

## Practical solutions for today, forethought for tomorrow

CHET THOMPSON, President and CEO, American Fuel & Petrochemical Manufacturers



Welcome to the 72nd annual AFPM Operations & Process Technology Summit! In its 72-year history, this event has seen many changes. From its beginnings in 1947 as a multi-day Q&A forum that was attended by many from our industry, it has evolved into an engaging and informative one-stop shop for professional,

technical and industry network development. Many of you have been attending this event for decades—some of you for 40 years or more—developing valuable connections and forging lasting friendships with industry peers.

The theme of this year's Summit is, "Maximizing your molecular advantage: Practical solutions for today, forethought for tomorrow." Ultimately, this is about creating efficiencies within your operations that lead to greater profitability and nimbleness to respond to changing circumstances. As always, this year's Summit will offer approaches for enhancing and streamlining daily operations, protecting your facilities against cyber threats, technologies to optimize plant operations, and much more.

This year, we are excited to provide even more content for our young professional attendees, including the Emerging Subject Matter Experts Forum, which highlights how

professionals can develop into experts on behalf of their organization and industry. We will also again offer our New Manager Morning Mixer, Emerging Leaders Networking Event and the Women in Industry Reception, which will help you expand your industry contacts and support your professional growth. I hope you will avail yourself of these great opportunities.

Lastly, an important piece of news. With appreciation for everything this event has offered us over the years, we are ready to build its success and take things to the next level. Next year, we will be hosting a new event on August 25–27 in San Antonio, the AFPM Summit: Excellence in Plant Performance. This Summit will combine everything you love about this Summit, our Reliability and Maintenance Conference, and our Cat Cracker meeting into a newer, fresher, more interactive event. We have listened to your feedback and aim to deliver. The new event will provide more collaboration and knowledge sharing, more timely topics with clear takeaways, more opportunities to network with your peers, and more cutting-edge technology infused throughout the experience.

For those of you who have attended the Summit for years, welcome back and thank you for your ongoing interest and support. You have made this event what it is today. I also welcome first-time attendees and know you will find tremendous value in the event. We look forward to enjoying this final Q&A with you and beginning anew in 2020! ●

### INSIDE THIS ISSUE

- 3** Schedule of sessions and special events
- 4** Grade the shift: Improving operations and process performance  
AIS Software details the "grade the shift" optimization method, and the solutions provided by a dedicated process monitoring and visualization application.
- 8** Return summertime profits to winter levels with temporary process cooling  
Using temporary rental equipment to provide supplemental cooling can allow facilities to operate at optimal throughputs year-round.
- 12** Creating an actionable roadmap for digital transformation  
To enable refining and petrochemical operations teams to target high-value opportunities, Emerson has developed a scalable action plan while minimizing risk.
- 14** 2019 Summit panelist bios
- 16** Innovative, high-temperature, water-gas shift catalyst  
Haldor Topsoe discusses its new catalyst: SK-501 Flex.
- 18** List of exhibitors, hospitality suites, meeting rooms map

## The world is going digital—so should training

JOE MCMULLEN, AVEVA

Technology is transforming the way businesses think, act and operate. Industry 4.0 is mostly responsible for the present reinvention wave. Digitalization, cloud computing, automation, the Industrial Internet of Things (IIoT) and artificial intelligence are the most significant drivers redefining how businesses will function.

A recent survey conducted by AVEVA revealed that 93% of industrial leaders confirmed that the digital transformation is a top priority. However, digitalization is not the endpoint, but part of the journey to higher operational excellence. Cloud computing, the IIoT and augmented/virtual reality (AR/VR) are tools that are redefining

how companies run complex, global businesses. More importantly, this digital transformation will create new jobs and processes that require vastly updated skill sets.

**Technologies, employees and business goals.** Digitalization is melding innovative technologies, employees and business goals. Implementing advanced technologies and the training to fully utilize such developments are paramount for success. Just installing new software and hardware will not attain project goals. Preparing employees to fully deploy and use these new systems and IIoT-based programs is the end game.

Well-trained employees carry out and support manufacturing and processing operations. In addition to the spending on hardware and software, companies must equally invest in and champion training initiatives. Before deciding on technology providers, decision makers must allocate funding for sustainable training/education programs.

