, wear or looseness that reduces the pressure available to actuate the valve	Reduced capacity to perform — loss of functional margin	LFM, STO, STC	3–4	0.160
4	Minor damage to the valve obturator plug, disk or ball caused by system conditions, leakage or debris including buildup of hydrocarbon products	Process media leak (L) or passing (P) through damaged or broken component	L/P	4 or leak rate test (not detected by PST)	0.080
5	Complete failure of control system components such as solenoids, pilots, speed controller, etc., due to moisture, debris or alignment	Completely failed or otherwise unable to supply pressure and position or move the valve	FTO, FTC	1–4	0.060

Table 1. Only Level 4 testing can detect all these causes.

After lengthy deliberation and analysis, the working group participants concluded that performance measurements are essential during PST execution to make the test meaningful and provide the information on valve operability needed to properly support safety objectives. The working group remains active and plans to continue improving guidance on automated valve testing as new data, experience or know-how emerge. Most recently, the working group has refocused its efforts on in situ proof-testing of automated valves in general. Using the PST guidance as a starting point, the working group is expanding the concepts to applications where PST is not available or the end user has elected to rely on full cycle testing. ●

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Accurately Measure Interfaces Between Immiscible Liquids

Understand the factors involved in selecting the right level instrument

By Lydia Miller, Emerson Automation Solutions

VARIOUS LIQUID products, for reasons of molecule polarity or differences in specific gravity, resist mixing and, if left alone, separate into distinct layers. Many plants deal with such liquids and must track the amounts of specific phases in tanks and vessels and, perhaps, even flowing through a pipe. So, here, we will look at level instrumentation suitable for this task. We will use oil and water as an example but the principles of oil/water interface measurement apply to a wide range of multi-phase processes.

Often, a plant desires distinct phases either to ease recovery of product or removal of impurities and, so, includes a separator or other equipment to spur the splitting of components. Sometimes, just determining which material is at a given level suffices. In other cases, knowing the location of the interface between the phases is important.

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SIMPLE SITUATION

Let's first consider when a plant only needs to ascertain what's at a given level. In such a case, it's usually important to have a sensor that's immersible and can measure in real time without the need to withdraw a sample.

Various detection technologies could do the job but one of the most economical and practical is a vibrating-fork level switch. It typically determines if the contents of a tank or vessel have reached or passed the instrument's sensor insertion point. A fork extends into the space; a piezo-electric crystal causes the

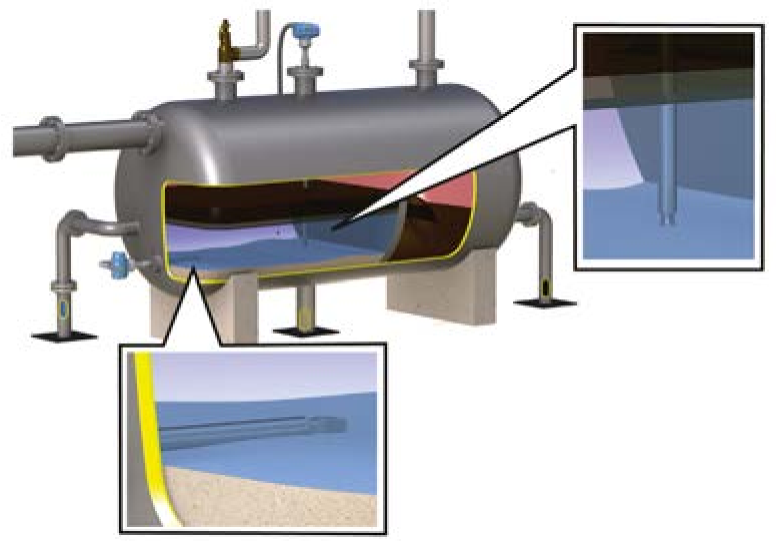

Figure 1. These can indicate if oil and water are at appropriate levels and if accumulated sand is taking up useful space.

Figure 2. When emptying a tank filled with multiple liquids, knowing the interface level is necessary to avoid cross contamination.

fork to vibrate at a specific frequency when in free air. When immersed in another medium, the frequency changes, which the instrument's electronics detect. In many situations, just indicating when the fork is immersed is enough. However, some more-sophisticated devices can characterize what the fork is immersed in by the degree of change in frequency. This is because the sensor behaves differently when immersed, e.g., in water versus oil; so, it can indicate if it's above or below the water/oil interface point.

You can use this capability in a variety of ways. Inserting multiple vibrating-fork level switches into a separator (Figure 1) in strategic positions can check that the oil and water levels are both where they belong. They also can determine where the water/oil interface point is and where it might be moving during filling or emptying sequences. In addition, a switch inserted into a pipe can indicate which liquid is flowing through at a given time; this, for instance, can help alert when all the water has been pumped out of a storage tank.

Yet, as versatile as it is, a vibrating-fork level switch only can signal whether it's immersed and in what (if the possible liquid characteristics differ sufficiently). Such a point level device can't indicate if it is deeply immersed or just below the surface.

