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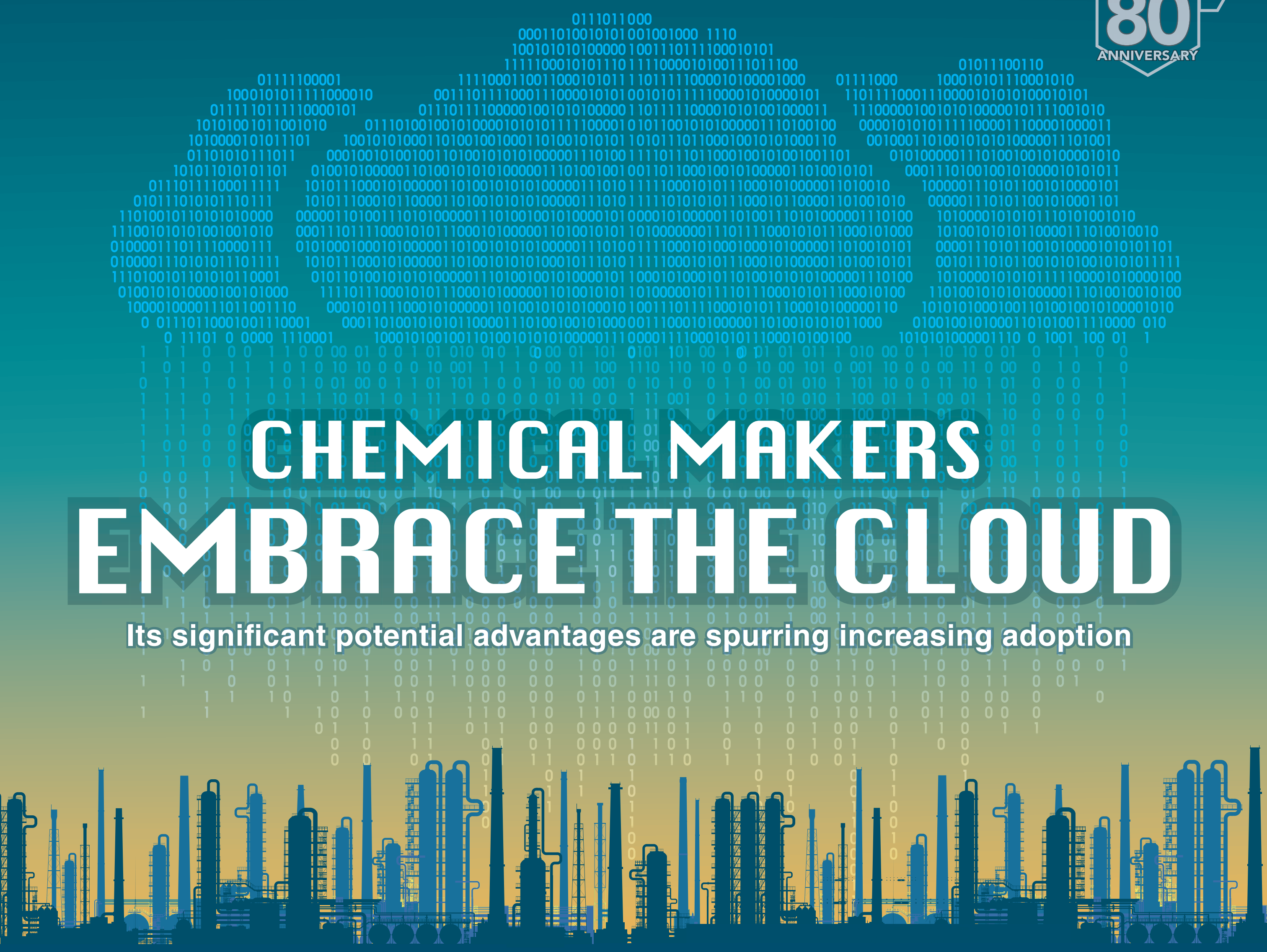

CHEMICAL MAKERS EMBRACE THE CLOUD

Its significant potential advantages are spurring increasing adoption

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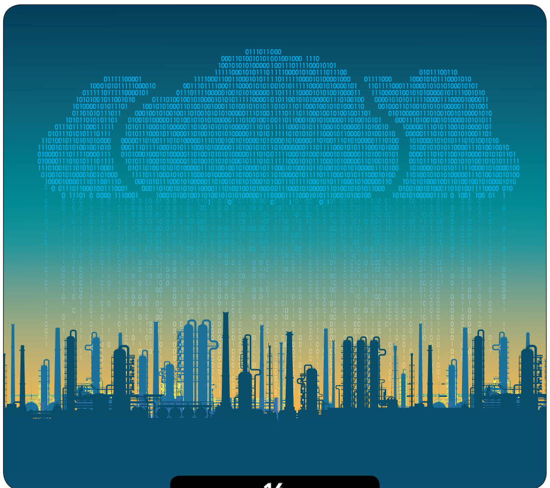

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Don't Be an IdIoT

Take a studied approach to best benefit from greater connectivity

Chemical companies are rethinking where data are stored and applications reside.

THE INDUSTRIAL Internet of Things (IIoT) is beginning to transform manufacturing. By connecting an ever-increasing number of assets, generating more and more-timely data, and enabling better analysis of these data, the IIoT promises abundant advantages. Even the inherently conservative chemical industry is starting to seize the opportunity afforded by the IIoT. However, properly leveraging the capabilities offered by the IIoT requires changing some of the traditional ways chemical companies have operated.

Indeed, as our recent article "Successfully Implement the Industrial Internet of Things," http://goo.gl/x8LLY3, points out, taking full advantage of the IIoT poses a variety of challenges to chemical makers. For instance, it requires breaking down the functional silos common at most companies. In addition, the breadth of opportunities posed by the IIoT can make deciding how best to justify and start implementing the IIoT complicated, if not confusing. That article suggests a distributed information system as an effective way to summarize the general requirements for individual applications and IIoT infrastructure.

The IIoT also is forcing chemical companies to rethink where data are stored and applications reside. Instead of relying on servers at the plant or elsewhere on a corporate network, some chemical firms are switching to Internet-based information storage and services, i.e., the "cloud." This month's cover story "Chemical Makers Embrace the Cloud," p. 16, http://goo.gl/SE16Ku, describes the successes achieved by Dow and BASF, among others, in using cloud-based storage and applications. The adoption of cloud-based applications can lower a company's costs for information technology as well as for software licenses, and also can provide an effective and quick way to ensure that all its units use the same software, stresses Lauren McCallum of SAP in that article. Chemical industry adoption of cloud-based applications falls in about the middle compared with other industries, she says.

As that article notes, ensuring security is crucial. BASF, for instance, puts any potential cloud provider through a detailed security assessment.

Other impediments at many chemical companies are the substantial investments in existing data collection and storage systems — and the massive effort required to move data to the cloud, explains Michael Risse of Seeq. However, it's not an "all or nothing" situation, he advises. For instance, the analytics software can reside on the cloud and use data kept at the plant.

Rest assured, *Chemical Processing*'s editors don't have their heads in the clouds regarding the IIOT's impact on the chemical industry. We're always looking for articles that provide practical guidance and insights about IIoT developments and trends. In addition, our "Automation Strategies" online blog, www.ChemicalProcessing.com/voices/online-only/, written by experts from the ARC Advisory Group, will continue to report on what's happening.

Attending relevant conferences is another way to keep track of IIoT developments and best practices. Events worth checking out include the ARC Industry Forum in Orlando, Fla., February 12–15, http://goo.gl/86Yx4n, and Smart Industry 2018 in Chicago, Sept. 24–28, www.smartindustry.com.

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Need Help? Ask The Experts

Tap the expertise of a roster of seasoned professionals

Our experts can help you address your technical issues.

CURIOSITY GOT the best of me and I decided to ask Google a few questions that readers recently posed to *Chemical Processing*'s Ask The Experts forum (chemicalprocessing.com/experts.) "OK, Google — Is there any guideline available for cleaning a sulfuric acid tank?" Google came back with a link to our Ask The Experts forum that answered that exact question.

I decided to get a little more granular. "OK, Google — Are PTFE- and PVDF-lined pipe and fittings suitable for a 30% sodium methylate solution between 10°C and 40°C?" Google gave me a bunch of sites where I could probably find a suitable answer if I researched enough. However, I'm assuming the answer would be very general — nothing as targeted as the one our corrosion expert, Greg Borgard, engineering consultant, Eli Lilly and Company, gave our reader.

Borgard is one of 29 experts we have who field questions from our audience. They are leading authorities in everything from combustion, compressors and corrosion to simulation, solids processing and steam and thermal systems.

"Often in these sorts of forums, an exact and precise answer is not possible, but that doesn't mean helpful information can't be passed along," says Borgard. For his forum on corrosion, he notes the answers are rarely yes or no — they involve different levels of risk and include several considerations that are very context specific. "As best as I can, I try to include items to think about in my answers that the questioner might not have had in mind when they asked the question."

Our Ask The Experts forum enables you to flip through all the questions and answers in each category by clicking on the "See questions in this category" button. If you feel that you can add to the conversation, you can post your own comment. And if you have a question, you can click on the "Pose a question" button to see if our experts can help you address your technical issues.

According to Borgard, some questions are beyond the scope of what he already knows and so involve research. "These are fun ones because we both learn something new," he says. "More often questions don't have enough context to provide me a good basis for giving an answer. So, when asking a question, don't be afraid to give details, even if you think the details might not be relevant. For corrosion and material compatibility, the answer is often "it depends" and so the context matters very much. A suitable material of construction for a waste treatment facility might not be suitable for a pharmaceutical plant."

What about experts seeking advice? "No one person has a corner on knowledge, and it is a wise person who benefits from both the successes and failures of others," notes Borgard. As for the best advice he's been given, it's not advice but a question: How do you know what you know?

"Many times in my career, problems have been posed to me that overstate what is known based on assumptions. An easy example illustrates this in that I was once told a valve in a line was open but there was no flow. In reality, the control system registered the valve being open, but in the field it was actually still closed. I have found that a lot of time and energy has been saved by taking the time at the beginning of any event to verify the facts of the case before trying to engineer a solution. Look at the equipment in the field, talk to the person who was there when it happened, look at the original data, and even ask an expert." ●

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PROGRAM AIMS TO HONOR WOMEN IN MANUFACTURING

Women play a vital role in industrial organizations and *Chemical Processing*'s publishing parent, Putman Media, is launching a recognition program: Influential Women in Manufacturing.

Through March 31, 2018, Putman is accepting nominations of women leading the charge for industrial innovation and manufacturing leadership in 2018.

The company encourages nominations of women at all levels of manufacturing organizations, from the plant floor to the executive suite.

Peers and business associates can submit nominations. Self-nominations also are accepted. http://goo.gl/WYcB6e

Overcome a Site's Lack of Drawings

Follow a few pointers to efficiently produce essential diagrams

If needed, offer to surrender the camera's memory card.

DRAFTING NEVER was my favorite class in high school. The instructor considered me a lost cause because I am left-handed. Everything I write invariably is traced by the heal of my hand as I traverse left to right. I eventually learned to avoid pencil smears by using wax paper. Then came programs like AutoCAD that made being a southpaw irrelevant.

One unavoidable situation you'll encounter in engineering design is working on a project for a facility that lacks drawings. How the plant ever got built without them remains a great mystery to me. I'm usually the one who must create drawings so the site can see what a mess they've caused.

To develop the process and instrumentation diagrams (P&IDs), first, prepare block flow diagrams (BFDs) of the processes. Forget about the details! You only want a birds-eye view of the plant. With a working set of BFDs, take on the P&IDs. I use photography and hand-sketched isometrics to complete this task. If a site prohibits photography, try negotiating: offer to surrender the camera's memory card afterwards. If this doesn't work, triple your price — you're going to need the hours.

Assuming photographs are allowed, follow this procedure for each line going to and from tanks in the process: 1) draw a basic isometric from mover, i.e., pump or compressor, to destination; and 2) photograph from start to finish in sequence. Shoot from different angles to show things easily missed from one angle alone. Take identification point (IP) photos as needed so you don't get lost in a sea of pictures.

Don't forget equipment nameplates. It's a waste of time to copy information into a notebook or pad. Instead, take photos. However, because nameplates can be shinny or lighting may be poor, take pictures from different angles: a straight perpendicular shot usually won't work because the light reflects straight back, over-exposing the picture. I usually find that 30° off perpendicular reduces over-exposure. Again, take IP pictures as you go, so you can remember which nameplate goes with which item.

Autofocus and zoom are absolute necessities for the camera. Give the zoom time to set up, especially in dim light. Zoom is useful for more than close-ups; I've successfully used it to read nametags or body stamps on distant equipment.

A camera zoom may not suffice, though. So, I usually bring a small pair of binoculars or rangefinder to see items out of range of the camera.

Another useful trick is to carry a pad of sticky notes and use them to create your own IPs. However, this approach can become cumbersome.

When you're done, plug your camera's memory card into a reader and edit the photos immediately. I mean immediately! Don't be afraid of being redundant by labeling the same line several times with line size, etc. Use a photo editor to annotate a picture with important items you'll want to remember later. Typically, I add: line sizes, identified from flanges, pipe stamps, check valves, body stamps and other labels (as a last resort, I've used Vernier calipers to determine a pipe size); flow direction and colored lines in pipe racks to discriminate a particular pipeline; and other identification information as well as comments.

Next, compare the photos to the isometric you drew while taking the photographs. Is anything unclear or missing? If so, take some more photographs. Ideally, your shots should reveal all mechanical details. The photos tell you what type of pipe is used and how valves are connected, e.g., flanged, threaded, socket-welded, etc. The isometric ties the photos together.

As for the editor, I use Picasa, a now-retired program. Fortunately, many other programs are available. Pick one that can reduce the size of picture files to allow easier export via email. My camera uses about 4–5 megabytes per photo. Picasa can decrease file size to about 200–300 kilobytes.

Once you've created a portfolio of pictures, organize them into equipment folders. To ease their use while drawing, I put the photos into a tablet that I can scroll through while drawing with AutoCAD. It's amazing what you forget even after a few days. The portfolio also is useful during reviews because reviewers often can't remember these details.

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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/

Acrylonitrile Process Promises Potent Pluses

Bio-based route uses inexpensive catalyst that provides high yield and avoids toxic byproduct

A METHOD for making acrylonitrile from renewable feedstocks boasts economics competitive to the commercial petroleum-based process, say its developers at the U.S. Dept. of Energy's National Renewable Energy Laboratory (NREL), Golden, Colo. The new route, which relies on an endothermic nitrilation reaction, provides higher yield than the standard propylene ammoxidation process, and eliminates safety issues posed by that method such as the threat of a runaway reaction and generation of hydrogen cyanide as a byproduct. Moreover, a simpler reactor configuration likely is possible.