**Training is an investment.** With the adoption of new technologies and operating procedures, training programs must evolve. They should incorporate the same models, developments and systems that are used in the field. Just as process control radically changed board and operator roles in plant operations, the digital transformation will demand updating training/education programs to adapt and integrate Industry 4.0 advancements.

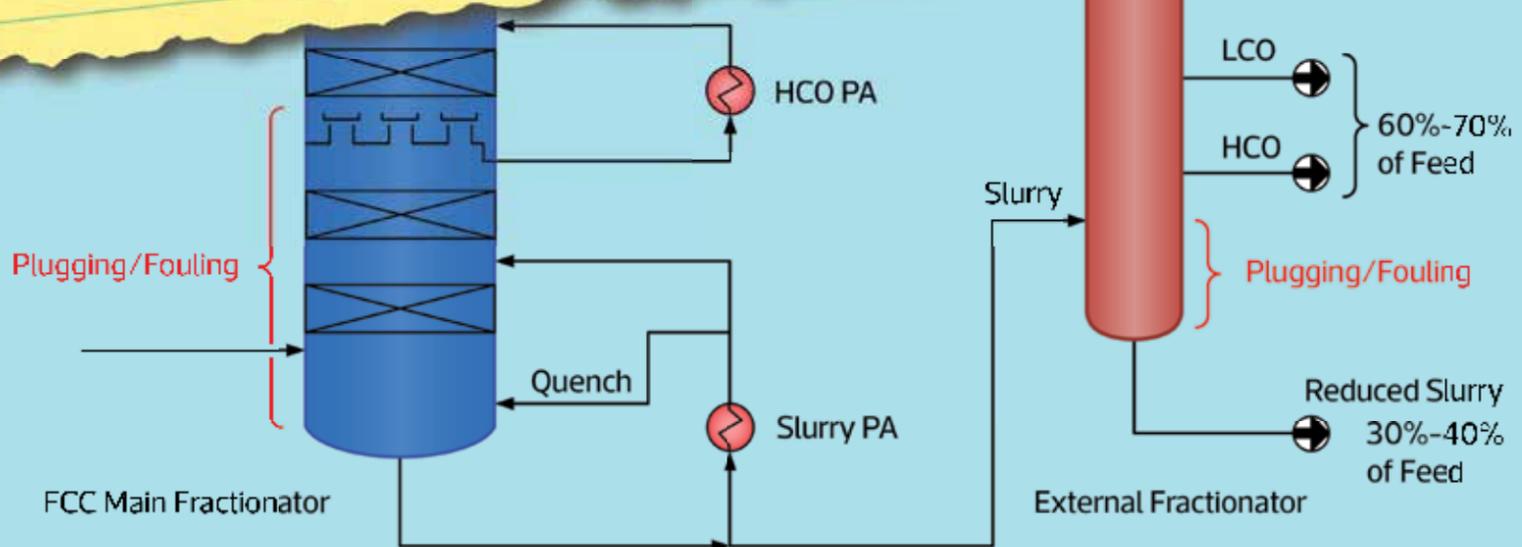
**Education programs must evolve.** Globally, all industries are applying innovative technologies to improve safety, optimize operations, increase profitability and more. Accordingly, training staff to work proficiently with innovative software and hardware is an ongoing process. As training is a core value, yesterday's methods will not produce the desired skills for today's operators. A recent ARC Forum report indicated that 42% of unscheduled downtime was due to human



**FIG. 1.** AR and VR training provide an immersive learning environment that enables trainees to practice procedures and become more familiar with approved actions to protect themselves, other personnel and the plant.

► See **DIGITAL**, page 3

# Process Notes



*Process to minimize FCC slurry product*

## Equipment Design Matters

Many attractive projects fail to meet expectations at startup. Disappointing performance often results from bad simulation practices and/or poor equipment design rather than faulty execution. Refineries are currently considering FCC revamps to increase olefins for more alky unit feed, maximize LCO product recovery, and minimize slurry product by producing HCO for hydrocracker feed. These changes raise fractionator operating temperature. Higher temperatures require better process and equipment designs to avoid fouling and coke formation, which lead to poor reliability and potentially to an unscheduled shutdown.

While getting the simulation right is important, process equipment design is equally critical to a project's success. Consider a project to minimize FCC main fractionator bottoms product (Slurry, DCO, CSO, etc.). As outlined in the top figure, an external fractionator can recover substantial quantities of LCO and HCO from the FCC slurry product, reducing slurry volume by 60% - 70%.