MULTIPLE LEVELS

Some applications require a continuous reading of the liquid level in a tank containing multiple products that separate into layers (Figure 2). Level switches can do part of the job, as just discussed, but the distance between the switches restricts measurement resolution. So, a plant should consider other options. The three main choices capable of measuring overall level as well as the interface below the surface are: magnetostrictive, guided-wave radar (GWR) and differential pressure (DP).

Magnetostrictive and GWR are somewhat similar in approach in that they both send an electronic pulse down a probe and calculate level based on the time of flight to the liquid surfaces and back. With a magnetostrictive instrument, the pulse is reflected by a float that is free to move up and down the probe, buoyed by the liquid to follow any change in its level. Floats come in different buoyancies and are chosen based on the specific density of the liquid. So, to locate a water/oil interface, the lower float is carefully tuned to float in water, whereas the upper float has greater buoyancy to float on top of the oil.

GWR also sends a pulse down a probe but doesn't use a float. The pulse is reflected directly off the surface of the liquids (Figure 3) — the main reflection from the top and a secondary reflection from the interface layer. This works provided the liquid on top has a lower dielectric constant (DK) or relative permittivity than the liquid underneath. GWR suits sensing oil on water

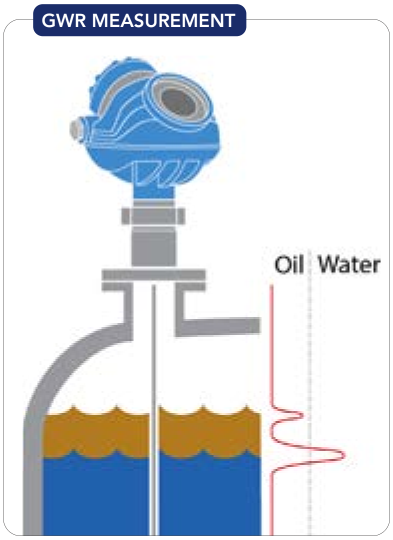

Figure 3. Pulse creates echoes both from the surface and the interface point.

well because most oil products have a very low DK, <5 typically, while water's is >50.

DP measurements operate differently. They use the pressure produced by the height of the two liquids to determine the level and interface of the liquids. Making this work for an interface requires precise knowledge of the density of both liquids and, potentially, an additional overall level measurement. DP level measurements can run into difficulties with emulsion layers or varying densities.

Magnetostrictive level instruments very accurately can measure the location of the float. However, that location isn't always where it might be expected. The float comes to rest where it's designed to float, so a change in the density of the liquid will change its final position. Additionally, situations can arise where residues coat the probe and floats, so they get partially or completely stuck in place, not moving freely or even at all in the worst cases. Obviously, this significantly undermines the accuracy of the measurement. Unfortunately, an operator may not be able to tell what's happening beyond realizing the readings are not changing. A more insidious problem is a loss of accuracy if the float can move partially but drags, reducing its ability to find the true level point. This condition isn't easy to recognize from the readings.

A GWR probe can tolerate some amount of buildup; so, in general, cleaning is unnecessary. Moreover, the instrument can indicate a developing problem of excessive buildup because the nature of the echo created by a dirty probe (Figure 4) differs from that of a clean probe. Some instruments with advanced diagnostics can quantify signal quality and send it as a secondary variable. Should signal quality ever drop below a critical level, an alert can warn operators of the problem so they can take appropriate action.

INDISTINCT LAYERS

One area where both GWR and magnetostrictive technologies struggle is emulsification of a tank's contents. In some situations, the two products will separate partially but not sufficiently to create a distinct interface. An emulsion layer, where the two products remain mixed, forms in the middle; both magnetostrictive and GWR technologies will give misleading readings — but in different ways (Figure 5).

With a magnetostrictive instrument, whether or not a distinct

Figure 4. Buildup on a GWR probe eventually changes the profile of the echo in recognizable ways so operators become aware of the problem.

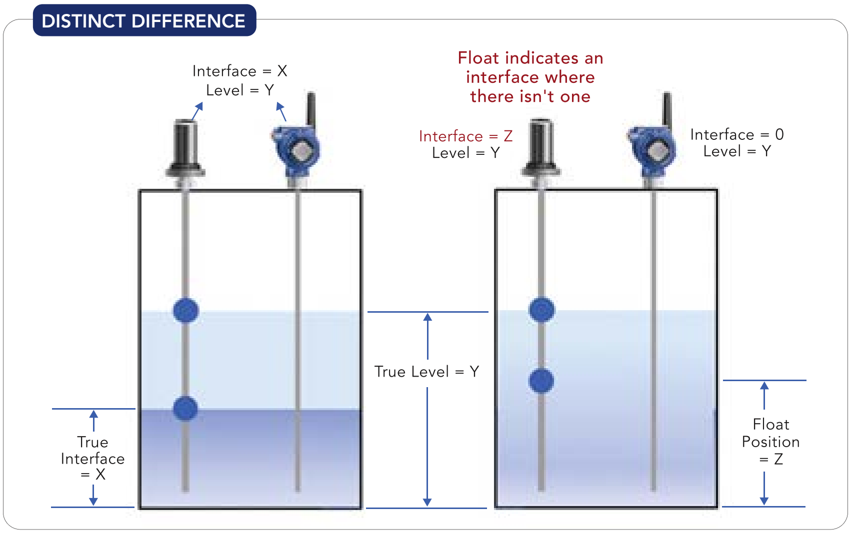

Figure 5. Magnetostrictive and GWR instruments respond differently to indistinct layers.