The route uses an inexpensive titanium dioxide solid-acid catalyst to transform ethyl 3-hydroxypropanoate from microbially produced 3-hydropropionic acid to acrylonitrile, explain the researchers. The 3-hydropropionic acid can come from non-food biomass such as agricultural wastes, they add.

Molar yields of acrylonitrile exceed 90% versus the 80–83% achieved in the well-established Sohio process. "This high acrylonitrile yield allows us to propose a potential industrial process for the conversion of lignocellulose to renewable acrylonitrile and carbon fibers," notes Gregg Beckham, group leader at NREL and senior author of a recent paper in *Science* on the process.

NREL estimates the process can lead to an acrylonitrile selling price of under $1/lb, a level competitive with that of petroleum-based production.

"In collaboration with industry, we are planning to scale up our work to produce 50 kg of acrylonitrile at the pilot scale. That will allow us to test a bio-based carbon fiber component to understand if the properties of bio-derived acrylonitrile differ from standard petroleum-based carbon fiber. We are also working towards improved catalyst development for the nitrilation chemistry, and are working to expand the nitrilation chemistry to other substrates to produce novel, bio-based nitrile compounds that can serve as polymer building blocks for new materials. Lastly, we are working on expanding the bio-based intermediates from which we can produce acrylonitrile. For example, we are trying to use lactic acid (which is already an industrial product produced via fermentation) instead of 3-hydroxypropionic acid (which is still in the scale-up phase) as an intermediate compound that can be derived biologically," says Beckham.

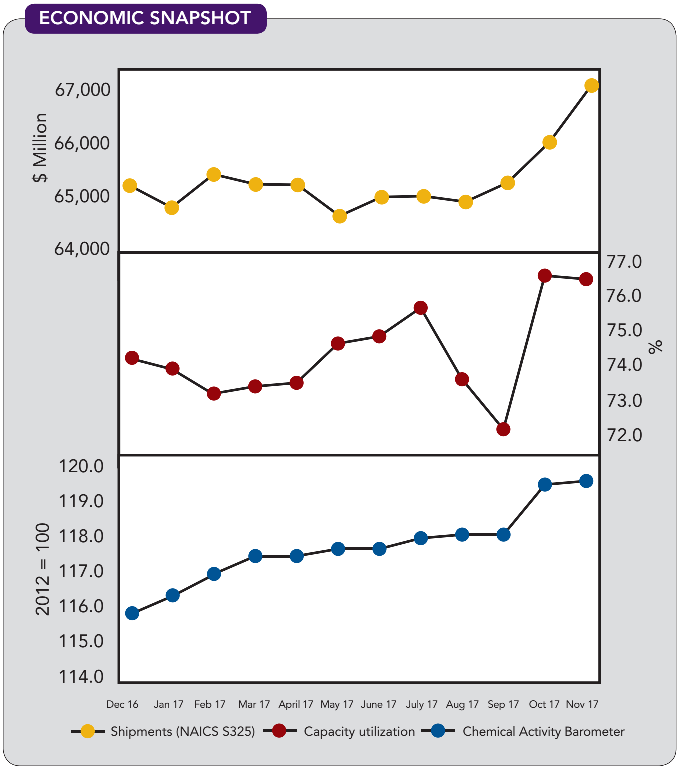
A number of issues require addressing, he admits.

"The catalyst is susceptible to carbon laydown during the process. There are both reaction engineering options (e.g., the use of a fluidized bed reactor, changing the ammonia content of the feed, etc.) that can be tuned to avoid this as well as catalyst design opportunities to produce more robust catalysts that avoid carbon deposition and deactivation. We are actively pursuing these strategies now.

"On the biology side, producing high titers, rates and yields of the bio-based intermediate is a challenge, separating and purifying it efficiently and cost-effectively from broth, avoiding waste salt production, recycle of the alcohol used for esterification (which can be recovered in the nitrilation catalytic step) are all process challenges. Catalyst activity and long-term stability are challenges. Making sure that the bio-based impurities, relative to that of impurities in petroleum-based acrylonitrile, for the final carbon fiber material properties, molecular weight, etc. might be a huge challenge. There is definitely still a lot of work to be done to see this through to a commercially viable process," notes Beckham.

"We are actively investigating the conversion of other compounds besides 3-hydroxypropionic acid to new building blocks," he reiterates.

ECONOMIC SNAPSHOT

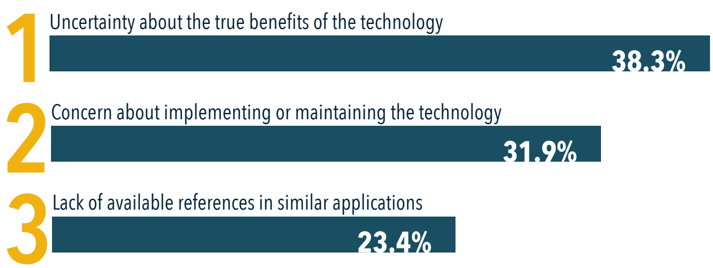


Shipments and the CAB rose but capacity utilization slipped slightly. *Source: American Chemistry Council.*

Survey Looks At Gas-Analytics Equipment

Chemical Processing Survey: Respondents are open to new applications as long as there's proof they work and are cost effective.

Three Barriers That Hinder Application Of Alternative Gas Analysis Technology



INDUSTRY EXPERIENCE

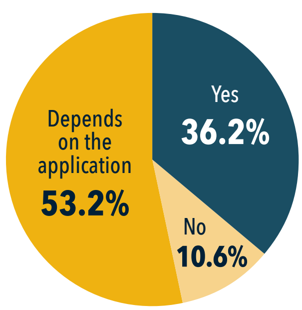
48%

HAVE BEEN IN THE CHEMICAL INDUSTRY FOR MORE THAN 20 YEARS.

13%

HAVE LESS THAN FIVE YEARS TENURE

Would you consider alternative gas-analysis technologies?



Three Top Considerations When Choosing A Gas Analyzer

Download "Gas Analytics: Study finds ROI, accuracy, proof key factors" https://goo.gl/rBch79

Photosynthesis-like Method Makes Ethylene

WITH WORLD ethylene demand expected to exceed 220 million metric tons/y by 2020, the search is on for new manufacturing methods to replace the energy-intensive, high-carbon-footprint cracking processes favored today. A team of scientists at the National University of Singapore (NUS) believe they have an alternative with their prototype device that mimics natural photosynthesis and works at room temperature and pressure to produce ethylene gas using only sunlight, water and carbon dioxide.

The work is being led by assistant professor Jason Boon Siang Yeo of the department of chemistry at NUS and the Solar Energy Research Institute of Singapore (SERIS).

Yeo and his team started in 2015 first designing a copper catalyst that could generate ethylene from readily available water and carbon dioxide when powered by electricity.

PROTOTYPE DEVICE

Figure 1. Solar-powered reaction of water and carbon dioxide to make methanol proceeds at ambient temperature and pressure. *Source: National University of Singapore.*

The team subsequently introduced this copper catalyst into an artificial photosynthesis system to convert carbon dioxide and water into ethylene using only solar energy. They designed a prototype device (Figure 1), which measures 15 cm × 25cm × 40cm, to carry out the reaction, and achieved a 30% faradaic efficiency of ethylene based on the amount of electrons generated from solar energy — the same efficiency as photosynthesis.

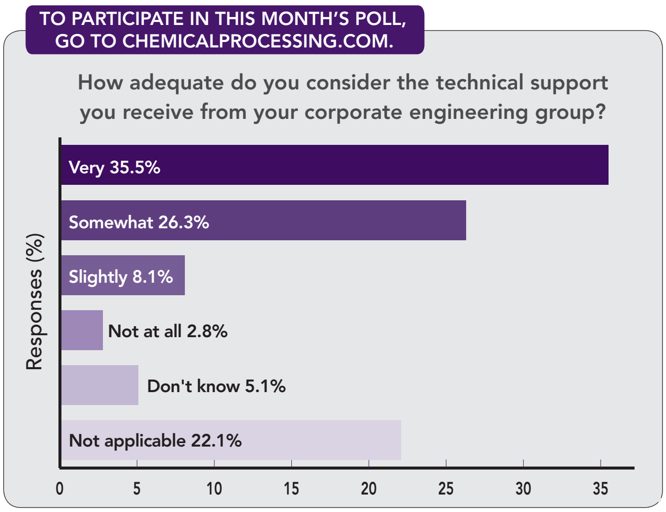
However, this stage wasn't without its challenges. "First, we optimized the efficiency of the cell by modifying its configuration and by improving the iridium oxide anode and the potassium hydrogen carbonate electrolyte. Then, we tested out different solar panels to achieve a best match between solar panels and our cell. Once the stability of the cell was optimized, we introduced a custom-built circuit for the continuous production of ethylene day and night, with solar radiation as the only energy input," explains Yeo.

The team now is working on scaling up their device for ethylene as well as using similar systems to produce liquid fuels such as ethanol and propanol.

Scale-up is focusing on two main areas: increasing the surface area of the electrode and the size of the cell, and designing a new cell that includes a gas diffusion electrode to achieve a higher reaction rate per surface area.

"Some of the technical challenges that need to be overcome are to develop an earth-abundant alternative catalyst to replace expensive iridium used in the anode, and to increase the working stability of the catalyst," he adds.

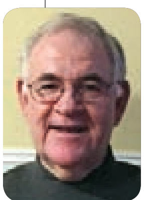
The work has attracted interest from the chemical industry, says Yeo, who declines to reveal details.



A majority of respondents rate technical support from corporate engineering as adequate or better.

Make the Best of Field Testing

Follow these tips for conducting a field performance test when it's unavoidable



It has a focus that day-to-day monitoring cannot bring.

THE PREVIOUS two columns probably have undermined, if not eliminated, your confidence in field testing (see, "Is Online Performance Testing Accurate?," http://goo.gl/TSUFzu, and "Trust but Verify Your Equipment," http://goo.gl/DyhwxM). However, sometimes field testing is the only option. So, do you hire someone to conduct the test? Do you purchase all the testing equipment and set up the test in the field. Do you use what you have and purchase the rest, then install and run the test?

Field testing has progressed from the days when a whole cadre of people logged individual instrument data. Data logging equipment eliminates the test and timing errors when inputting manual measurements. Accurate field (or temporary) instrumentation also is available. What may be missing are points to install the instrumentation or an orientation that lends itself to accurate measurement.

When contacted to do a field test of an existing heat exchanger in the process, Jake had few details and decided to visit the plant for a closer look. He could collect the design data while there. Hopefully, the file hadn't been purged in one of the many clean-ups of files. It even might be in their newly developed cloud.

At the site, Jake met with plant personnel and formed a plan to do the performance test. He reviewed the reason for the request; the heat exchanger created a bottleneck in the process.

First, he had one of the junior engineers look through the files. He needed the design specifications for the heat exchanger and any changes made over the years. Also, they needed the current operating requirements for the heat exchanger. From experience, Jake knew that a plant's expectations for individual pieces of equipment change over time. Processes also change as equipment is optimized; oftentimes, these changes are not recorded.

Next, the team headed to the field to make sure the field test equipment matched the files and the process flow diagram. They scraped off years of paint to gain information from the manufacturer's equipment tags. In some cases, the tags were buried in insulation, requiring special precautions. Finally, they compared actual equipment orientation to that shown on the flow charts to determine if any changes were made to piping.

Then, the team checked the availability of data point instrumentation in the field. They collected data on type and specifications for any installed instruments. They also defined extra test points and detailed locations for items needed.

Jake and the plant engineers then returned to the office to review the information collected. The exchanger had indeed been modified over the years. Several corrosion issues had surfaced and materials were changed to minimize the corrosion. Process conditions also had changed. Jake and the team updated the current process and instrumentation diagram to reflect the changes, then drew their own diagram for the test with all the pertinent data on it.

One of the plant engineers plugged the current design information into an HTRI model to verify they had the most up-to-date calculations. This uncovered a missing item in the equipment history; no one had checked to see how the heat exchanger would perform with the changes in process conditions. As it turned out, the heat exchanger cooling-fluid flow rate needed increased to match process conditions. They updated their working diagram, then ran the test. They also checked and confirmed availability of the extra flow.

All instrumentation, new and old, was calibrated for a secure baseline. Instead of manually logging all the data, Jake used a data-logger connected to all the field instrumentation. Jake mused at how the younger generation had missed out on all the "fun" of the old days when data logging really meant many people writing down individual readings on a multiple sheets of paper. He did not miss those days. He set process conditions to the diagram values and started a one-hour test at stable conditions.

The engineers then downloaded the information from the data loggers into their performance spreadsheet. The data loggers continued monitoring while the team evaluated the results. With the correction in flow, the heat exchanger met the new operating requirements. They also found a small amount of fouling; the team put in a work order to clean the tubes at the next opportunity.

So, field testing still has a place in the life of a plant. While it probably could be done online, the single-event activity nature of the performance test can ensure that all equipment and process data are up to date and any missing data in the equipment history or process are added to the files. It has a focus that day-to-day monitoring cannot bring. Happy energy hunting. ●

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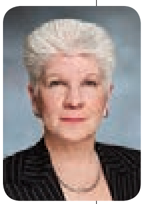
Expect the EPA to Be Busy in 2018

Efforts will focus on TSCA regulations and changes to the Chemical Data Reporting rule



THE NEW Year promises to be a busy one in the chemical area. The U.S. Environmental Protection Agency (EPA) hit all of its new Toxic Substances Control Act (TSCA) marks in timely promulgating rules or taking other steps required by the new TSCA. TSCA developments we expect to monitor in 2018 include:

Fee proposal. The EPA likey will propose a rule soon to implement the fees provisions of TSCA Section 26(b).

Prioritization. We don't expect the EPA to work significantly on prioritizing chemicals. However, there could be developments concerning the pre-prioritization process — a concept that wasn't included in the final prioritization rule. The EPA noted that it hopes to implement a pre-prioritization approach by June 2018 to help ensure prioritization can begin in December 2018.

First ten chemicals for risk evaluation under amended TSCA. The EPA continued last year its risk evaluation work on the first ten chemicals selected under Section 6(b)(2)(A). The new TSCA requires the EPA to complete a risk evaluation for a chemical substance as soon as practicable, but no later than three years after the date on which the agency initiated the evaluation. This means the risk evaluation process for the first ten chemicals should be completed by December 2019; an extension of no more than six months is allowed. If the evaluation concludes that one or more condition(s) of use presents an unreasonable risk as defined under TSCA, the EPA must propose a risk management rule under TSCA Section 6(a) within one year of the completed risk evaluation and a final risk management rule one year later (within two years of the completed risk evaluation). The legislation includes provisions for extensions of no more than two years.