Upgrading a significant quantity of low-value slurry to LCO and HCO provides a powerful economic incentive to execute a recovery project, but poor reliability can destroy project value. Good process design is important. For example, proper quench and pumparound system control is essential. However, ultimate results are driven by equipment design rather than the theory of a process model.

In both the main and external fractionators, liquid distributors must be designed for practical flow rates and to handle solids. Unsophisticated distributor design creates uneven liquid distribution that reduces fractionation efficiency and LCO recovery against the endpoint specification. The main fractionator slurry pumparound and quench distributors must eliminate hot spots in the grid and bottoms liquid pool, respectively, to prevent coke formation. The picture below illustrates the result when equipment design is left to low-cost vendor solutions.

Finally, the bottom product from the external fractionator (reduced slurry) will be nasty. Stripping trays must be specially designed to work in this extremely fouling service, and bottoms pumps must be compatible with very low API material containing solids.

Equipment design matters. Don't miss performance goals by applying generic equipment design to specialized problems.



errors. Improving performance and training of operations and maintenance staff can increase safety performance and operational excellence.

**Innovation requires new thinking.**

The world is going digital, and so should training programs. The digital revolution, cloud computing and the IIoT continue to make inroads for processing and oil and gas operations. As companies plan IIoT and digitalization projects, such investments should also be tied to process key performance indicators (KPIs) and have measurable improvement benchmarks for operations and maintenance jobs.

Blending the IIoT and the cloud enables using advanced dynamic, high-fidelity simulation models and human-machine interface (HMI) control graphics that replicate actual process operations. With the cloud, live process data can be used in operator training simulation (OTS) models to create digital twins, which are very suitable for training scenarios. Dynamic OTS methods and models replicate true

process responses from trainee interactions. Intense OTS sessions closely duplicate actual work conditions.

More importantly, the same models are used in training, real-time optimization (RTO) and optimization programs. Process engineers and operators receive consistency in information and develop greater trust in the data and simulation results. Likewise, they gain confidence in their actions through extensive practice in a safe environment. Robust simulation models support AR and VR training (FIG. 1), which is an immersive learning environment. For emergency events, VR enables trainees to practice procedures and become more familiar with approved actions to protect themselves, other personnel and the plant.

**New tool kits.** With the digitalization wave, increased connectivity between process data, control systems and users is possible and mandates different technical expertise. The job roles of operators, engineers and maintenance must evolve with the installation of IIoT applications.

Digitalization and cloud computing are considered great disruptors; both support a transformative platform to the next level of operational excellence. Failure to innovate or adapt is truly a death sentence for any company unwilling to change.

As in any significant technology revolution, the digitalization wave is creating uncertainty, especially for new users. It is all new territory, and there are numerous ways and suppliers that can be part of the IIoT solution. Unfortunately, some decision makers get stuck in digitalization/IIoT limbo and struggle in choosing the path forward.

As in any major project, trust and confidence in technology and engineering vendors are crucial. These projects are longer-term commitments and require guaranteed durability service life. The most significant benefit of the IIoT is the ability

to use the cloud. Physical barriers are removed, and global access by numerous users is possible. Such open platforms enable remote and self-training options for employees.

**Longer view on training and the IIoT.**

As the digital transformation continues, cloud-based training will prove more valuable. Better-trained staff are the key to meeting company goals in profits, operational excellence and more. Top-tier companies will embrace the digitalization transformation and further deploy OTS to maximize operator effectiveness, increase safety performance and optimize processing operations. Success in the digitalization journey will involve working with trusted engineering and technology partners to share the road.