interface exists, the lower float will come to rest where the density matches the float's buoyancy. With an emulsion layer, the float will stay somewhere in the midst of the emulsion. So, if operators are unaware of the emulsion layer, they might assume all liquid above the float is oil and below is water. Using the float location to pull oil from the top likely will lead to getting some water, too. A DP measurement similarly depends on the densities of the liquids and also will give a measurement in the midst of an emulsion layer. However, you can recalibrate DP level readings for density changes. You can't adjust the magnetostrictive float design.

GWR has the opposite problem. It requires a fairly distinct interface point. This has to do with the way GWR detects a surface. When the pulse is moving down the probe, it sends an echo not due to hitting a liquid surface but because the surface represents a point with an immediate and drastic change in DK between air and the oil. The water/oil interface also must exhibit an immediate and drastic change in DK, as occurs between oil and water assuming a defined transition. Recently developed GWR transmitters can differentiate emulsion layers of about 50 mm. However, thicker emulsified bands aren't always distinct enough and generate no second echo or one too undefined to be useful. As a result, the GWR instrument reports no interface.

In applications with emulsions, it helps to install a GWR instrument in a calm area of the vessel where the layers have the best chance to separate and, so, enable a better interface measurement. The use of a large coaxial probe or a stilling well can foster better product separation and, therefore, more accurate level measurements. However, a poorly designed stilling well can interfere with the separation and create an inaccurate picture of the interface point. If the holes or slots are too far apart, the interface inside might not match the rest of the contents. Slots must overlap to allow full circulation of the liquids.

Which of these measurement problems is more tolerable depends on the situation. Having some idea that there is an interface, whether distinct or not, might suffice in some cases. On the other hand, having the interface measurement fade to nothing might warn operators about a process upset or that an upstream separator is being run too hard.

THIN LAYERS

So far we've covered situations in which the two layers are both fairly thick. However, sometimes the secondary component only forms a thin layer. This poses difficulties for both magnetostrictive and GWR technologies.

For magnetostrictive instruments, the floats create limitations due to their physical size. If the layer is thin-

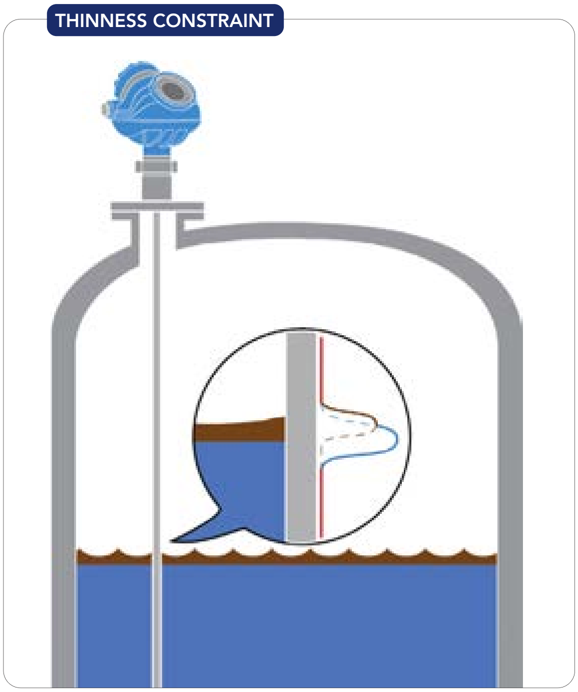

Figure 6. Measuring thin layers depends on an instrument's ability to separate close echoes.

ner than the floats are long, they will touch each other on the probe. Even GWR instruments have minimum thickness requirements due to limitations on the ability to separate return echoes (Figure 6). Typical minimums for GWR vary between 125 to 200 mm depending on the specific make and model. Magnetostrictive instrument minimums generally are greater and depend on the particular instrument type and float size.

Newer, highly sophisticated GWR instrument technologies have improved the ability to resolve very short pulse-duration differences, allowing some of the latest models to measure well-defined thin interfaces down to 25 mm. This significant improvement results from improved software able to detect signal peaks that are closer together without having to decrease signal bandwidth.

The tools available to chemical makers working with immiscible products are improving. The ability to identify which product is flowing through a pipe or to accurately determine the contents of a tank with thick or thin layers can improve process control and possibly identify when something has gone wrong, allowing for timely corrective action. Such measurements can enable a plant to optimize processes and maximize operational efficiency and profitability. ●

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Quash Commissioning Quandaries

Problems in testing a tank underscore larger issues

THIS MONTH'S PUZZLER

Steam was used to sterilize and then pressure test a new 12-ft-dia. storage tank for our reactor train. Unfortunately, the tank shell ruptured. It was rated for 45 psig, not vacuum. It didn't have a U stamp; our project engineering group decided not to spend the $3,500 required. The old tank is in the bone yard. There isn't anything wrong with it, except that is about 25% too small and was de-rated to 20 psig; in fact, its R stamp is current and it's rated for full vacuum.