Existing chemical risk management. The significant new use rule (SNUR) on long-chain perfluoroalkyl carboxylate and sulfonate chemical substances is quite delayed. No discernable progress was made in promulgating this rule in 2017. Similarly, the proposed SNURs for nonylphenol and nonylphenol ethoxylates (NP/NPE rule) and toluene diisocyanate (TDI) will likely remain a low priority as the EPA works on the first ten chemicals and other high-priority rulemakings.

Anticipated proposal for changes to the Chemical Data Reporting (CDR) rule. The EPA is expected to issue proposed changes to the CDR rule in May 2018, with changes to be adopted for the 2020 CDR reporting cycle. The agency will be looking to adjust the categories used for reporting under industrial, commercial and consumer uses to achieve more-refined use information and better estimates of exposure potential. Should changes be adopted, this will be the fifth modification of reporting for this rule in five reporting cycles.

Inventory notification. Chemical manufacturers and importers were to complete reporting of "active" substances by February 7, 2018. As of publishing date, the EPA has indicated there's no extension of this deadline; the statute limits the reporting period to 180 days. Stakeholders were cautioned to submit their notifications early, because the EPA's Central Data Exchange has experienced operational problems related to high volumes of submissions during a short time period in past CDR reporting cycles. The EPA will soon issue an interim list of active substances following the reporting deadline, which processors can use as a basis for their active notification submissions due no later than October 5, 2018.

Processors likely won't need to expend much effort, as the chemicals they use should have been reported during the manufacturer/importer reporting timeframe (an exception concerns the situation with chemicals that are only infrequently produced or imported and are stockpiled and drawn down over time by a processor). Processors that find themselves submitting multiple active notifications may wish to revisit their existing agreements with chemical suppliers and associated TSCA compliance obligations. The EPA states it will have the final active/inactive chemical lists reflected in the published TSCA Inventory as soon as practicable after the October processor reporting deadline, which we believe will be about two months, or sometime in December 2018.

Stay tuned. All these developments are important and will impact significantly chemical processor business practices. ●

Processors likely won't need to expend much effort.

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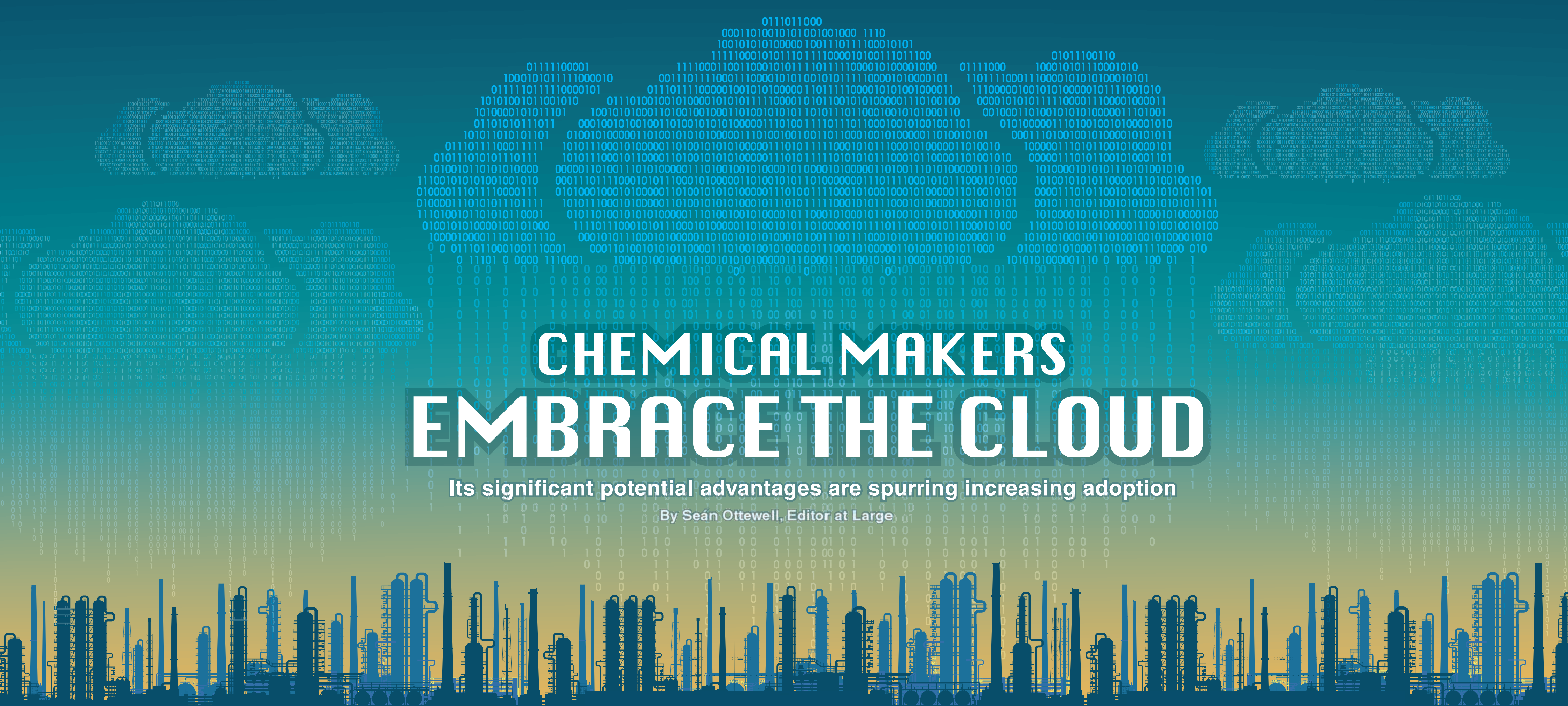
Lynn is managing director of Bergeson & Campbell, P.C., a Washington, D.C.-based law firm that concentrates on chemical industry issues. The views expressed herein are solely those of the author. This column is not intended to provide, nor should be construed as, legal advice.



CHEMICAL MAKERS EMBRACE THE CLOUD

Its significant potential advantages are spurring increasing adoption

By Seán Ottewell, Editor at Large

USE OF Internet-based information storage and services — the so-called cloud — instead of traditional direct connection to servers is gaining adherents in the chemical industry — and, thus, challenging traditional conservative information technology (IT) habits, notes Lauren McCallum, solutions manager, industry business solutions — chemical, SAP, Philadelphia. Indeed, companies including Dow Chemical, BP and BASF are rapidly expanding their adoption of cloud-based applications — and reaping substantial benefits.

For example, Dow Chemical, Midland, Mich., says it has saved over $85 million as a result of the improved supply-chain visibility offered by cloud-based services.

The importance of this was highlighted for the first time when Storm Bill approached Texas in June 2015. The company quickly was able to identify 5,900 railcars in the storm's impact zone. This allowed Dow to warn customers of any potential delivery problems well in advance and, for critical deliveries, to arrange for shipping from other locations. Similarly, when a cargo ship caught fire in 2016, it took Dow's supply chain team less than ten minutes to determine what containers were on the vessel. Again, the company alerted customers and organized alternative supplies.

Dow also is using three cloud-based Oracle applications to improve its human resources (HR) operations. Together, the three form the backbone of the company's HR analytics system that delivers real-time personnel data throughout the company to enable matching people with the most appropriate jobs.

For its part BP, London, has been working with Amazon Web Services (AWS) over the last few years to improve the efficiency of its workplace practices. In 2016, the company decided on a fully cloud-based strategy. Using AWS tools and services, BP recorded a 30–40% reduction in the total cost of IT hosting even before the system was fully optimized.

ENSURING SECURITY

Nevertheless, for any cloud-based activity, security remains key. "The cloud would be unthinkable without security. By outsourcing data and applications to the cloud, companies entrust the authorization to use their data to the external cloud provider. Before doing that, they need to define their own compliance security guidelines," stresses a spokeswoman for BASF, Ludwigshafen, Germany.

For BASF, this means that any cloud provider must pass a security assessment for the classification needed before processing company data. This ensures compliance with security criteria including encryption and periodic security updates as well as contractual agreements such as the location of jurisdiction and data-privacy regulations.

The company's involvement with different cloud environments has enabled it to retire and consolidate IT infrastructure. "For example, we have leveraged the facilities of our former onsite data center for the new BASF supercomputer," she says. (For details on the company's plans for the supercomputer, see "Digitalization Drives Development," http://goo.gl/9PNQPw.)

Two current projects particularly are benefiting from using cloud infrastructure.

The first is a joint project with SAP to evaluate digital cooperation with business partners. This involves the SAP Asset Intelligence Network, a collaborative network that brings together information from manufacturers, service providers and plant operators in a cloud-based platform. "The goal is to establish a

Figure 1. Cloud-based platform enables customers to access information on dispersions and additives. *Source: BASF.*

fully integrated and centrally located asset information repository. With this single source of truth for asset information, it is intended to further improve the efficiency of engineering and maintenance processes throughout the asset lifecycle," she explains.

The SAP Asset Intelligence Network allows BASF to collaborate with its customers in a digital ecosystem and manage smart devices in the industrial Internet of Things (IIoT). The evaluation project likely will run for several more months and is part of the BASF 4.0 digitalization initiative.

A second example of cloud use is an online platform named Lab Assistant (Figure 1) developed by BASF's Dispersions & Pigments Division. This tool helps customers find the right chemicals for their own products. The cloud platform provides information about BASF's dispersions and additives portfolio, e.g., pH levels and viscosity, or regulatory status in a given country. Customers also can find recommendations for decorative paints, including formulations or active ingredient calculations.

Also, since the 2014 deployment of cloud-based Microsoft Office 365 to better integrate the working environment of its 100,000 staff, BASF has been working on a broader Connected Enterprise project to improve global collaboration both within the company and with its external partners. Via a seven-step process, BASF has introduced modern communication and collaboration tools — including smartphones, tablets and notebooks — so employees can work at maximum efficiency wherever they are located. However, ensuring success has demanded a strong focus on training.

"These big technical changes also demanded a sophisticated change management. That is why we started an extensive initiative to support our employees in learning new ways of working. We chose an approach with multiple formats and media: a smartphone app, training videos, live online trainings, a change agent network, handbooks and some face-to-face trainings. We provided our documents in 24 languages and took care to early engage executives and offer specific workshops to target groups such as assistants and employee representatives," notes the spokeswoman.

"The BASF project involves digital transformation of their entire source-to-pay process using Ariba solutions and Ariba Network. The project is progressing well," says SAP's McCallum. "A number of other chemical companies are also currently implementing Ariba solutions, including one which is using Ariba Strategic Support Suite to implement a structured and consistent sourcing process and centralized document management system," she adds.

KEY DRIVERS

McCallum cites two main drivers for chemical industry adoption of cloud-based applications. First is the need to increase margin in a historically low margin business, especially for companies with activist investors on their boards. Profitability is critical, and applications with subscription contracts and lower IT costs look more attractive to shareholders than expensive perpetual licenses, she notes.

"Secondly, the need for agility is driven by extraordinary amounts of merger, divestiture and acquisition activity. For companies who are growing by acquisition and who want to get all their business units/acquired entities using the same software quickly, without a large capital expenditure, cloud solutions are the best option. Or, conversely, for spin-offs who need their own software landscapes ASAP, cloud solutions provide a faster and cheaper way to get there. Less hardware. Less IT support required. Faster user adoption. More scalable as the company grows or shrinks," she stresses.

Chemical industry adoption of cloud-based applications is about middle of the way when compared with other industries that SAP is involved with — although uptake has been more rapid than expected given the industry's historically conservative IT habits.

"Perhaps this is the case because many, if not most, chemical companies have had the same ERP [enterprise resource planning] system for years, even decades, during which time old configuration and customizations have accumulated. This results in systems that are difficult to upgrade and that impede adoption of new business processes.

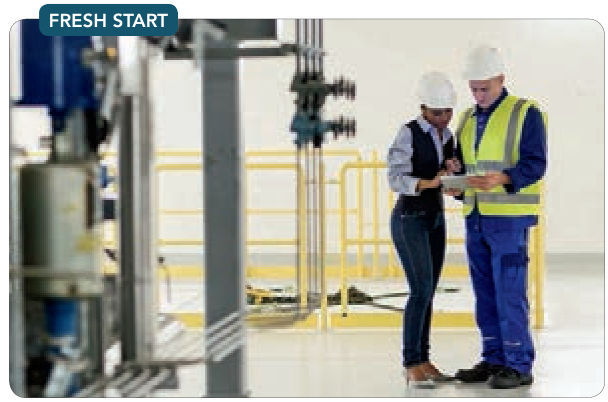


Figure 2. A move to the cloud can do away with issues posed by legacy software. *Source: SAP.*

Those companies whose competitive advantage is hampered by cumbersome on-premises systems see the move to the cloud as an opportunity to start afresh with software that will automatically be upgraded as business processes evolve and change," she explains (Figure 2).

Early adopters of cloud applications in the chemical industry started with "shared services" applications such as HR and procurement. "Solutions like these provided an easy way for companies to test the waters of [the] cloud, without risking mission-critical activities. Pretty quickly, we saw companies moving more differentiating business processes to the cloud, such as sales and operations planning, and some chemical companies are currently considering moving even their manufacturing operations to the cloud," notes McCallum.

The cloud is ideal for any non-specialized functionality that multiple users need to access from many different places and that can be standardized across the company, she counsels. "HR, travel, indirect procurement are obvious examples. The selling point here is ease of use and standardization, in addition to lower implementation, support, and license cost."

However, chemical companies must understand issues the cloud does pose: for instance, compliance with data-privacy legislation in different countries and the impact of where specific servers are physically located; uptime, i.e., how often will the system be down for upgrades and how long will these take; and disaster recovery.

ALTERNATIVE SCENARIOS

Chemical companies can choose from among a number of options to avoid the security, legal or transition costs that typically raise most concern with cloud computing, says Michael Risse, vice president of Seeq Corp., Seattle, Wash.

"Given chemical company financial and governance investments in existing data collection and storage systems, some organizations are uninterested in beginning their cloud efforts with a massive project to move their data to the cloud. At the same time, with a reasonable Internet connection, data movement is not necessarily a prerequisite for end users to unlock insights in their data," he notes.

By using a cloud deployment of analytics software, a secure (HTTPS) connection, and a remote connection agent, a chemical maker can take advantage of browser-based applications running on the cloud that connect back to its on-premise data. "The advantage here is that the solution is deployed and accessible in a matter of hours. So, the cloud is the deployment platform for analytics, but the data stays where

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it is, enabling deployment and insight in hours rather than months," he explains.

Another option is to make the cloud the destination for monitoring datasets collected from remote or IIoT end points. This, he emphasizes, frequently is a natural and easier option than trying to reroute data from carriers and wireless systems into IT systems and then to the cloud because data "born on the cloud" is a popular option for many monitoring applications.