To learn more, visit the AVEVA team in the Exhibition Hall. ●

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- Access the most up-to-date attendee list
- Send private messages and schedule meetings with fellow registrants
- Post updates to sessions, keynotes and exhibitor booths and obtain up-to-date event details
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**2019 OPERATIONS & PROCESS TECHNOLOGY SUMMIT**

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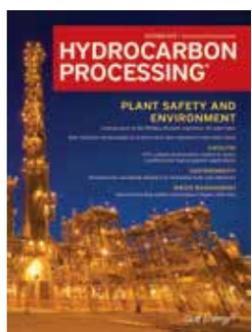
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**SCHEDULE OF SESSIONS AND SPECIAL EVENTS**

**SUNDAY, OCTOBER 13, 2019**

- 3:30–6:30 p.m. Registration
- 4–5 p.m. Student and Emerging Leaders Meetup
- 5:30–6:30 p.m. The Summit Welcome Reception

**MONDAY, OCTOBER 14, 2019**

- 7 a.m.–6:30 p.m. Registration
- 7–8 a.m. New Manager Morning Mixer
- 8–8:55 a.m. **General session**
- 9–10 a.m. **Concurrent Sessions:**
  - Cybersecurity
  - Operational Planning, Control & Automation Technologies (OPCAT)
  - Principles & Practices: Emerging Leaders Town Hall
  - Principles & Practices: SME
  - Q&A and Discussion Session: Gasoline Processes
- 10–10:15 a.m. Coffee Break
- 10:15 a.m.–12 p.m. **Concurrent Sessions cont.**
- 12–2 p.m. Lunch in Exhibit Hall
- 2–3:30 p.m. **Concurrent Sessions:**
  - Cybersecurity
  - Operational Planning, Control & Automation Technologies (OPCAT)
  - Principles & Practices: Auxiliary Facilities
  - Principles & Practices: Gasoline Processes
  - Q&A and Discussion Session: Hydroprocessing
- 3:30–3:45 p.m. Refreshment Break
- 3:45–5:15 p.m. **Concurrent Sessions cont.**
- 5:15–6:30 p.m. Reception in Exhibit Hall

**TUESDAY, OCTOBER 15, 2019**

- 7 a.m.–5 p.m. Registration
- 8 a.m.–10 a.m. **Concurrent Sessions:**
  - Cybersecurity
  - Operational Planning, Control & Automation Technologies (OPCAT)
  - Principles & Practices: Hydroprocessing
  - Q&A and Discussion Session: Crude
- 8–12 p.m. EMpower Session
- 10–10:15 a.m. Coffee Break
- 10:15 a.m.–12 p.m. **Concurrent Sessions cont.**
- 12–2 p.m. Lunch in Exhibit Hall
- 2–3:30 p.m. **Concurrent Sessions:**
  - Operational Planning, Control & Automation Technologies
  - Principles & Practices: Crude
  - Q&A and Discussion Session: FCC
- 3:30–3:45 p.m. Refreshment Break
- 3:45–5:15 p.m. **Concurrent Sessions cont.**
- 5:30–6:30 p.m. **Women in Refining Reception\***  
\*Reception open to registered women only

**WEDNESDAY, OCTOBER 16, 2019**

- 7:30–10 a.m. Registration
- 8–9:30 a.m. **Concurrent Sessions:**
  - Principles & Practices: FCC
  - Principles & Practices: Fostering Profitability
- 9:30–9:45 a.m. Coffee Break
- 9:45–11 a.m. **Concurrent Sessions cont.**

# Grade the shift: Improving operations and process performance

RICK KAISER and ROGAN JONES, AIS Software

On the last day of each year, the lead operator at a major American oil field challenges his team to push more crude oil down the pipeline than they had the year before. They do everything possible during their 12-hr shift to accomplish this: creating clear goals, working together to establish targets, closely monitoring the process, openly communicating the results, celebrating their successes and discussing lessons learned. This all-out effort is repeated every year, and while it is usually successful, it is not for the faint of heart.

While sustaining such a high level of production over the long term is neither possible nor advisable, the careful daily application of these techniques can result in steady and progressive improvements in refining margins. This approach has been successfully used at many refineries throughout the world, where it is often referred to as “grading the shift.”

“Grade the shift” is a work process that follows the traditional plan, do,

study and act (PDSA) cycle of continuous improvement (FIG. 1) specifically applied to process facilities. This approach establishes a goal, creates a plan, executes the plan, compares the results against the goal, makes a few changes and then repeats.

The “grade the shift” method, detailed in FIG. 2, is an optimization cycle that:

- Establishes clear and realistic goals with key stakeholders (management, operations, engineering and maintenance)
- Communicates the goals clearly to the workers
- Gives operations the freedom to perform their jobs
- Solicits feedback on status and problems encountered
- Displays the important process values, targets and margin drivers
- Compiles and distributes the results.