There were a few things I observed after investigating for a day: 1) maintenance staff conducted the work because the people in operations were tied up in re-training during the downtime (the week between Christmas and New Year's); the instrument tech and the youngest mechanic on our crew admitted they'd never done this type of work before; 2) the project engineer was busy on other projects while the superintendent was away on vacation and out of touch; 3) the top manway cover that was supposed to be closed during the pressure test but open during the steam sterilization was bolted tightly (sterilization follows pressure testing); 4) a ½-in. flange on a gasketed vent line was loosened to act as a vent during sterilization — the crew was given this advice over the phone by a production foreman taking a break from skiing; and 5) a fire hose was used to fill the tank for the pressure test, which seems extreme to me.

What can we do to avoid this problem in the future? What can be done now to get us up and operating?

REVAMP COMMISSIONING

The troubleshooting request fails to mention the pressure/vacuum relief system configuration and the vessel vacuum rating, nor specify explicitly whether this is an over-pressure rupture or a tear from vacuum collapse. The problem statement implies it could have been either. Regardless, formal constraints for under- and over-pressure are needed during the commissioning/startup phase. In other words, the steam supply crosstie to the vessel and the method to limit flow/pressure would be established by engineering calculation and the connections, depressurization, padding and vents sized and specified in the commissioning/startup procedures, so that the relief system is not overwhelmed, unsafe conditions are prevented and commissioning steps are of an acceptable duration. Even if not required by process safety management, consider a rigorous safety review (process hazard analysis) of the commissioning procedures following a standard methodology.

Having a code stamp is no guarantee that the vessel or relief was properly specified for the commissioning conditions. The code stamp itself in a non-code state would only be a validation of quality for the specified construction. So far as the information available, one cannot say whether fabrication itself was at fault or not. One might require including commissioning conditions on the vessel specification sheets issued for bid/fabrication, so that the vessel and/or relief are appropriately designed. As a side note, although the pressure vessel is rated for 45 psig, it is unlikely to withstand vacuum at a 12-ft diameter unless explicitly designed for vacuum. (Liquid drainage and steam collapse are well known to generate vacuum and should have been included in the relief scenario evaluation if not a full vacuum-rated vessel.)

Restarting with the old vessel may be feasible but all the same issues are present and must be addressed, unless the derating calculations confirmed it still has a full vacuum rating.

Gary Holleran,
senior process engineer (retired)
BASF, Beaumont, Texas

FIRE THE CEO!

I couldn't believe what I was reading in the Puzzler. This company needs psychological help and is a disgrace to the chemical industry and chemical engineering profession.

I can bet you that even a ten-year old would fire the chief executive officer of this company. I am being honest — the company needs an honest opinion; they are jeopardizing lives.

Girish Malhotra, president
EPCOT International,
Pepper Pike, Ohio

TACKLE SEVERAL ISSUES

One of the chronic problems companies face is keeping personnel up-to-date and happy. The mistake here can't really be blamed on two people caught holding the dirty end of the st ick. Nor can it be blamed on the foreman: people need vacations. When I took an informal poll of about ten production engineers, none would recommend production work to their children — regardless of what it paid.

No, the blame lies with the planner. It's a tough job because the planner has to be ready to substitute qualified people in case someone is sick. Some blame goes to the project engineer for not being present, given the limited skill of the instrument tech and young mechanic — knowing your people is part of good leadership. However, it may be that the project engineer didn't know any better either. Other people who should be in line for a chewing-out include the safety manager, the superintendent, perhaps the trainer and probably the maintenance manager.

The post-mortem review of this accident should include an analysis of training needs. Everyone onsite who might be called out to do a pressure test should know how to do one. Don't forget the managers; they should be able to teach the class in their sleep.

So, what went wrong? Steam condensed, causing a vacuum in a vessel that wasn't rated for full vacuum or there was a mistake in the vessel design; that's one reason why you pay for the U stamp. Somehow the directions were mixed up so that steam was used for the pressure test and the sterilization. The manway should have been open for the sterilization to prevent condensing steam from collapsing the vessel. The underlying problem is that the mechanic, the instrument tech and the foreman on the phone apparently didn't understand what happens when steam condenses.

As for using a fire hose to fill the tank for a pressure test, that seems fine to me. I've seen it before. Filling it and then pumping it up to 1.3 times the rated pressure, 58.5 psig, (changed from 1.5 as of ASME 2010) with a pump is a common method. Why wasn't this done? Perhaps because it seemed easier and faster to use steam for the test and for sterilizing the tank while still closed. This an improper approach for sterilization because you want the steam to provide a steady heat flux at an autoclave temperature. Condensing steam doesn't do that.

What can be done now to get the plant up and operating? Well, the obvious pathway is to re-use the old vessel in your boneyard. You have two questions for operations management:

1) Can they live with 20 psig?

2) Can they work with a tank that is 20% too small?

Note that 20 psig limits the operating pressure to only 16 psig unless relief valves with seals are used, then 18 psig is allowed.