"In this case, end users can then access the data by either running analytics on the cloud or by running the analytics solution on premise with a remote connection to the cloud-based data. In either scenario, the monitoring data may be complemented or contextualized by connecting the analytics solutions to other data sources — historians, manufacturing execution systems, etc. — to get a complete view of all data. For chemical companies, this scenario can be used to enable new insights into supply chain and operations by complementing existing data with data from wireless or cellular networks," he adds.

A third scenario is accessing multiple sites from a cloud deployment of analytics software. While moving or copying the data to the cloud also could facilitate cross-plant comparisons for yields, quality, etc., a simple remote connection for occasional queries and comparisons may suffice, depending on the frequency and requirements of the end user.

"These early comparisons may be a proof point to demonstrate the value of cross-plant analysis, after which a company may choose to begin the process of moving data to the cloud for future leverage. As with the other scenarios, taking a cloud-based analytics software approach with connectivity to on-premise data enables rapid deployment of new software while maintaining the status-quo for data collection, storage, access and governance," notes Risse.

Cloud computing provides many advantages to organizations in typical IT scenarios for on-demand capacity in storage and computing power, he says. However, this should not preclude companies from leveraging other benefits of cloud computing such as rapid deployment, remote access and low cost, advises Risse.

"Leveraging software as a service (SAAS) offerings to reduce overhead and capital expenditures are additional opportunities. If data lakes and data aggregation are the goal, the cloud is certainly an option, but it's not the only model, and other approaches may be a better fit for chemical companies," he concludes.

Find Tank Wetted Surface Area

Rigorous equations enable accurate determinations for vessels with various head types

By Daniel E. Jones, consultant

"API RECOMMENDED Practice 521 specifies that a vessel containing liquid, mounted such that its lowest point is less is less than 7.62 m (25 ft) above ground level, must be fitted with a pressure-relief device to protect it against an external fire. The vent area needed for fire relief must always be calculated, even if this turns out not to be the limiting case.

"The relieving load calculation requires the engineer to know the wetted surface area that would be exposed to the fire. If the vessel's elevation and diameter are such that the entire vessel is not within the 25-ft vertical fire zone, a partial surface area calculation is needed" [1].

This quotation underscores the importance of accurate wetted surface area calculations in tanks. The article it comes from deals with only one specific tank configuration: a cylindrical horizontal tank with hemispheroidal heads, specifically 2:1 heads where the head protrusion beyond the end of the cylindrical portion of the tank is half the radius of the cylindrical portion. That article gives the wetted surface area of one head as:

$$S = \frac{\pi R^2}{2}\left\{(F-0.5)\sqrt{1+12(F-0.5)^2} + 1 + \frac{1}{4\varepsilon}\ln\left[\frac{4\varepsilon\,(F-0.5)+\sqrt{1+12(F-0.5)^2}}{2-\sqrt{3}}\right]\right\} \qquad (1)$$

where F is fractional fill height, $h/2R$, where h is the height of fluid in the head, R is the radius of the tank (and head), and ε is the eccentricity of the ellipse defining the tank head by rotation around its minor axis. Even though Eq. 1 is a function of ε, it only can be valid for $\varepsilon = \sqrt{3}/2$ (i.e., a 2:1 ellipsoidal head); this can be shown simply by doubling the surface area for a half-full tank ($F = 0.5$) and equating that to the surface area for a full tank ($F = 1$). Solving that equation for ε yields a unique value of $\varepsilon = \sqrt{3}/2$. Eq. 1 also gives the correct wetted surface areas for half-full and full heads as can be shown using well-known surface areas for oblate spheroids [2]:

$$S = 2\pi R^2\left(1 + \frac{1-\varepsilon^2}{2\varepsilon}\ln\frac{1+\varepsilon}{1-\varepsilon}\right)$$

$$\equiv S = 2\pi R^2\left(1 + \frac{a^2}{2R\sqrt{R^2-a^2}}\ln\frac{R+\sqrt{R^2-a^2}}{R-\sqrt{R^2-a^2}}\right),\ \varepsilon \neq 1,\ a \neq R \qquad (2)$$

where the eccentricity has been eliminated to provide a practical equation for tank heads in terms of a — the protrusion of the tank head beyond the end of the cylindrical portion of the tank, i.e., $\varepsilon = \sqrt{1-(a/R)^2}$.

Even though Eq. 1 is correct for the 2:1 head at half-full and full values, it is not rigorous for other fill levels, including the wetted surface area for $h = 0$, which must be 0 for heads of all ε (i.e., a). If a fill level of 0 is put in Eq. (1), the surface area, S, is found to be a function of ε, i.e., $S = (\pi R^2/8\varepsilon)\ln[(2-2\varepsilon)/(2-\sqrt{3})]$. So for an empty tank, Eq. 1 can't be valid unless $\varepsilon = \sqrt{3}/2$.

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BROADER SUITABILITY

A rigorous equation valid for the wetted surface area for any hemispheroidal head (one head only) of any diameter, fill height and a (and, hence, ε) is:

$$S = \frac{2}{R}\int_{R-h}^{R}\int_{0}^{\sqrt{R^2-x^2}}\sqrt{\frac{(R^2-a^2)\,x^2+(R^2-a^2)\,y^2-R^4}{x^2+y^2-R^2}}\,dy\,dx$$

for all a; $0 \le h \le D$ (3)

This equation simplifies for some special cases of hemispheroidal heads:

A COMPARISON

Case 1: One head, R = 1.5 m, a = 0.5 m ($\varepsilon = \sqrt{3}/2$)			
h, m	Eq. 1, m²	Eq. 2, m²	% error
0.1	0.4595	0.2466	86.3
0.5	2.0717	1.4014	47.8
1.0	3.6373	3.0802	18.1
1.5	4.8779	4.8779	0.0
2.0	6.1185	6.6756	-8.3
2.5	7.6841	8.3545	-8.0
3.0	9.7559	9.7559	0.0
Case 2: One head, R = 1.5 m, a = 1 m (ε = 0.7453559925)			
h, m	Eq. 1, m²	Eq. 2, m²	% error
0.1	1.1610	0.3204	262.4
0.5	2.5516	1.7054	49.6
1.0	3.9188	3.5927	9.1
1.5	5.0955	5.5625	-8.4
2.0	6.3704	7.5324	-15.4
2.5	7.9913	9.4197	-15.2
3.0	10.1116	11.1251	-9.1

Table 1.Results from using the two equations differ markedly.

$$S = R^2\cos^{-1}\frac{R-h}{R} - (R-h)\sqrt{2Rh - h^2}$$

for $a = 0;\ 0 \le h \le D$ (3a)

$$S = \frac{\pi R^2}{2} + \frac{\pi a^2 R}{4\sqrt{R^2 - a^2}}\ln\frac{R+\sqrt{R^2-a^2}}{R-\sqrt{R^2-a^2}}$$

for $0 < |a| < R;\ h = R$ (3b)

$$S = \pi R^2$$

for $|a| = R;\ h = R$ (3c)

$$S = \frac{\pi R^2}{2} + \frac{\pi a^2 R}{\sqrt{a^2 - R^2}}\cos^{-1}\frac{R}{|a|}$$

for $|a| > R;\ h = R$ (3d)

$$S = \pi R^2 + \frac{\pi a^2 R}{2\sqrt{R^2 - a^2}}\ln\frac{R+\sqrt{R^2-a^2}}{R-\sqrt{R^2-a^2}}$$

for $0 < |a| < R;\ h = D$ (3e)

$$S = 2\pi R^2$$

for $|a| = R;\ h = D$ (3f)

$$S = \pi R^2 + \frac{\pi a^2 R}{\sqrt{a^2 - R^2}}\cos^{-1}\frac{R}{|a|}$$

for $|a| > R;\ h = D$ (3g)

Table 1 compares the wetted surface areas of hemispheroidal heads at various fill heights calculated using Eq. 1 to rigorous values calculated using Eq. 3 for a head of radius 1.5 m for two different values of a (i.e., ε) and shows the percentage error in values calculated with Eq. 1.

Using Eq. 1 can result in quite a large error in a wetted surface area calculation for a hemispheroidal head — but

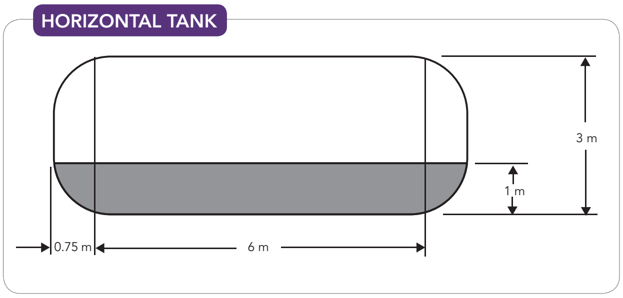

Figure 1. Ref. 1 used this cylindrical vessel with 2:1 hemispheroidal heads for an example calculation.

the total error over the entire tank may be inconsequential, especially because large safety factors usually are applied to theoretical calculated values. However, there is no good reason to use approximate calculations given the available rigorous equations, which many graphing calculators can easily and rapidly solve.

Let's compare the results for the wetted tank area example given in Ref. 1 with the area found using rigorous Eq. 3. As shown in Figure 1, the example tank has a horizontal cylindrical body 6 m long and a diameter of 3 m. The heads are 2:1 hemispheroidal heads, i.e., $a = 0.75$ m. The fluid level is 1 m. Using Eq. 1, the wetted area of both heads is 7.2746 m^2. Standard well-known formulas for calculating the wetted surface area of the cylindrical portion of the tank give 22.1573 m^2. So, the total tank wetted surface area is 29.4319 m^2. In contrast, using Eq. 3, the correct area for both heads is 6.1604 m^2 — adding the cylindrical area gives the correct total tank wetted surface area of 28.3177 m^2. Thus, the error in total tank wetted surface area is 3.9%, although the wetted head surface area is in error by 18.1%.

An additional bonus of using Eq. 3 is that it handles all values of a — i.e., it is valid for flat heads ($a = 0$), hemispherical heads ($a = R$), oblate hemispheroidal heads ($a < R$) and prolate hemispheroidal heads ($a > R$).

Equations for wetted surface areas of horizontal and vertical cylindrical tanks with conical, guppy and torispherical heads are available as are equations for horizontal elliptical tanks with hemiellipsoidal heads [3]. ●

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REDUCE Pilot Plant Capital Costs

Consider eight ways to improve project economics

By Stephen Benbrook, EPIC Systems

SECURING FUNDING for your pilot plant can often be the most difficult obstacle to overcome when scaling up your process technology. While a pilot plant generally serves as a key stepping stone in taking a process from bench scale to full production, there usually still is strong pressure to minimize its cost. However, by skimping too much on the funding, you may build a pilot unit that does not give enough useful data for the construction of a production plant.

On the other hand, keeping costs reasonable could make the difference between your project getting cancelled or delayed due to capital restraints and smoothly moving through the capital approval process. This article will cover eight factors to consider when determining areas for cutting costs while developing your pilot plant.

Always keep in mind the goals of your particular project when considering this list. These factors often involve tradeoffs. Having a clear priority on what outcomes you need will determine which areas you can re-evaluate and which are set in stone.

EVALUATING PILOT PLANT COSTS

To get a better handle on the potential costs of your pilot plant, review your project and assess each of the following factors:

1. *Operating cost.* Can you shift capital cost to operating cost? Because a pilot plant is a temporary operation, you could get by with less automation and more manual operator intervention. This can significantly reduce both instrumentation and equipment cost but might demand more attention from operators to keep the pilot plant running. Just be careful not to sacrifice the robustness of your overall system. People can be inconsistent and potentially can act as a new source of process upsets, increased transient states, or required startups and shutdowns.

For example, imagine a production-scale plant will be processing 120 mt/day of a dry flowable bulk solid. At production levels, this will require extensive solids-handling equipment including truck unloading, silos and conveyance. However, at a pilot level, you probably wouldn't need full-scale solids-handling equipment and might get by with an operator with a shovel. Often solids-handling issues are well understood and so reducing equipment and using labor can save money with little risk. In a full-scale facility, solid handling isn't trivial and still can pose unwelcome surprises. For tips about dealing with solids, see *CP*'s Solid Advice column, www.ChemicalProcessing.com/voices/solid-advice/. Purchase smaller, less expensive equipment to fully vet the technology or, depending upon run time, it might make sense to have an operator manually load a hopper.

2. *Required production rates.* When deciding upon the production rate of your pilot plant, you must strike a balance between cost and accuracy. Will your pilot plant reflect operating conditions of full production and to what degree? A 1,000:1 difference between production and pilot rates is too big to give much confidence in most situations. A 2:1 ratio

provides an immense amount of confidence but would be a waste of money. Good engineering judgment and cost/benefit analysis are critical when making this choice.

It's wise to keep in mind areas where a professional can assist. Knowing which unit operations are most likely to change with scale and how to combat this is key. For instance, if you have a packed-bed reactor with a heat-transfer jacket, a smart decision would be to choose a defined tube diameter and length. You would then use your pilot plant to vet this fixed tube diameter and length with a single large tube. The full-size production scale might require 150 tubes, but each individually should function exactly like the one in the pilot plant. This will give everyone involved a high confidence around the reactor.

3. *Materials of construction*. You might be able to economize by using a material that has a "good" or "fair" rating, based upon the particulars of your process and how long the pilot plant needs to run. The best way to confidently make this call before building the pilot plant is via coupon testing at lab scale.

Additional coupon testing in your pilot plant for production-grade equipment can also contribute to long-term savings. This helps ensure that any materials tradeoffs you might be considering won't raise glaring issues. Nearly identical materials can lead to drastically different outcomes.

4. *Instrumentation*. If the data gathered won't change any design decisions or refine any selections, it might not be worth the cost to install instrumentation for measuring these data. It is natural to want as much instrumentation as you can get on your pilot plant — but you must balance that desire with cost. Knowing which measurements are critical and which just fall into the "nice to know" category is imperative.

Depending upon the unit operations used, instrumentation can vary from 25% of the overall cost of a pilot plant to much more than the cost of the rest of the equipment combined. Keeping this number in check is critical but you still must ensure the pilot gathers all the data required for vetting the full-sized facility.

5. *Location*. If possible, locating your pilot plant on a site with existing utilities almost always is an excellent decision. It is doubly so if required raw materials for your process already exist there. However, check the air and water permits, especially if your process might alter an existing permit. Updating these permits not only incurs a cost in staff time but also can lead to non-trivial schedule delays.

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Figure 1. Off-site fabrication can improve the quality of pilot-plant elements and also compress the project schedule.

6. *Modular fabrication*. First, you must determine if modular fabrication makes sense. Off-site construction at a fabrication facility (Figure 1) helps compress project timeline, ensure quality manufacture inside a controlled environment, and reduce the total number of craftsman hours worked on site, which cuts the chances of accidents.