**Weekly business plan.** Key stakeholders must work closely together to identify realistic, attainable and measurable goals that can be achieved within the constraints of process, equipment, labor force, safety and regulations. Business planning must set targets to drive optimal process conditions. Margin drivers, which are process value tags that display the economic consequences of off-target values, must be included on key performance indicator (KPI) dashboards for everyone to see. Controls must be in place to limit who can recommend and set process values, targets and margin drivers.

**Visualization system updated.** Everyone from the boardroom to the control room must have real-time access to the KPI dashboards that display process values, targets and margin drivers. The displays must be clear, consistent and meaningful to everyone who uses them, including management, operations, engineering and maintenance.

**Start of shift meeting.** At the beginning of the shift, production team leads must provide operations with their instructions that support production goals and economic drivers. After that, the operators run the plant and record progress in their shift reports, which then roll up into the managers’ daily reports. With clear process safety guidelines in place, operators can positively impact the margin contribution and produce consistent positive results.

**Console meeting.** Unexpected changes in processes and equipment happen all the time. Production specialists, maintenance crews and engineers communicate with control room operators throughout the day regarding these changes. Workarounds must be identified, clearly documented and incorporated into the daily operation of the plant. Operators must include the specific details of these changes and their workarounds in the shift reports for later analysis.

**Production meeting.** As the shift progresses, production unit leaders must monitor process values and targets. The production goals are evaluated, and the process is tweaked as needed. The analysis and actions performed by the production unit leaders are documented in shift reports, including recommendations to key stakeholders.

**Site alignment meeting.** Throughout the shift, senior leadership will be watching the margin drivers and KPIs, which are then discussed during the site alignment meeting. Decisions made during the meeting must be communicated back to the key stakeholders and rolled up into the weekly business plan.

**End of shift meeting.** Console operators and the production team leads review the daily production numbers, capture their lessons learned and communicate the results to the next shift in the shift handover report.

**Weekly business plan.** Before the start of the next shift, business planning must review and update new targets and margin drivers based on all information documented during the previous shift. The cycle then begins again.

**Takeaway.** “Grade the shift” provides the structure needed to set production goals, establish targets, monitor processes, communicate results and celebrate successes across multiple units and work groups. To be successful, goals must be attainable with no more than three to six margin drivers clearly showing the economic impact of workers’ actions. The structure requires a dedicated process monitoring application that not only displays real-time process values, targets, KPIs and margin drivers, but also integrates worker comments and generates shift reports.

To learn more about process visualization and worker communication tools, please visit AIS Software at booth #30 in the Exhibition Hall. •

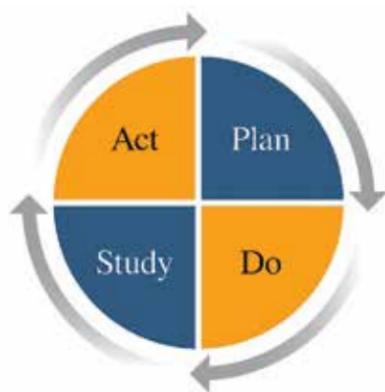


FIG. 1. The plan, do, study and act (PDSA) cycle.

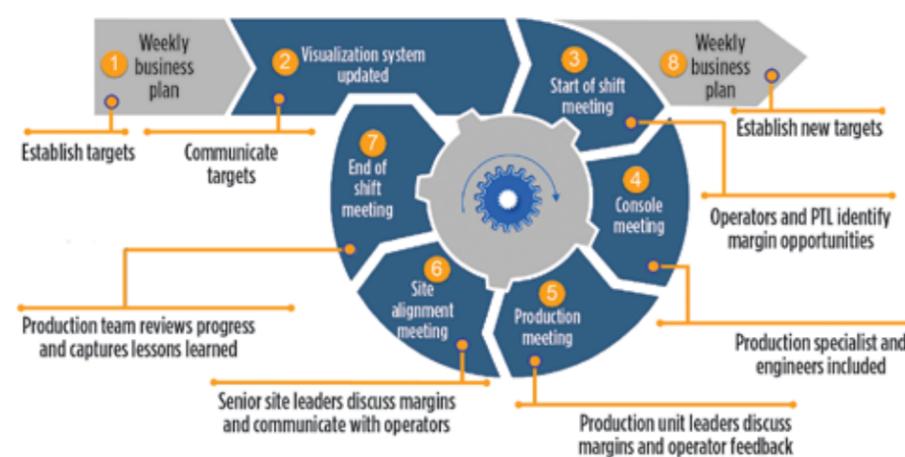


FIG. 2. “Grade the shift” optimization cycle. (Source: McKinsey, 2019).