The other questions are for the project team. Will removing the tank and re-installing it de-rate its pressure rating further? How much damage was done to the tank while removing it? And how much will it cost to repair that? How will the piping mate-up against the old tank? Piping often is changed — re-routed or re-sized. And, lastly, how much will all this cost? It may take one-to-three months to repair the tank and another month to re-install it. Or it may be possible to repair the tank in-place, depending on how this affects the plant operation; this usually isn't a good option if it requires a shutdown. Lastly, explore other ways to increase capacity while keeping the old tank for a year or so. Perhaps reactor optimization is possible but hasn't been assessed because installing the new tank was easier and took less engineering time.

Dirk Willard, consultant
Wooster, Ohio

Process Puzzler continues on p. 37.

Don't Slip Up with Slipstream Filtration

The optimum configuration depends on a couple of key factors

As the slipstream fraction goes up, the best choice changes.

CONTAMINATED HOT oil had so undermined the performance of a vaporizer that it no longer could provide the required duty. The contamination, which had occurred over time, had led to fouling of the heat exchanger and fired heater. Adding a filter for the hot oil clearly was necessary. Configuring the filtration system brought up an interesting question, one worth exploring here.

Best practice for most hot oil systems is to use a partial flow filter to keep the hot oil clean. The filter treats a slipstream of hot oil. This reduces the filter size (and cost) while keeping the oil clean enough for reliable performance.

Figure 1 shows a simple hot oil system with two possible slipstream systems: a more-flow (MF) configuration (left) and a more-head (MH) configuration (right). Figure 1 focuses on the slipstream. The main circulating flow to supply oil to the thermal load has its own independent flow control system (not shown).

For the MF configuration, the slipstream goes from the pump discharge to the pump suction. As long as the circulating loop has a higher pressure drop than the filter, the only effect on the pump is a required higher flow rate. The discharge pressure of the pump can remain the same. In this system, the pressure drop in the main circulating loop sets the maximum available pressure drop for the filter. The hydraulics of the main loop potentially limit filter sizing and life.

For the MH configuration, the slipstream splits from the pump suction, goes through the filter and then returns to the main flow. The pump capacity needed doesn't change but the pump discharge pressure must increase by the pressure drop through the filter.

TWO CONFIGURATIONS

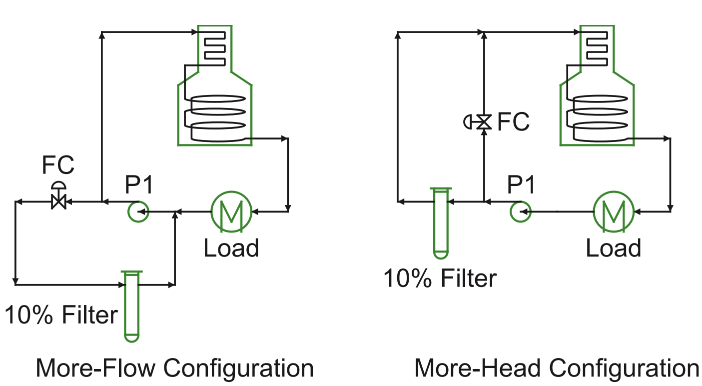

Figure 1. The same size slipstream doesn't mean the same size power demand.

Which system is better? To answer this, we focus on the pump power, P. The hydraulic power required is linearly proportional to both the mass flow through the pump, M, and the pressure rise over the pump, ΔPr: $P \propto M \Delta Pr$.

For a new unit where you have full ability to select an ideal pump, the analysis is straightforward.

To add detail to the example, let's propose a reasonable pressure drop of 12 psi across the filter element to control filter operating costs and a pressure drop of 80 psi across the main loop in the hot oil system. The slipstream rate is 10% of the total flow required to deliver the heat load.

Using the MF system, the pump discharge pressure stays the same and the flow rate rises by 10%. The pump power goes up by 10%.

With the MH system, the total pressure drop increases to 92 psi from 80 psi. This is a 15% boost in discharge head. The pump flow rate stays the same but the pump power rises by 15%.

Most hot oil systems follow this pattern. The percent change in pressure drop required for a reasonable filter element life will exceed the percent change in flow. This is because most hot oil systems have relatively low slipstream rates and filter applications generally need relatively high pressure drops.

As the slipstream fraction goes up, the advantage shifts from the MF to the MH option in new systems. To go back to the example, shifting to a 30% slipstream rate increases the power demand of MF to +30% while MH's remains +15%.

For adding a slipstream filter to an existing system, the choice depends upon the overall system hydraulics and configuration. In some systems, neither option will fit within existing equipment constraints.

Two other options, suitable particularly for larger systems and existing systems with constraints, are booster pumps and two-stage pumps.

If the system is large enough, a booster pump for the slipstream going to the filter may make sense. It minimizes energy consumption but incurs extra capital expense for the additional equipment and controls. Existing systems with significant hydraulic constraints may require a booster pump.

Some applications can benefit from installing a pump that discharges flow at multiple pressure levels. One example uses an API pump with a modified shaft and back head and a drilled-hole impeller second stage for the slipstream flow. In many ways, this is the ideal choice because it doesn't require extra flow and only the flow going through the filter is at a higher discharge pressure. However, industry is far less familiar with this option; so, it has seen very limited adoption despite its benefits.