Shop-fabricated modules offer additional advantages. The controlled fabrication environment means no delays due to inclement weather as well as a higher quality product because every weld is made in ideal conditions. Moreover, it avoids the need for plant personnel to get a general and hot-work permit every day. More of every craft labor hour you're paying for is spent making progress on your project. This faster installation means less downtime in existing operation units and a speedy return of your facility to making product.

In addition to quality and safety improvements, the schedule compression comes from the ability to concurrently perform any required site work and fabrication as opposed to waiting for the site work to be completed before starting fabrication. Completed skids are fabricated offsite and fully tested, arriving at your plant ready to attach to utilities and come online. (For more on this option, see "Consider Modular Pilot Plant Construction," http://goo.gl/Kdo8fb.)

7. *Existing processes*. Are you reinventing the wheel? It is important to refrain from wasting time by testing parts of the process that are clearly established. Instead, focus only on those elements required for validating your technology.

If a portion of your production facility uses a mature well-understood technology, then excluding that technology may make sense. This can involve everything from using CO_2 from bulk tanks instead of scrubbing flue gas, burning syngas instead of feeding it into a second process, or not purifying your final product.

The closer you can get to matching how something is used in the process, the greater degree of confidence you should have in excluding it. If you're starting with the same raw materials and only performing the first half of your process, you're likely to be on sound ground. However, if your starting point is an intermediate, then you may face a lot of risk depending upon how close the approximation is to the actual intermediate. In the case cited above of using bulk CO_2 instead of actual flue gas, you must carefully consider any possible contaminants that might carry over from the flue gas (e.g., soot, CO, NO_x and SO_x). Finding out after the fact that a ppm-level contaminant is slowly and steadily poisoning your catalyst would make for a terrible start to your brand-new plant.

8. *Process robustness.* Certain unit operations and pieces of equipment tend to scale more easily. The more subtle and sensitive a unit operation is, the more difficult it is to scale. In moving from lab- to pilot-plant scale, see if you can break down an operation into multiple steps that individually are more forgiving. This should make your overall process more robust and repeatable.

Depending upon the equipment being replaced, this technique could increase or decrease costs, but it should always yield a more reliable process. For example, can a reaction step that is sensitive to having the stoichiometrically perfect amounts of reactants achieve the same end results by instead running at a huge excess of one reactant with a subsequent stripping step? While taking two steps for something that could be done in one may seem inelegant, the change may provide substantial gains in reliable data collection and process repeatability.

CONSIDER THE OPTIONS

While general guidelines do not work for every project, reducing pilot plant costs is possible. Combine the advice in this article with good engineering sense about your own technology. Also, consider getting an engineer with experience in pilot-plant design to assist in deciding where it makes the most sense to reduce costs for your project. Plant design partners should bring extensive knowledge of what works and what doesn't work at a plant level and a pilot level, which you then can marry with your knowledge of your exact technology for the best outcome. ●

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Don't Let Baffles
Baffle You

Understand the role of baffles and best practices for them

By Gail Pogal and Richard O. Kehn, SPX Flow — Lightnin

BAFFLES ARE internals, generally flat plates, used in agitated vessels to optimize and stabilize the mixing flow pattern and minimize variation in agitator power draw. Baffle recommendations are part of the agitator vendor's scope although the baffles are designed and fabricated by others. Proper baffle implementation dramatically impacts process results.

Low viscosity fluids in agitated vessels *without* baffles swirl and have surface vortices with little top-to-bottom vessel turnover. Velocity gradients are minimal. Particle tracing within a horizontal plane shows circular motion almost like the horses on a carousel — rotation but not interaction. Particle traces in a vertical plane show minimal motion, a poor configuration for blending or solid suspension.

As Figure 1 illustrates, baffles provide advantages with such fluids. Baffles establish an axial flow pattern, minimizing the tangential or swirl component imparted by the rotation of mixing impellers. The baffled flow pattern facilitates top-to-bottom bulk motion, increasing the velocity across heat transfer surfaces and facilitating blending and solid suspension. However, top entry on-center-mounted agitators on a properly baffled vessel draw more power than on an unbaffled vessel because the impeller pumps more fluid in a given amount of time.

In mass transfer reactions, where power draw is a critical parameter, proper baffling increases impeller power draw and improves blending, which increases the mass transfer capabilities of the mixer.

For vertical cylindrical vessels, "standard" baffles — defined as four flat plates of 1/12 vessel diameter, installed radially along the vessel straight side and spaced at 90° — are common for top entry agitators mounted on center. They are recommended based upon "standard" assumptions about the agitator, vessel, fluids and mixing requirements. Many processes frequently deviate from these assumptions! We will discuss frequently encountered deviations.

A common misconception is that the number of baffles must equal the number of impeller blades. This arose from the change in baffle recommendations that occurred when high efficiency impellers came into the market, replacing many pitched blade turbines. More accurately, the optimum number of baffles is a function of the ability of an impeller to generate axial flow in the process fluids.

When processing low viscosity fluids with high efficiency axial flow impellers, performance differences between three and four equally spaced baffles are barely discernable. In these fluids, four bladed pitched blade turbines and six bladed radial flow impellers require four baffles.

BAFFLE ADJUSTMENTS

Practical considerations or vessel internals often rule out spacing baffles equidistant around the vessel circumference. Redistributing baffles within a few degrees of equal spacing is fine. However, removing a baffle without respacing the remaining baffles is problematic. In other words, it's much better to have three baffles at 0°, 120° and 240° than three at 0°, 90° and 180°.

When you must reduce the number of baffles, adjustment of baffle width can maintain power draw and facilitate an axial flow pattern. For a low viscosity fluid, an installation with two baffles at widths of 0.1 × vessel diameter will draw approximately the same power as three baffles at 0.062 × vessel diameter.

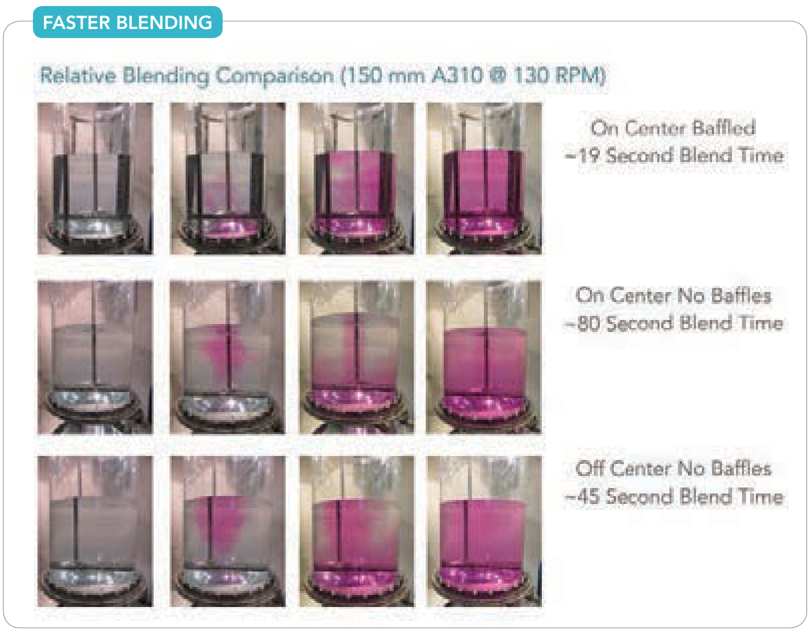

Figure 1. Use of baffles dramatically decreases blend time.

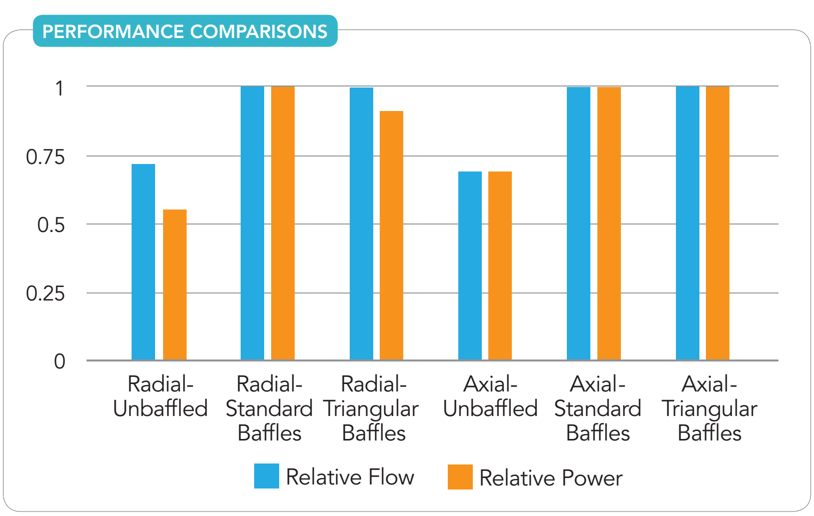

Figure 2. Standard and triangular baffles offer nearly identical performance with axial flow impellers.

As seen in Figure 1, off-center mounting in an unbaffled vertical cylindrical vessel will create an axial flow pattern and less swirl than an on-center mounting in the unbaffled vessel. For small vessels, an angle mounted agitator, often called a portable agitator, may make sense. These asymmetric options usually are impractical in large mixers from a mechanical design point of view.

The need for sanitary processing or the handling of fluids with a tendency to foul surfaces creates demand for alternative installation locations and baffle designs.

The Lightnin Mixing Technology Laboratory recently studied triangular baffles. Tests using A510 high efficiency axial and Rushton (radial) impellers evaluated power and flow for the same operation in water for unbaffled, standard plate baffle and triangular baffle configurations. As shown in Figure 2, with the axial flow impeller, the performance of the triangular cross-section baffle essentially equals that of the standard plate baffle. However, with the radial impeller, both flow and power draw decline. With both impellers, lack of baffles results in a marked performance decline.

Another study, summarized in a presentation at the Mixing XIII conference of the North American Mixing Forum (NAMF), looked at the power draw of an A310 high efficiency axial flow impeller in water in an off-center unbaffled configuration. As expected, at constant speed, removing the baffles reduced measured power draw approximately 40% [1].

When fouling or contamination between batches is a concern, installing baffles at ⅓ width off-wall promotes flow between the baffles and vessel wall. At higher viscosities, opt for ½ width off-wall.

Canted baffles, angled in the direction of flow, often are used for cleanliness or when the baffles are heat transfer surfaces. The width of the baffle is calculated to provide the recommended radial component. For example, if a 7-in. baffle width is desired, a 45° canted baffle of 10 in. is suggested because the radial component is (sin 45°) × 10 in. = 7 in.

Triangular baffles with a radial component equivalent to the suggested baffle width are nearly as effective as baffle plates for axial impellers. A typical triangular baffle would have a vertex pointing toward the vessel center with a 45° angle made from two plates. To replace a 4-in. baffle with a 45° triangle, the side plates joining at the vertex would each be 4.33 in. The leading face of the baffle is 4 in./sin 67.5°.

Baffles often are helpful when vessels have bottom cones or dishes. Cone bottoms have a small inherent baffling effect. If an impeller is in the cone, use one or two baffles scaled to the cone diameter at the impeller elevation if installation clearances allow.

At power levels above 1 hp/1,000 gal, opt for baffles extending into a dish if an impeller is at or below the vessel tangent line. Without baffles in a dished bottom, an axial impeller at the tangent line exhibits swirl.

With radial flow impellers, particularly in gassed applications, extended baffles are essential for promoting a useful flow pattern to improve gas dispersion.

Raising the position of a lower impeller up into the baffled straight side of a dished or cone bottom vessel can dramatically improve the mixing flow pattern.

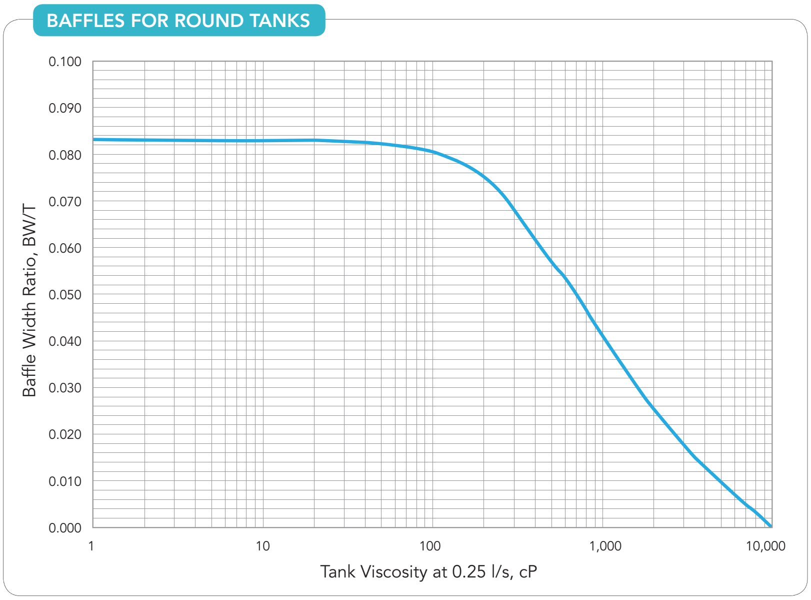

Figure 3. Recommended baffle width depends upon viscosity.

IMPORTANT FACTORS

Baffle recommendations vary with fluid properties and geometry. Common factors influencing baffle recommendations include:

- solids wet-out;
- higher viscosity or non-Newtonian (e.g., pseudoplastic) fluids;
- unusually high or low power intensities;
- glassed vessels;
- internal coils, jackets, vertical tubes and flat plate heat transfer surfaces;
- rectangular, horizontal or asymmetric vessels;
- side-entry mixers; and
- dip pipes, thermowells, probes and other vessel internals.

Solids wet-out. A common requirement is to add solids at the liquid surface. Solids can take many forms. Some have a tendency to float; others are difficult to wet-out, forming air-filled clumps. Fine solids also may trap air. Typically, the mixer/baffle interaction is designed to facilitate drawdown, either through vortex creation or a recirculation loop.

Usually, when solids must be drawn down, a vortex is created with a down-pumping axial flow impeller and baffles cut off at the height of the impeller. Reference 2 provides general recommendations for impeller submergence and baffle width. Installations with cut-back baffles at 2% of tank diameter have proven more effective than unbaffled ones. Fluctuating liquid levels during solids addition present challenges that must be considered.

For solids drawdown, we cannot over-emphasize the value of small scale experimentation and scaleup correlations using the Froude number:

$Fr = N^2D/g$

where N is the rotational speed of the agitator, D is impeller diameter, and g is gravitational acceleration, which in imperial units is 1.39×10^6 when rotation is in rpm and diameter is in inches.

During process design, characterizing the behavior of process solids in process liquids is vital. Small scale, even bench scale, experiments often demonstrate that drawing down solids from the liquid surface impacts mixer design more than the need to suspend the same solids once incorporated into the process fluid. This requirement for solids drawdown may suggest a larger mixer than the that used for suspension of the same solids.