**RICK KAISER** is a licensed professional engineer with 28 yr of experience in the oil and gas industry. He has extensive upstream and downstream experience as

an automation engineer in the oilfields of northern Alaska and as a mechanical engineer at refineries in Washington State. He works at AIS Software in Bellingham, Washington, as a Product Manager for software solutions used at oil, gas and petrochemical facilities around the world.



**ROGAN JONES** is VP and Co-founder of AIS Software in Bellingham, Washington. He graduated with a BS degree from California Polytechnic Institute (Cal Poly)

in Pomona, California and has spent the last 25 yr in the oil and gas industry. He has extensive coding and programming experience across multiple industries and has consulted with numerous clients around the world to improve operations management.

## RELEVANT IDEAS OFFERED IN PRINCIPLES & PRACTICES SESSIONS

The informative and interactive Principles & Practices (P&P) sessions will again be showcased at this year’s Operations & Process Technology Summit.

**FCC.** This P&P session will look at the FCCU through a lens of a full turnaround cycle—startup to startup. With more and more FCC engineers rotating through FCC positions without having the benefit of participating in a full turnaround cycle, this session is intended to complement engineers’ learnings and facilitate good stewardship of the FCCU, while providing them with knowledge/tools to impact a successful future turnaround.

**Crude/vacuum distillation and coking.** This ses-

sion will cover caustic use in crude units, benefits and risks; reflections on crude unit monitoring; and the use of advanced analytics in crude blending and quality control.

**Fostering profitability.** This P&P session will focus on the impacts of market and industry economics on our industries, including the impact of IMO regulations, how sweet/sour crude differentials are shifting, the impact of changing pipeline and mid-stream logistics systems, and other market drivers that will affect profitability in the next few years. The session will also focus on unique and holistic ways that operating companies can utilize to identify, justify, implement and sustain energy projects.

**Gasoline processes.** This session will address a variety of topics: alternative alkylation technologies; general reforming overview with various types of reforming including fixed-bed, cyclic, CCR and general descriptions of what makes them different; low coke operations and CCR reforming unit impacts; intro to light naphtha isomerization; and the impact of heavy feed to light naphtha iso unit.

**New P&P topics.** This session details auxiliary facilities covering topics about corrosion control, amine units best practices, operations and cooling water critical exchangers best practices, and a discussion on the processes involved with becoming an SME for your company and industry. •



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HORIZON

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For further information,  
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# The inherent advantages of rate-predictive control

ALLAN KERN, APC Performance LLC

Rate-predictive control (RPC) is a new patented control algorithm that is an alternative to industry standard proportional-integral-derivative (PID) for single-loop control. It is also used as the internal control algorithm for model-less multivariable control (XMC). RPC has several inherent advantages over PID and model-based control.

RPC—like PID, but unlike model-based control—is a *feedback* control algorithm. Feedback remains industry's first choice for nearly all control loops due to its ease of deployment, low maintenance and high rate of success and reliability. The timing of feedback control is always perfect, because it responds as the process responds, so there are no model-based

timing issues. In most applications, feedback control readily rejects process disturbances in a timely and reliable manner without unacceptable levels of deviation.

RPC is *predictive*, though in a different way than model-based control. RPC looks at the ongoing rate-of-change of the controlled variable and predicts its implicit future value, which is simply the current value plus the rate-of-change multiplied by the process settling time. The settling time is RPC's main tuning parameter, which is easy to tune and has a forgiving margin for error, much like PID integral time. The predictive nature of RPC makes it more responsive to disturbances and more stable as control returns to setpoint.

RPC is *adaptive* to changes in process response. Among hundreds of US patents for process control, RPC is the only one with the claim of being inherently adaptive (think naturally self-tuning), as shown in **FIG. 1**. For example, if process gain changes, then the process response changes accordingly, and so does RPC's prediction and controller response. It is profound yet simple for an industry where PID retuning and model-maintenance have always been as much the rule as the exception, and where successful adaptive control has long been the grail of process control.