You always should carefully check the hydraulics of systems with slipstream filters before arbitrarily selecting a flow configuration. The best choice for an application will vary with system hydraulics and the size of the slipstream.

ANDREW SLOLEY, Contributing Editor
ASloley@putman.net

JUNE'S PUZZLER

I am a new graduate now working as a production engineer at an extrusion plastic manufacturer and would like to make a good start. I manage a process to produce paint pigments and would welcome some tips on optimizing the operation (Figure 1).

From what I've gathered in a few weeks, we have bouts of clogging in the paint spray nozzles at the extruder. We also see far more fines in the screen than corporate engineering considers appropriate. We change bags every couple of weeks, which seems too often; the bags are tossed in drums as toxic waste.

A FINE MESS

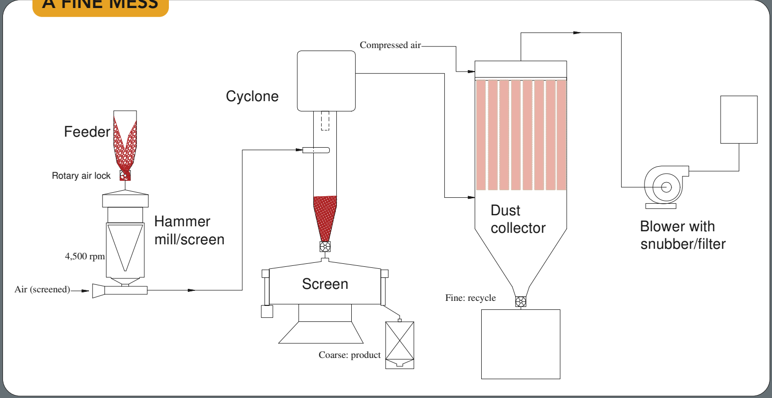

Figure 1. Clogging of nozzles as well as potential environmental issues cause concern.

Laboratory results show a lot of dust collected on the coarse product. Dust sometimes appears to get through the baghouse to the blower. I see dust on the duct connections to the blower and at the outlet to the atmosphere. One operator complained that dust clogs the product container nozzle of the grind collected at the screen.

I talked to several managers and engineers. The production manager said not to worry about it because the plant always has run this way. Someone in corporate engineering suggested digging through the files, hinting this wasn't the first design for the system. The plant safety manager isn't worried about the dust but the corporate manager is concerned because exposure to this pigment is a problem in Europe.

Can you suggest anything I should look at to reduce downtime and improve product quality?

Send us your comments, suggestions or solutions for this question by May 15, 2020. We'll include as many of them as possible in the June 2020 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, Schaumb urg, IL 60173. Fax: (630) 467-1120. Please include your name, title, location and company affiliation in the response.

And, of course, if you have a process problem you'd like to pose to our readers, send it along and we'll be pleased to consider it for publication.

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The Proline Promag W 300/400/500 electromagnetic flowmeters feature a "0 x DN full bore" option designed to address a close-knit pipeline network or obstacles in pipes. They can be installed in tight spaces, such as compact systems or skids, because they do not need any inlet or outlet runs. The devices measure with high accuracy (±0.5%), even directly downstream of pipe bends, T fittings or insertion devices. The flowmeters can handle swirls that frequently occur downstream of obstacles such as pipe bends and insertion devices, and even those downstream of unknown obstacles such as build-up on the pipe wall, protruding seals or different inside diameters.

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Software Helps Spot Process Issues

Micro Motion ProcessViz is standalone software for flow meter process data visualization. Instant visualization of raw process data can translate into direct actionable information, helping plant operators reduce the time needed to identify a problem in the flow process. This can potentially save a facility money by reducing the need for stoppages or shutdowns to trace the source of a problem. The software supports Micro Motion Coriolis transmitters with data historian output capabilities such as the 5700 and 4200 models and provides a snapshot of a moment in time in the flow process. The data are available in a usable format that allows the user to identify and analyze process issues.

Emerson
888-889-9170
www.Emerson.com/MicroMotion ProcessViz

Press Fittings Speed Pipe Installation

MegaPress G press fitting technology is now available for carbon steel pipe up to 4 in. The system allows secure press connections on 2½-, 3- and 4-in. pipe in 16 seconds or less. Constructed of carbon steel with a corrosion-resistant zinc nickel coating and graphite separator ring in larger sizes, the fittings are suitable for use with ASTM Schedule 5 to Schedule 40 carbon steel pipe. Using the system means no open flames, faster connections and labor savings, resulting in safer and more efficient projects. It reportedly can reduce labor costs by as much as 60% to 90% over traditional methods.