HORIZONTAL REACTOR OPTIMIZATION

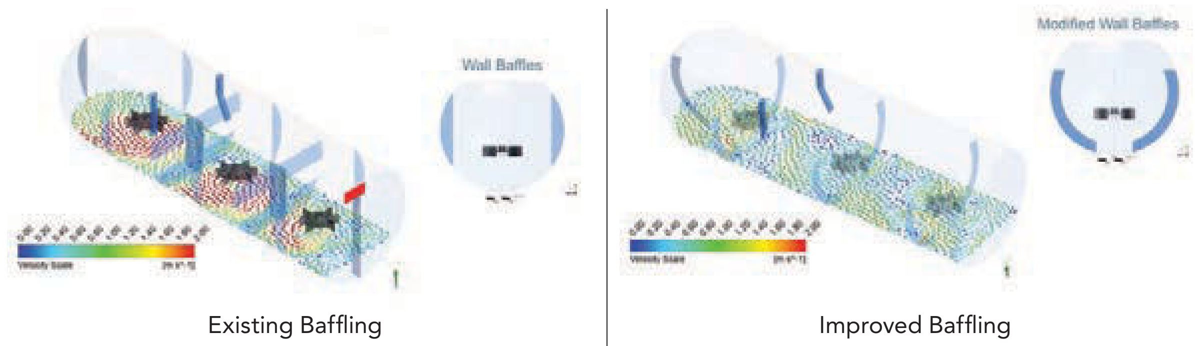

Figure 4. Removal of walls and new baffles reduced swirl and improved mixing.

Sometimes, you can create a recirculation loop for drawing down solids in a baffled vessel with an up-pumping axial flow impeller. Instead of going into a central vortex, solids will be pumped outward along the surface and drawn down along the walls.

An alternative and highly efficient method for introducing solids is below the liquid surface. This doesn't require modifications to baffle recommendations based upon the mixer and vessel geometry.

Higher viscosity fluids. A common statement is: "As viscosity increases, baffle size decreases." Figure 3, which charts the ratio of baffle width to tank diameter against viscosity, enables determining baffle width for full scale applications.

However, a more accurate baffle width statement is: "As Reynolds number decreases, baffle size decreases." Reynolds number, *Re*, which correlates well with mixing requirements, is a function of both the fluid and the mixer/vessel size:

$$Re = 10.75\ \rho N D^2/\mu$$

where ρ is density, μ is viscosity, and imperial units are used.

Baffle recommendations for mixing non-Newtonian fluids — such as many food ingredients, personal care products, resins, latexes, pulps, clay slurries, etc. — require consideration of the viscosity at an appropriately selected shear rate.

As scale increases from bench, to lab, to pilot, to production, flow patterns and the need for baffling may change. Use caution when scaling up bench mixing studies to larger scales because geometric similarity is relevant only in similar fluid regimes. For the same fluids, full scale installations always have higher Reynolds numbers and are likely to be turbulent even when the lab installation isn't. Fluid regimes in the lab often are laminar or transitional due to the small vessel sizes. For this reason, effective small-scale mixing studies frequently require simulant fluids to mimic the expected full-scale Reynolds number.

Unusually high or low power intensities. For higher power intensity reactor agitators, use four baffles. At low power intensities, opting for one or two baffles is better than doing without baffling. With two baffles, spacing at 180° is important. Two baffles in the same quadrant provide no better results than a single baffle.

Glassed vessels. Such units traditionally were fitted with one "beavertail" baffle, resulting in an under-baffled situation. Advances in glassing technology have enabled use of multiple baffles similar to those found in metal vessels.

Internal coils, jackets, vertical tubes and flat plate heat transfer surfaces. Coil supports and the turns of the coils themselves can act as baffles. To prevent swirling, reduce baffling as the number of coil banks increases. It is best to put baffles on the outside of the coils to maximize flow through the coils.

With jacketed vessels, use off-wall baffle installation.

Vertical tubes and flat plate heat transfer surfaces behave as baffles. Once you've calculated the appropriate heat-transfer area, you may need to cant the surfaces to avoid over-baffling the vessel.

In general, optimizing the flow patterns over heat transfer surfaces in agitated vessels necessitates designing a system where these surfaces, impellers and baffles work together. Three-di-

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mensional computational fluid dynamics (3D CFD) can be quite helpful.

Rectangular, horizontal or asymmetric vessels. Rectangular vessels are partially self-baffling. Additional baffling occasionally is recommended. Horizontal and asymmetric vessels pose unique challenges. For example, a recent horizontal reactor optimization improved mixing with minor changes to the agitator itself but with a new baffle configuration, as shown in the 3D-CFD model depicted in Figure 4. (This model comes from a study that utilized 3D CFD not only to model flow patterns but also to predict baffles forces for use by the vessel designer [3].)

Side-entry mixers. Don't use baffles with side-entry mixers. Many applications can benefit from offsets or angle-mounting configurations.

Dip pipes, thermowells, probes and other vessel internals. It's tempting to use baffles as the structural support for vessel internals. However, careful consideration of the flow patterns around the baffles is necessary because the flow patterns in the vicinity of the baffles are atypical of the bulk motion. Flow velocities on the trailing sides of baffles often are the lowest velocities in the vessel. Recommendations from agitator vendors, often supported by 3D CFD, can be helpful in locating these internals.

MECHANICAL CONCERNS

Baffles allow for a stable flow pattern in the vessel, which leads to lower variability mechanical loads on the agitator itself as well as the vessel nozzle and mixing mounting structure.

Forces developed by the agitation system determine baffle thickness and mounting hardware. The agitator vendor should provide the force data necessary to specify baffle thickness. Many years ago, Dr. James Oldshue presented the relationship for baffle design load, L_d, as follows:

$$L_d = (10{,}500\, P_m \times DF)/(B \times T_f \times N)$$

where L_d is baffle force in lb, P_m is motor horsepower, DF is the dynamic load factor (normally 2.0), B is the number of baffles, T_f is the tank diameter in ft, and N is in rpm [4].

This formula assumes the baffle force is a constant force perpendicular to the baffle acting in the direction of impeller rotation and is the same on each baffle. The forces are greater on the leading (higher velocity) side of the baffle than on the trailing side.

Generally, in low pressure or open vessels, make baffles the same thickness as the vessel shell, but never less than ¼ in. Always place wall supports on the trailing side of the baffle and uniformly space them along the baffle height.

Baffle force varies with baffle height and time. The force is concentrated at impeller(s) elevation(s). 3D-CFD plots enable visualizing timed-average pressure distributions on both sides of the baffles. Using 3D-CFD analysis for baffle design is most useful when baffle costs are substantial.

Recent studies presented at AIChE [5] used 3D CFD to characterize baffle loads based upon impeller design. The predicted loads then were experimentally validated in the laboratory. This work showed the classic baffle load correlation to be conservative, particularly for axial flow impellers. Specifically, based upon actual power draw, for the radial flow impeller, CFD predicted a maximum baffle force of 9.3 N (versus 15.2 N calculated); for the pitched blade turbine, CFD predicted 4.6 N (versus 14.4 N calculated). Both conditions were at equal agitator power.

A key take-away is that axial flow impellers impart less force on the baffles than radial flow impellers do.

Pressure profiles along baffles can be predicted with 3D CFD. This information is useful in locating baffles supports, troubleshooting or when the costs of high alloy baffles and mounting structures are significant.

In addition to promoting an effective mixing flow pattern, the proper installation of baffles reduces forces on the agitator. An agitator is designed assuming that baffle recommendations have been followed. This is critical because at equal power input, the removal of baffles in a vertical cylindrical vessel will increase fluid force 1.5–2.0 × the initial force on the agitator. Even if the agitator is moved off-center to improve the mixing flow pattern, fluid forces rise similarly [1].

When circumstances require, operating without baffles can result in a stable, but not necessarily optimal, flow pattern as long as vortexing down to the impellers doesn't occur. Due to the losses in mixing efficiency and increased forces on the agitator itself, operation without baffles requires forethought and rarely is an appropriate retrofit.

FINAL THOUGHTS

Baffle recommendations are a critical part of the agitation system design. Because baffles aren't part of the agitator vendor's scope, coordination is important — yet frequently overlooked.

When there is uncertainty about the need for baffles or the potential for process change, include baffle clips in the vessel design. This enables the addition of baffles later. ●

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Temperature Profiling Enhances Reactor Operation

Optical determination of gradients in catalyst-filled tubes fosters optimization

By Joachim Koelsch, Siemens Process Industries and Drives

INLINE MEASUREMENTS of temperature profiles in spatially confined applications place special demands on sensing technology. This especially applies to determining temperature changes in tube and tube-bundle reactors. Yet, getting such data can help optimize the reaction. That's why Evonik, Marl, Germany, opted for innovative fiber-optic temperature measurement technology.

Reliable determination of the temperature profile within the catalyst filling has far-reaching significance for the catalytic conversion of gases and liquids in tube/tube-bundle reactors. This profile substantially influences the course of the reaction, the quality of the material conversion, and the aging of the catalyst. The identification of hotspots — areas with excessive temperatures that can occur in the filling — plays an important role in minimizing problems.

Evonik's Matthias Hüning (Figure 1), a specialist in electrical measurement and control technology in the company's high-performance polymers business sector, describes the problem in his plant as follows: "We use tube-bundle reactors in our production plant for laurolactam, a starting material for Vestamid L. The challenge is to install a sufficient number of temperature measurement points in a small space within a single tube reactor in order to quickly detect high temperatures and undertake countermeasures. In this way, we can prevent destruction or the accelerated aging of the catalyst due to overheating. This avoids a plant shutdown, which would otherwise be required due to the complicated procedure for replacing a catalyst."

PLANT SPECIALIST

Figure 1. Matthias Hüning of Evonik plugs a glass-fiber coupler connected to the measuring probe into channel one of the transmitter.

The small diameter of the reactor tubes, the necessary number of measurement points and the demands on the speed of data acquisition ruled out the use of a conventional measuring system, i.e., resistance temperature detectors (RTDs) or thermocouples. So, working with Siemens, Evonik decided to install a Sitrans TO500 system. It features fiber-optic temperature sensing based on Fiber Bragg Grating (FBG) technology. This allows a greater number of measuring points while simultaneously reducing the protective tube in the reactor. Initial implementation took place in 2013; due to its success, an additional system was installed in a similar application this year.

OPTICAL TEMPERATURE SENSING

Contactless measuring procedures with fiber-optic sensors are becoming increasingly common in the chemical industry. The sensors are insensitive to electromagnetic interference and also chemically resistant. Another advantage is the possibility to couple the optical signals.

FBGs enable optical temperature detection. They are optical periodic structures inscribed in optical fibers. Because a particular wavelength of incident light is reflected while all others are passed, each grating acts as a narrow-band filter.

If a light beam with a broad spectrum goes through an FBG, the reflections of each section of the changing refractive index only affect a specific wavelength of light to any substantial degree. This is called the Bragg wavelength, λb; it is calculated by:

$$\lambda b = 2n\Lambda$$

where n is the effective refractive index of the fiber core, and Λ is the distance between the gratings, also referred to as the grating period. A fiber may contain multiple gratings.

Changes in length of the fiber from force or heat deform the grating and result in a shift of the reflected wavelength. This mainly stems from alteration of the refractive index of the quartz glass by the thermo-optic effect [1,2]. Because both strain and temperature cause a change in the wavelength, the FBG when used as a temperature sensor must not experience any mechanical stress, to eliminate the influence of strain.

The Sitrans TO500 system uses this wavelength change to determine temperature. The system consists of a transmitter to which as many as four fiber-optic measuring probes — each with up to 48 FBGs — can be connected. This enables the system to synchronously measure the temperature at up to 192 locations. Measuring probes can be precisely tailored to the application in regard to length, number of sensors and the sensor positions.

In the Evonik application, FBGs are inscribed every 20 cm (Figure 2). Each measuring probe has a diameter of approximately 1 mm and records temperatures within a range of 0°C to 400°C, with a measuring error of <0.5 K. Response time is very fast; the T90 time is under four seconds [3].

Because the measured value transmission (reflection of light) takes place in the same fiber, no additional cables are necessary, which substantially reduces the required diameter of the protective tubes for the measurement setup. This provides two key benefits: 1) a larger cross-section and, hence, volume is available for the reaction in the reactor; and 2) the small air gap between the fiber with its inscribed gratings and the tube walls keeps the gap's damping effect low and, thus, cuts the response time of the sensors.

At Evonik, a glass-fiber coupler connects the sensing fiber in the reactor and the transmission line to the transmitter. This coupler just needs disconnecting when maintenance requires, for example, opening the reactor cover. The measuring probe itself can be easily pulled out when necessary and rolled onto a spindle. The latter also enables it to be easily and safely transported.

The Sitrans TO500 transmitter provides the determined values for analysis in control systems via a Profibus DP interface and makes them available for management of the assets and optimization of the process.

VALUABLE INSIGHTS

"Our plant personnel can detect the development of hotspots or the effectiveness of the catalyst in good time with the detailed recording and visualization of the complete temperature profile in the reactor," notes Hüning. "We use this information to initiate measures to reduce the temperature, for example, in the first scenario. In the second scenario, we can perform maintenance procedures, such as replacing the catalyst when necessary due to its age." Both extend the life of the catalyst in the reactor, which means cost-effective, preventative maintenance procedures occur based on need.

Optical temperature measurement using FBGs along fiber-optic media provides an elegant way to simultaneously record and process a wide range of temperatures to enhance monitoring. It allows efficiently detecting faults and optimizing reaction processes, thereby achieving higher product throughput in the plant.

MEASUREMENT SCHEMATIC

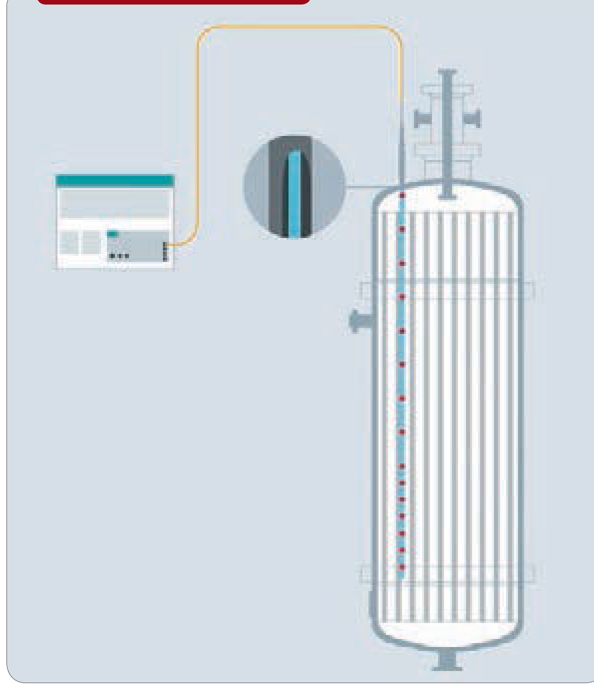

Figure 2. Fiber-optic probe takes measurements at multiple points along the reactor tube.