## Limitations of model-based control.

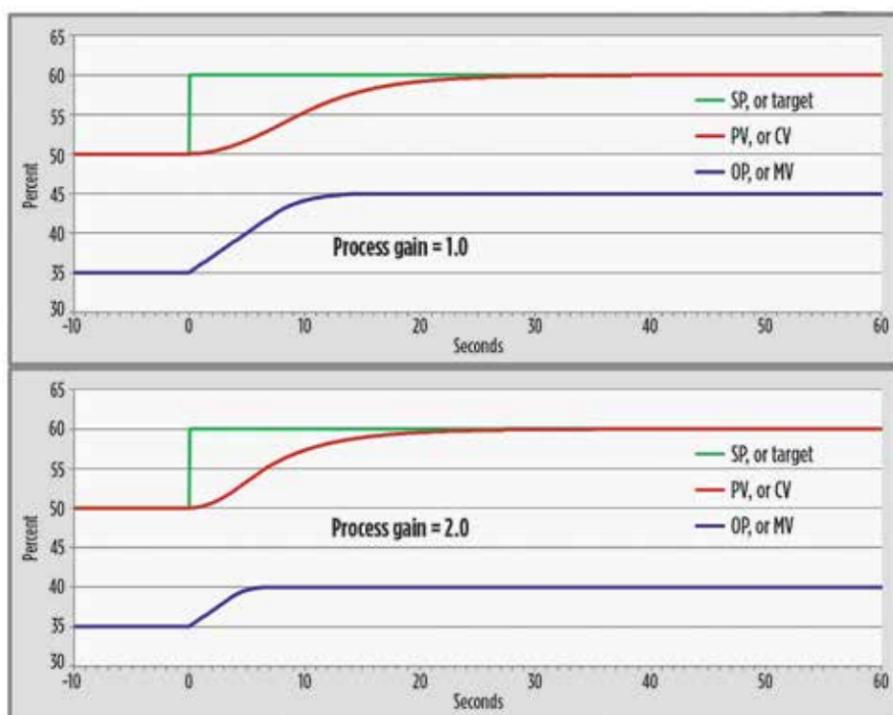
Model-based control, which is synonymous with feedforward, is often considered superior to feedback because it has the potential to reject disturbances proactively with minimal deviation. However, the widespread adoption of model-based control over the last few decades, primarily in the form of model-based multivariable control, has revealed limitations of model-based control in practice.

1. Reliable model-based control depends on reliable models. When process responses change and no longer match the models built into the controller, model-based control performance degrades and may compound disturbances. In other words, the promise of model-based control of improved performance also carries the risk of poorer and less-reliable performance. Decades of experience have shown that process models are much less reliable and shorter-lived than originally expected, and that nearly continuous model-maintenance is necessary

to mitigate this risk. This is the root reason that auto-tuning has fallen short of industry expectations and that even continuous adaptive modeling cannot overcome this limitation of model-based control.

2. Due to the first reason, model-based control technology has pursued numerous adaptations to help improve stable and reliable performance in the face of "model mismatch." However, to the extent that model-based control can tolerate model error, it is reverting to feedback control. This raises the question: Why spend so much time and money on models and model maintenance, only to fall back on feedback control? Wouldn't it make more sense to begin with feedback control and then apply feedforward selectively, only where it is necessary and warranted? The answer to this has always been yes for single-loop control; in retrospect, it should probably be yes for multivariable control, as well. Most processes (in the author's experience) require at most a handful of important models for effective multivariable control and optimization, rather than dozens or hundreds.

A further inherent advantage of RPC and XMC is that they are not model-based, so that model-related activities—such as plant testing, model-identification and model maintenance—are largely eliminated. RPC and XMC incorporate feedforward *selectively*, based on traditional proven advanced regulatory control (ARC) methodologies. ●



**FIG. 1.** RPC is inherently adaptive to changes in process gain. In the top graph, process gain is 1, while in the bottom graph, process gain is 2. Control performance remains "perfect," with no change to RPC tuning parameters.