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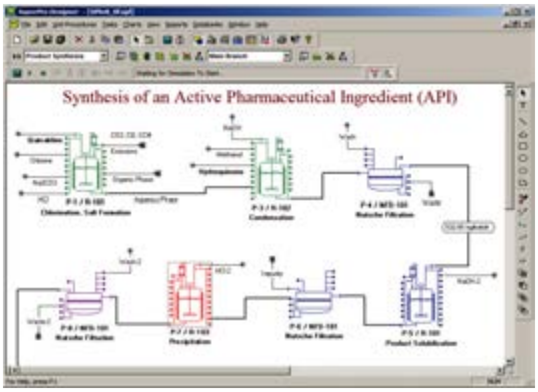
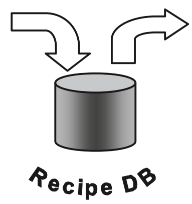
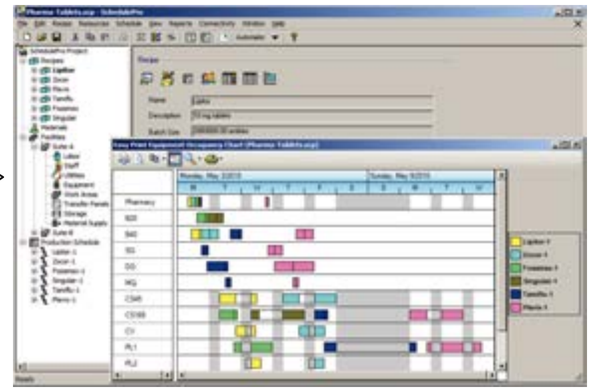


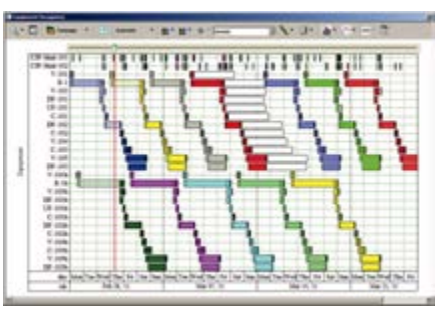
Use SuperPro Designer to model, evaluate, and optimize batch and continuous processes



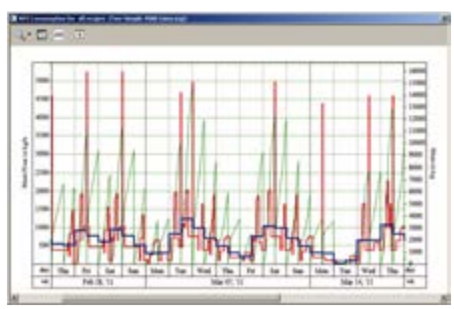
SchedulePro®



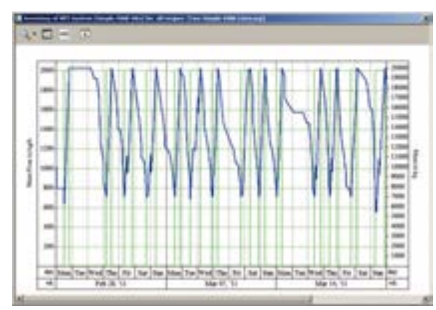
Migrate to SchedulePro to model, schedule, and debottleneck multi-product facilities



Easy production tracking, conflict resolution and rescheduling



Tracking demand for resources (e.g., labor, materials, utilities, etc.)



Managing inventories for input, intermediate, and output materials

SuperPro Designer is a comprehensive process simulator that facilitates modeling, cost analysis, debottlenecking, cycle time reduction, and environmental impact assessment of integrated biochemical, bio-fuel, fine chemical, pharmaceutical (bulk & fine), food, consumer product, mineral processing, water purification, wastewater treatment, and related processes. Its development was initiated at the Massachusetts Institute of Technology (MIT). SuperPro is already in use at more than 500 companies and 900 universities around the globe (including 18 of the top 20 pharmaceutical companies and 9 of the top 10 biopharmaceutical companies).

SchedulePro is a versatile production planning, scheduling, and resource management tool. It generates feasible production schedules for multi-product facilities that do not violate constraints related to the limited availability of equipment, labor, utilities, and inventories of materials. It can be used in conjunction with SuperPro (by importing its recipes) or independently (by creating recipes directly in SchedulePro). Any industry that manufactures multiple products by sharing production lines and resources can benefit from the use of SchedulePro. Engineering companies use it as a modeling tool to size shared utilities, determine equipment requirements, reduce cycle times, and debottleneck facilities.

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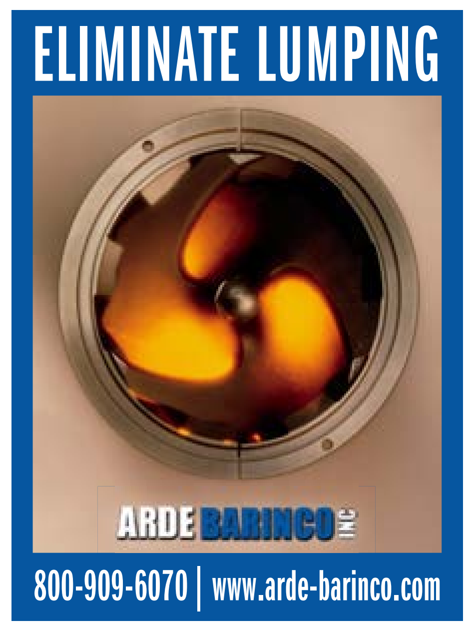