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Untangle Tower Trouble

Take specific steps to plug gaps in essential data

THIS MONTH'S PUZZLER

Our client is having trouble with a C_3/C_4 (propane/butane) splitter in a fluid catalytic cracker. I'd like to impress the client by solving its problems but am confused by the information collected during the kick-off walkdown.

The splitter tower has a tight i-C_4 limit. The real problem is C_3 impurities in the bottoms. A third of the trays in the upper tower were replaced a year ago by a bed of 1-in. packing to improve C_3 recovery from the bottoms. However, recovery didn't improve. A distribution plate instead of spray nozzles distributed the liquid over the packing; the reasoning was that this would avoid the nozzles' turndown limitations and their risk of fouling. The plant then introduced spray nozzles anyway — with no effect on recovery.

The operators are fairly new because of cutbacks in staff. They tell me that to their knowledge the tower has always performed like this. One older foreman says performance was better before the packing replaced the trays but the trays were old, corroded and leaking. Corporate engineering installed pressure transmitters across the packing a few months after the packing was installed. The pressure drop was higher than expected, so the 1-in. packing was replaced by 2-in. packing. However, this didn't improve tower performance. Unfortunately, the upper and lower pressure transmitters weren't trended because of limited distributed-control-system memory. Corporate engineering modeled the beds and can find nothing wrong with its decision to replace the trays.

How should we approach this problem?

FILL IN THE GAPS

Work with the vendors and corporate engineering because it doesn't sound like there's much depth at the refinery; instead of a confusing flurry of contradictory information, you have little. Start with equipment records. If there aren't any, collect the maintenance files and equipment tags if all else fails. Then, get the vendor files and make comparisons: create a timeline of changes to the tower.

Because refinery shutdowns are few and far between, try techniques that avoid disrupting production — unless tower performance worsens. Forget about pressure data: unless the same precision gauge always is used, measurement error will preclude divining a problem. Creating a clear picture without trend data is problematic at best. Also, forget about models: they're good for design but not much help for solving mechanical problems within a tower.

Here's how to approach this problem:

1. Collect new data. Bump the tower parameters, i.e., feed conditions, recycle, etc., and see how this affects product qualities. A slight change can show much without damaging product.
2. Review maintenance records. Has anything else changed in the tower? Sometimes, maintenance items that seem minor, like changing out an identical condenser control valve during a turnaround, don't get considered because they are so routine.
3. Consider what changed. How does the tower performance compare now to the past?
4. Expand the analysis to include the entire tower, not just the new packing. What happens under the packing is just as important as what happens in the packing.
5. Present these data to the original tower design vendors, the designer of the packed section, and other vendors.
6. Review options. Consider the ones that have the greatest chance of success and least risk to production first. Look at options that will confirm or refute causes. Also, deploy options that don't require shutting down operations completely.
7. Create a checklist for inspection when the tower is down. Include the following: a) confirming that the liquid tray is level and not plugged; and b) pulling the packing out and checking for breakage and how the gas is distributed at the bottom of the section — poor performance in random packing can depend on gas and liquid distribution.

Dirk Willard, consultant
Vernon, Texas

APRIL'S PUZZLER

Our refinery sells propylene to a polymer manufacturer. The railyard loading system (Figure 1) at the edge of our site usually gets little attention; I reckon it largely has been ignored for decades. However, the system drew management notice when we went through a patch of extremely cold weather. The frigid temperature caused the air lines to the control valve to plug when moisture in the lines froze. When I went to sort out that issue, the foreman was eager to share his other troubles: 1) the pump vapor-locks; 2) the compressor starts and stops too frequently, leading to too rapid replacement of the motor starter heaters; 3) the pressure relief on the compressor pops open often and sticks open; 4) the measurement from the orifice plate is erratic; 5) the pump frequently must go to the shop, mostly to replace seals and bearings; and 6) units at the refinery can't agree on an outage schedule to allow shutting down system for cleaning and maintenance. What can I suggest to improve this operation?

Send us your comments, suggestions or solutions for this question by March 9, 2018. We'll include as many of them as possible in the April 2018 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*, 555 W. Pierce Road, Suite 301, Itasca, IL 60143. 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.

PROPYLENE LOADING

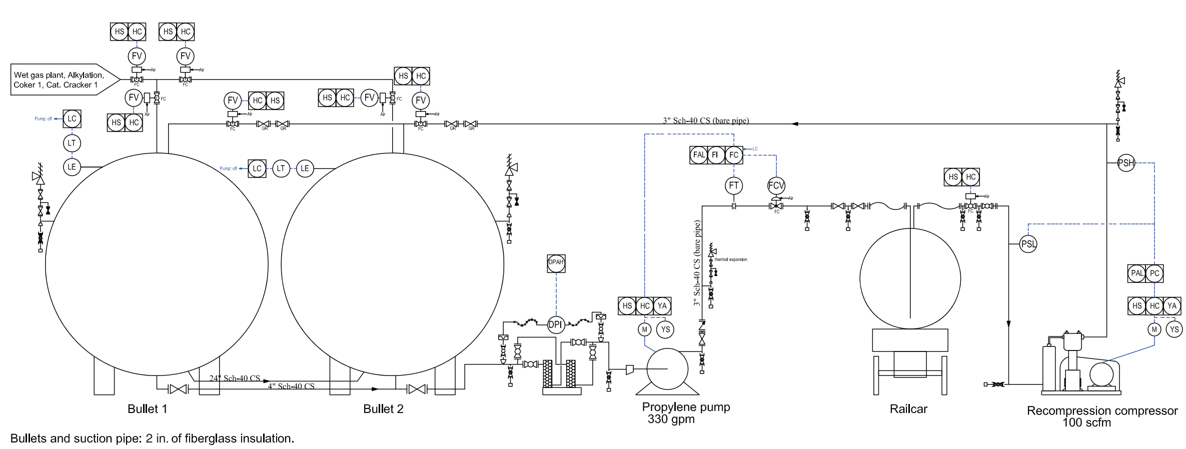

Figure 1. Long-neglected system is suffering a variety of problems.

Do More Than Troubleshoot

Find time to make improvements that deter difficulties

Change without extra resources allocated rarely works as well as planned.

CRISES AND current problems command immediate attention. Achieving fast fixes is a priority. So, understandably, such troubleshooting captures a lot of attention in most plants.

This often results in efforts to improve base operations getting pushed to a lower priority — and, thus, people spending insufficient time trying to forestall future problems. That's unfortunate because the best problem is the one that you don't have.

Improving base operations frequently involves making many things a little bit better rather than altering one thing a lot. Making one big change is more akin to troubleshooting.

The approach of cumulative small changes sounds a lot like the focus promised by "continuous improvement programs." In fact, it is. However, as the experiences of many plants and companies show, having a program isn't really the major factor behind success. Attitude counts more than an official program. And, of course, a positive attitude only goes so far without ability.

Success hinges on the interaction of three major aspects: (1) receptiveness to new ideas; (2) adequate technical knowledge; and (3) organizational attitude. The first requires willingness to question the status quo. The second demands suitable knowledge about the plant, process fundamentals, equipment, and interactions between the process requirements and equipment behavior. The third gets into issues such as balancing the uncertainty of changing procedures versus possible benefits, and reallocating resources and responsibilities.

Organizational attitude often doesn't receive enough consideration. So, let's focus on it.

Improvement requires more than technical ability. It requires change. Change demands both physical and mental effort. If too much change happens at the same time, people make mistakes. Change without extra resources allocated rarely works as well as planned. Even small changes can tax organizations. A response that "we just can't handle that right now" may seem reflexive but also may be a rational and realistic response to overload.

Changes, even minor ones, usually require some combination of two steps. First, staff need extra time so they can slow down and follow step-by-step procedure lists rather than relying on unwritten habits. Second, they should get extra training offline from the daily work so they can build new habits. Regretfully, the resources given (time, training) rarely suffice.

Successful organizations explicitly recognize the effort required for change and factor that into workload and budgets. These organizations then set an expectation of how many changes they are budgeting for. An example expectation would be "budget for six operating procedure changes per year to improve product quality." Many other specific approaches are possible; however, few are ever done.

Change shifts responsibilities. Improvements can alter workload as well as maintenance requirements. For instance, a switch to more inspections, monitoring and preventive part replacement and less repair work after-failure demands care. If staffing isn't revised as well, the inspectors may become overloaded.

Needed changes eventually may propagate higher up the organization. Alterations in responsibility and workload may necessitate the splitting or merging of departments. Some supervisors may get greater responsibility and authority. Often, people at higher supervisory levels resist change more than those at lower levels because they have put in a lot of time and effort getting to their current position.

Changes in work can truly lead to changes in importance of job functions and relative opportunities and status. Few of us are saintly enough to sacrifice too much of our potential or identity without some suitable tradeoff (benefit). The job of management is to align incentives so that changes that support the organization's objectives mesh closely with individuals' incentives. Effective improvement requires good management.

Success also demands conscious effort to foster attitudes to support change. Proper budgeting for the effort makes change more likely. Management also must understand the dynamics of changing work functions, workload and organizational modifications required.

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ASloley@putman.net

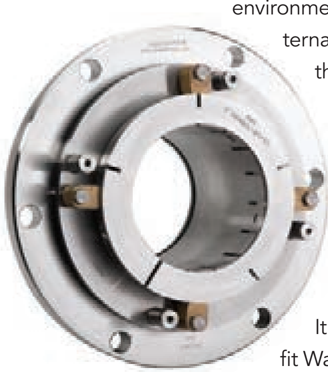
Rotary Drum Dryer Delivers Efficiency

The MDG rotary drum dryer provides a stable pressure dew point (pdp) of -40°F at almost zero energy cost, the company reports. The air dryer delivers cost-effective dry and oil-free air, with a total power consumption below 0.2 kW in all operational conditions. Its simplified design takes up less floor space, has no heating elements, no blower and no loss of compressed air. With fewer moving parts, the dryer reportedly requires less maintenance while offering more reliability than other dryers with -40°F pdp performance. Its zero purge design eliminates the waste of compressed air associated with twin tower dryers.

Atlas Copco Compressors LLC
866-546-3588
www.atlascopco.us

Seal Suits Heavy Duty Applications

The 170L slurry cartridge single seal is engineered to operate in severe slurry environments without external seal flushes in the majority of applications. The seal helps reduce water expenses, especially where clean water is scarce or costly. It is designed to fit Warman AH series pumps without pump modification. This eliminates the need to dimensionally check each pump to determine seal form and fit, as well as the requirement to modify the pump to fit a seal design. A single clamping screw prevents equipment shaft damage and simplifies seal removal in sticky or viscous fluids, or where solids have a tendency to clog up standard set screw designs.



A.W. Chesterton Company
781-438-7000
www.chesterton.com

Software Update Includes Operator Training Feature

aspenONE Version 10.1 now includes Aspen Operator Training that enables seamless deployment of training for operators and engineers, brings operator training simulation online sooner and sustains safety throughout the asset's lifetime. Other enhancements to the software suite include costing updates for Aspen Capital Cost Estimator and ASME design code updates for Aspen Exchanger Design & Rating. The Aspen Simulation Workbook excel interface is now compatible with both 32-bit and 64-bit computers. The aspenONE manufacturing execution systems software now provides easier migration to the web-based aspenONE Process Explorer. Users can access key performance indicators via real-time dashboards configured using improved navigation and drag and drop functionality.

AspenTech
855-882-7736
http://aspentech.com

Sensor Handles Segmented Silos

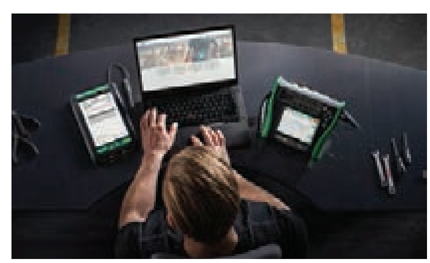
The 3DLevelScanner acoustic sensor's new firmware helps manage inventory in silos with pie-shaped segments. The 3DLevelScanner measures and models the topography of material contained in these unusually shaped wedges. The firmware then applies the measured distances to a 3D model of vessel dimensions to calculate a highly accurate volume measurement, reports the company. The sensor also can detect

buildup on the outer perimeter of the silo or along on the walls, allowing for improved inventory and drawing attention to any needed maintenance.

BinMaster
800-278-4241
www.binmaster.com

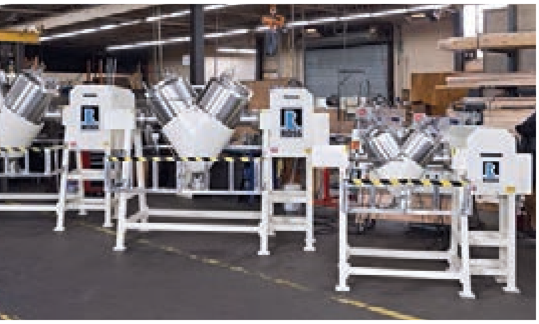
Calibration Software Speeds Certification

LOGiCAL is a free, cloud-based calibration certificate generation software that reads the calibration results from Beamex documenting calibrators. When performing calibrations, the calibrators automatically store the results in their memory. The software reads these results and converts



them into a PDF calibration certificate to either store or print. When running the software, the cloud communicates with the calibrators using a web service technology, meaning the calibration certificate is generated using any device connected to the internet and a web browser. The software is compatible with most browsers, such as Chrome or Safari.

Beamex, Inc.
800-888-9892
www.beamex.com



Tumble Blenders Now Include Light Curtain

This protective light curtain provides automatic safety shutoff of tumble blenders whenever an operator crosses a defined security boundary. Due to the nature of the rotating mix chamber, a safety railing is supplied standard on all tumble blenders. The addition of optional light curtains further improves operator safety. The blenders offer gentle agitation for dry applications such as powders and pellets in many process industries. They reportedly are ideal blenders for batches requiring the dispersion of extremely small minor components and low shear intensity. Tumble blenders range from ½ to 100 ft^3 capacities.

Charles Ross & Son Company
1-800-243-7677
www.mixers.com

Service Speeds PLC Modernization

A service helps modernize programmable logic control (PLC) systems easily, safely and more cost effectively, sometimes in less than one hour, says the company. By reducing downtime and disruption to the operation, the service simplifies migration to the company's Modicon M580 programmable automation controllers (ePAC). With built-in Ethernet, the PLC reportedly can enable 100% ROI within three months. The service combines a Unity M580 application converter with a migration expert configuration utility tool, which identifies operational gaps and provides recommendations to solve systems challenges. This combination allows users to convert Unity software applications on both Quantum and Premium platforms to be compatible with the ePAC.

Schneider Electric
877-342-5173
www.schneider-electric.us

Manifold Eases Gauge Removal

V03 manifold/valve assemblies provide isolation and control in systems equipped with Ashcroft 1132 and 1133 differential pressure gauges. Available in three- or five-way configurations, these stainless steel manifolds permit removal of the gauge without disrupting the process. They also allow high- and low-side equalization prior to startup to eliminate damaging high-side spikes. 1132 and 1133 gauges can be direct mounted or remote mounted via a capillary or hard tubing.

Ashcroft Inc.
203-385-0635
www.ashcroft.com

Containment System Reduces Emergency Shutdowns

The Xtreme Shell is a two-piece shell designed to fully encapsulate a leaking flange, valve, manifold or leak point. The shell diverts the leak via a drain port and discharge line to a secure containment system. This allows users to mitigate an emergency, and perform repairs at more convenient time, such as scheduled shutdowns. The system is designed to eliminate the mess that can increase risk of accidents, injuries, ground contamination and unsafe working conditions around machines and walkways. Simple and quick to install indoors or outdoors, the UV-resistant system handles fluids up to 200°F and is impact resistant to -20°F.

Andax Industries LLC
800-999-1358
www.andax.com

Software Simplifies Piping Design and Modification

Pipe-Flo v16.1 incorporates several improvements to existing features. The latest release includes the Overtime module, and updates such as a new and modern platform, defined tank geometries, adjustable centrifugal pump speed, device elevations and more than 6,000 new fluids. The software offers a variety of ways to view and analyze fluid piping systems. The program aids in the design, commissioning, operation and modification of fluid piping systems. The visibility provided allows a common basis for operators, process and design engineers and management to understand, communicate and document their fluid piping systems and processes.

Engineered Software, Inc.
360-359-4030
www.eng-software.com

Tablet PC Aids Commissioning

The Field Xpert SMT70 is an industrial tablet PC for commissioning and maintenance staff to manage field instruments and document the work progress. The tablet comes preinstalled with DeviceCare device configuration software and device library. The

Field Xpert SMT70 supports HART, Profibus DP/PA, Foundation Fieldbus, Modbus, CDI and Endress+Hauser service interfaces. It can connect to field instrumentation devices directly via a USB or Bluetooth wireless modem, or via a gateway, remote I/O or multiplexer to a bus system. The device library has more than 2,700 pre-installed device and communication drivers, allowing it to work with many different instruments from a variety of vendors.

Endress+Hauser
317-535-1376
www.us.endress.com/SMT70

Ball Valves Resist Corrosion

Two ball valves have been added to the polypropylene bolted ball valves line. The first is a 2-in. full-port 3-way bottom-load valve. The second new

valve is a 2-in. full-port 3-way side-load flange valve. Both ball valves are manufactured from glass-reinforced polypropylene for strength and durability, and will not rust or corrode. The valves incorporate a self-aligning ball that rotates freely against Teflon seats, and come standard with EPDM O-rings and Viton O-ring stem seal.

Bee Valve Inc.
440.366.0220
www.beevalve.com

Software Includes HART Functionality

TwinCAT automation software and I/O system hardware, now with integrated HART protocol functionality, is designed to promote simple project planning and reliable commissioning. The software facilitates the application of comprehensive HART functions directly from the engineering interface, reducing development efforts. In this way, the TwinCAT field device tool

(FDT) container enables implementation of any field device drivers. This means an entire HART configuration can be implemented using a single software tool. The Beckhoff CommDTM integrates the TwinCAT platform into existing process control systems. With its help, the device drivers can be implemented in any FDT container.

Beckhoff Process Automation
952-890-0000
www.beckhoffautomation.com

Feeder Prevents Clumping

Model VMF-90A volumetric screw feeder is designed for automated additive dosing in chemical and water treatment processes. For feeding dry

powdered or pelletized materials, it achieves feed rates of up to 10.19 ft^3 per hour. The unit uses gravimetric feeding enhanced with a built-in mechanical cam-actuated hopper agitator. The agitator continually conditions the material to promote uniform flow and prevent clumping. The stainless steel hopper has a capacity of 1.5 ft^3. A stainless-steel auger (0.50-, 0.75- or 1.5-in. diameter) with bayonet-style connection enhances a steady feed rate. The feeder is water and dust proof and controls are housed in a NEMA 4X, UL-approved enclosure.

Scaletron
800-257-5911
www.scaletronscales.com

Software Analyzes Data from Multiple Sources

SIMCA-online 14, an advanced data analytics and visualization program, makes it possible to combine and analyze data from all sources to isolate, understand and act on the information. The multivariate data analysis engine enables companies to detect and analyze deviations from normal operating conditions by modeling an idealized process. Once this model is transferred into SIMCA-online, it serves as a reference for current production. The newly enhanced software offers an intuitive graphical interface and the flexibility to handle complex data, such as reworking, splitting and merging. Projects can be uploaded directly to an available SIMCA-online server for real-time visualization of the process from a data point of view.

MKS Data Analytics Solutions
978-645-5500
www.mksdataanalytics.com

PC Display Resists Chemicals

The Simatic IPC377E basic panel PC, based on Intel Celeron processor technology, helps optimize cost for PC-based applications in industrial environments. The panel PC combines the openness and performance of an industrial PC with a long-lasting, robust display with anti-glare glass front, analog-resistive with single-touch operation, scratchproof and resistant to chemicals. The display is available in three sizes: 12-, 15- or 19-in. diagonal screen. The panel PC reportedly is suited for economical implementation of HMI applications or the acquisition and networking of production and energy data. It is easy to integrate in existing machines and plant concepts.

Siemens Corp.
800-743-6367
http://sie.ag/2FuxQas

System Improves Maintenance Efficiency

The latest version of AMS Device Manager resolves the problem of nuisance alerts with pre-defined con-

figuration templates that filter out all alerts tangential to the core problem, leaving only meaningful, actionable notifications. The release also delivers the new AMS Device View web interface, a browser-based display with mobile-friendly dashboards. The web interface allows users to view device health and calibration status from a wide range of devices, both on and off the plant floor. Focusing on device health rather than alerts helps users hone in on devices that need maintenance without being distracted by a long list of issues.

Emerson Automation Solutions
800-722-2865
www.Emerson.com

Filter Covers Larger Surface Area

Tri-Flow compact filter technology for submicron particulate and fumes delivers performance identical to a HEPA filter, while providing MERV 16 alternative to bags and cartridges, which are typically MERV 10–13, says the company. In addition, the filter provides 2–3 times more filtration area compared to filter bags. Filtration efficiencies are 99.999% on 0.5 micron and larger particles by weight. The filters are self-supporting; media is pleated and continuously bonded for maximum stability. Aerodynamic gasketing optimizes pulse cleaning efficiency. Self-cleaning filter elements have a multi-year service life, and are easy to maintain with integral pulse-jet cleaning.

Tri-Mer Corp.
989-723-7838
www.tri-mer.com

Module Monitors Chemical Injection Process

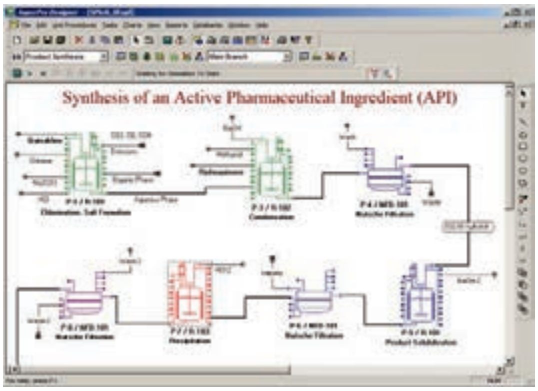
The Mirador chemical injection control and diagnostic module is designed to remotely monitor and change process configurations on dosage, calibration, temperature limits and other parameters for reduced waste and production costs. Operating on an open-based platform with Modbus RTU communication protocol, the system seamlessly integrates with sensors, communications and software to provide full operational visibility, tracking, control and analysis over chemical injection processes from a remote control station. Through a simple retrofit to existing tank-and-pump-only systems, this subsystem reportedly addresses 95% of chemical injection systems that work by on/off control capacity to deliver chemical to the point of injection.

DCiii, LLC
361-882-3444
www.dc3control.com

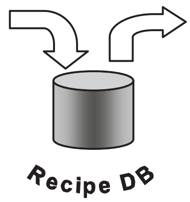
Intelligen Suite®

The Market-Leading Engineering Suite for Modeling, Evaluation, Scheduling, and Debottlenecking of Multi-Product Facilities

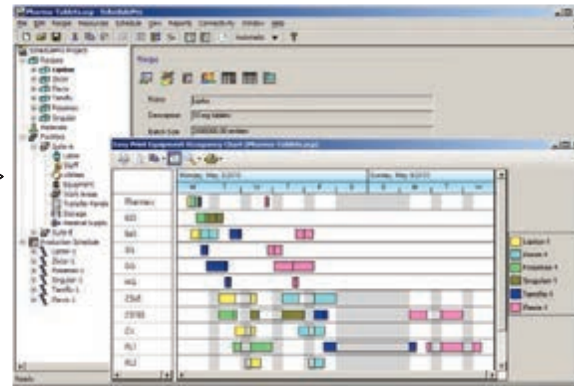
SuperPro®



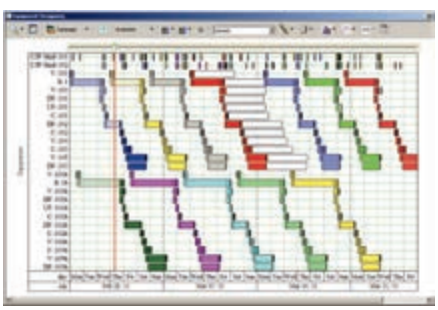
Use SuperPro Designer to model, evaluate, and optimize batch and continuous processes



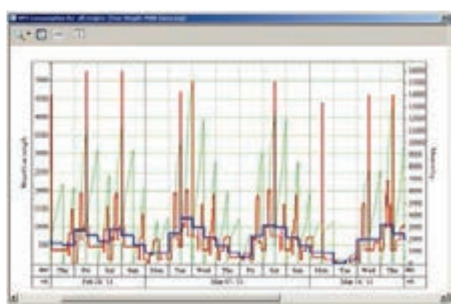
SchedulePro®



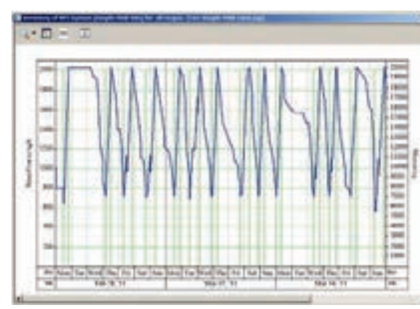
Migrate to SchedulePro to model, schedule, and debottleneck multi-product facilities



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.

Visit our website to download detailed product literature and functional evaluation versions of our tools

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An NFPA-compliant indoor flameless venting system by the inventors of indoor flameless venting, REMBE, the Q-Rohr-3 eliminates the need for relocating dust collectors and other equipment outside. The recently introduced Q-Rohr-3-6T/6T-AL are now approved for use with dusts, gases, hybrid mixtures and metal dusts. The Q-Rohr-3 products are the perfect solution for applications found in pharmaceutical, coatings, steel, iron and other industries.

REMBE, INC., (704) 716-7022, www.rembe.us

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IChemE Council Survives No-Confidence Vote

Fifty disgruntled members had raised a motion against the leadership

"Fact Checker" documents became points of contention on social media.

THE INSTITUTION of Chemical Engineers (IChemE), Rugby, U.K., has hailed the results of an emergency general meeting (EGM) held in London on January 11 as a powerful vote of confidence in its leadership. Seven out of every ten members who voted supported the current president and council of the organization.

The meeting was called on October 4, 2017 after member Keith Plumb garnered the 50 signatures necessary to pose a motion of no confidence in the IChemE. That motion stated: "We the undersigned members no longer believe that the Institution of Chemical Engineers represents the wishes or interests of the majority of its members. We therefore call for a vote of no confidence in the president and council of the Institution of Chemical Engineers."

The no-confidence call was the culmination of years of exchanges and comments from and between disgruntled members, many on social media. Their concerns are many and include the erosion of voting rights for many of the more than 44,000 members of the IChemE, a ruling council top-heavy with academics, the treatment of a former council member by both council and IChemE management, the organization's inflated salaries and pensions, rising membership subscriptions, and the lack of practical engineering and safety skills in graduates produced by chemical engineering departments.

In response, IChemE's council issued a statement describing these comments as "ranging from the sensible to the outrageous."

It also added a counter-motion to the ballot. This stated: "The members of the Institution have confidence that the president and council will ensure IChemE complies with its Royal Charter and charitable obligations and will work to continually improve the management and governance of the Institution to the benefit of its members."

The IChemE then organized a series of webinars and meetings to present its point of view to the membership before the EGM took place. It also published a set of "Fact Checker" documents on its website. Both became points of contention on social media, with supporters of the no-confidence motion wondering why the machinery of the IChemE wasn't being made available for them to present their point of view, and querying the veracity of some of the information in the Fact Checker.

The December 2017 issue of the satirical magazine *Private Eye* covered the ongoing spat under the headline "Chemical engineers: storm in a beaker."

The EGM itself began on January 11 under the chairmanship of IChemE president John McGagh with the organization's CEO Jon Prichard acting as meeting secretary.

Speakers from the floor were given three-minute slots to address the meeting with their views on the two motions and to question McGagh and Prichard.

One of the concerns raised involved the content of the Fact Checker documents. McGagh assured the meeting that more information concerning IChemE's pension scheme, staff salaries and investments would be made available in due course.

Then the EGM moved to the count. Council's motion received 2,924 votes in favor (72.1%) with 1,132 votes against (27.9%). The no-confidence motion received 1,158 votes in support (28.5%) and 2,900 votes against (71.5%). Together, that represent a total turnout of 31.1% of members who were eligible to vote.

Welcoming the result, IChemE deputy president Ken Rivers said Council now must reach out to those who are not content and voted for the no-confidence motion. "To you I want to say that we are listening, we have heard many of your concerns, and we want to understand your views better," he said.

"The EGM process has brought into sharp contrast some areas of difference between some of us. It highlighted some divisions, but it is also the opportunity to deliver a renewed sense of unity around a common agenda," he added, pointing to the IChemE's meeting in May at which proposed changes to how the organization will be run in the future are up for discussion.

One of the no-confidence-motion signatories, an IChemE fellow with over 30 years of experience, noted: "We never expected to win, but are sorely disappointed with the way that the IChemE has handled the whole thing — particularly the project fear idea that passing our motion would affect either IChemE's charitable status, or its ability to confer chartered status. This is nonsense. At the same time we certainly didn't expect to get 28% of the vote: if you get that sort of result at an EGM in the corporate world, people would be standing down."

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sottewell@putman.net