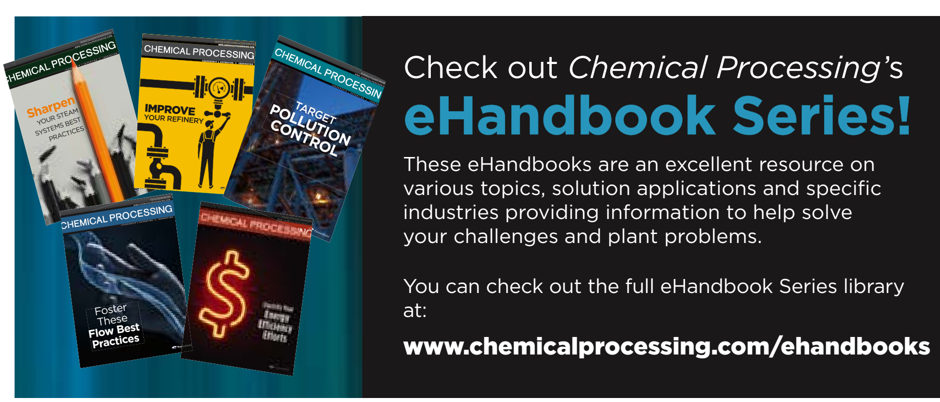

Researchers Target Aquatic Microplastics

Studies show exposure to the material poses risk for organisms and ecosystems

Results found that microplastics cause mortality.

EXPOSURE TO microplastics has dramatic effects on freshwater systems after just 15 days, say Spanish researchers. The stream ecology group at UPV/EHU-University of the Basque country, Bilbao, carried out the work in collaboration with the National Museum of Natural Sciences, Madrid, and reported their findings in a recent issue of *Environmental Pollution*.

"Concern about contamination caused by microplastics is growing. Owing to their abundance, ubiquity and persistence over time, microplastics pose a potential risk for organisms and ecosystems. Yet, studies into their distribution in freshwater systems, in both lakes and rivers, and their effects on the organisms in these waters are few and far between, and there is very little information about their potential effect on the functioning of these ecosystems," notes stream ecology group researcher Naiara López-Rojo.

Two parallel studies investigated how the larvae of one freshwater amphibian and one invertebrate evolved during 15 days of exposure to microplastics at different concentrations.

One looked at tadpole survival, food and growth as well as ingestion and egestion of the microplastics. This included analysis of whether the microplastics affect periphyton, the microscopic organisms that make up the main food supply of tadpoles.

The second focused on how microplastics affect the decomposition of leaf litter — one of the most important processes in river ecosystems — and on the detritivore invertebrates that live on it. This included analysis of the microplastics' degree of attachment to the leaf litter and degree of its ingestion and egestion of the detritivores — and so evaluating the trophic transfer mechanisms of the microplastics.

"The results found that microplastics cause mortality in detritivores in all concentrations and in the highest concentration mortality is nine times higher. In the case of tadpoles, they die in the highest concentration of microplastics. In other concentrations [low and medium] we did not see any lethality, but we did see a reduction in the growth of the amphibians," López-Rojo explains.

The presence of microplastics in the tadpoles, in their feces and in the periphyton suggests they could be significant stressors for amphibians, she adds. Also, amphibians could be an important transmission channel of freshwater microplastics to terrestrial ecosystems.

In the case of the invertebrates, the tests suggest microplastics were also ingested (very likely through the ingestion of particles attached to the leaf litter) and some of them excreted.

"The more the concentration of microplastics increased, the less the leaf litter decomposed. These results provide fresh evidence of the damaging effects of this contaminant on aquatic life and on the functioning of river ecosystems, and highlight the need to standardize the methods to be used in future experiments on microplastics to be able to draw comparisons," concludes López-Rojo.

Meanwhile, the European Commission is limiting the use of intentionally added microplastic particles in a variety of chemical substances over the potential impact of such particles on the marine environment.

In addition, the European Chemical Industry Council (CEFIC), Brussels, is running two projects designed to provide data for a robust risk assessment on microplastics' potential impact on the environment and to develop an appropriate way to deal with them.

The first, started in Q1 2019, runs for two years and has a budget of €200,000 ($225,000). It aims to better understand the characteristics, processes and environmental conditions associated with the fate and transport of microplastics to help determine appropriate environmental concentrations and put into context the relevance of hazards from these contaminants.

Additionally, it calls for developing a microplastic environmental fate and transport model that can facilitate risk assessment for different microplastic categories and inform safer chemical development and future sustainability efforts.

The second is a €400,000 ($450,000) three-year two-phase project also started in 2019. Phase one involves a comprehensive literature review to identify key ecological hazard research gaps and appropriate methods for conducting hazard tests to fill such gaps.

The review, currently underway, focuses on the applicability, adaptability and usage of existing toxicity testing methods for evaluating the hazards of solid polymer materials for representative test organisms such as fish, invertebrates, algae and others identified as potentially sensitive to these particles.

Building on this review, the second phase involves targeted ecological hazard research to evaluate how both intrinsic and extrinsic factors influence the effects of microplastics on sensitive environmental species. ●

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