## OPSWAT TO PROVIDE CIP CYBERSECURITY TRAINING AND CERTIFICATION

Designed for cybersecurity professionals and critical infrastructure protection (CIP) stakeholders, OPSWAT Academy, a new CIP cybersecurity training and certification program, will provide beginner, intermediate and advanced education strategically designed to reflect the real-world responsibilities and technical proficiencies required of modern-day CIP security professionals and stakeholders. Through courses that promote best practices and practical approaches to CIP cybersecurity, the OPSWAT Academy is helping to properly prime what is largely an understaffed and underprepared workforce for mission critical jobs that are ready today. To date, more than 200 OPSWAT customers, partners and cybersecurity professionals and stakeholders who were given early access have become OPSWAT Academy certified.

"Unlike other certification programs that focus too much on concepts and theories, the OPSWAT Academy takes a practical, hands-on approach to CIP cybersecurity workforce training," said Benny Czarny, CEO of OPSWAT.

Since 2015, the cybersecurity industry has seen a 50% increase in unfilled jobs; by 2021, that number is estimated to reach 3.5 MM. By prioritizing technical skill development over more traditional

curriculum, the OPSWAT Academy is pioneering a new approach to training the next generation of CIP cybersecurity professionals.

**Training with a zero-trust mentality.** The OPSWAT Academy will help participants excel at applying the technologies, processes and procedures required to start and sustain a career in CIP cybersecurity. The curriculum closely follows The Purdue Enterprise Reference Architecture, or the Purdue Model, which establishes best practices on data security between ICS networks, enterprise networks, the Internet and now the expanded perimeter of the cloud. As such, the OPSWAT Academy becomes the first critical infrastructure cybersecurity training program to offer certification focused on deep content disarm and reconstruction technology (CDR).

Initially, the OPSWAT Academy will focus on making OPSWAT customers and partners successful with philosophical and product-centric training, followed closely by curriculum designed for the entire industrial cybersecurity ecosystem. By focusing on practical workforce training and development, the OPSWAT Academy is designed for students to immediately translate what they learn

in the virtual classroom into practice within a critical infrastructure security environment.

"OPSWAT's philosophy is trust no file, trust no device," said Dan Lanir, VP of customer success at OPSWAT. "This philosophy, as well as customer feedback, is the foundation of the Academy's curriculum, which was developed to underscore the strict data transfer and device access procedures between the different security zones established in the Purdue Model."

OPSWAT Academy will have one master certification, OPSWAT Critical Infrastructure Protection Associate (OCIPA), that comprises four specific certifications based on discipline.

Specifically, the OPSWAT Academy will teach: CIP cybersecurity technologies that protect files during data transfer (deep content disarm and reconstruction (deep CDR), file-based vulnerability assessment, multiscanning, etc.); CIP cybersecurity technologies that ensure devices accessing the CIP networks meet security compliance standards (endpoint compliance, endpoint malware detection, endpoint vulnerability assessment, cloud-based access security, etc.); the nuances of protecting interoperability between ICS and external networks; and the need for a zero-trust mentality. ●



# JM

## Using our resources efficiently

Johnson Matthey is passionate about how science can enable global solutions for clean air, improved health and the most efficient use of our planet's natural resources.

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# Return summertime profits to winter levels with temporary process cooling

UMESH MATHUR and BRYAN MARKLAND, Aggreko

Refineries often face cutbacks throughout the summer months when ambient air and cooling water temperatures rise dramatically. Historical data show that plant equipment performance worsens dramatically when high temperatures and humidity set in. For years, facility managers have accepted reduced throughput to maintain safe operations, environmental compliance and product purity. Unfortunately, this happens at a time when market demands peak and profit margins are high.

Using temporary rental equipment to provide supplemental cooling has been proven to solve such bottlenecks and seasonal limitations in thousands of successful projects. These strategies maximize revenues and allow facilities (FIG. 1) to operate at optimal throughputs year-round.

**Identifying the problem.** Increased ambient heat and humidity impact major heat exchange equipment severely throughout the plant, causing subpar performance. Compared to winter levels, cooling water temperatures can be 20°F–30°F higher and ambient air can be 60°F–70°F warmer. Consequently, many major heat exchangers are “pinched,” and their performance becomes inadequate. Diminished process cooling can threaten to violate process and equipment constraints, or increase volatile emissions dramatically, potentially causing violations of regulatory or safety limits.

However, it is possible to reverse these effects through strategic cooling

by deploying industrial-quality rental solutions during the summer months.

Cooling the refinery’s cooling water supplied to a heat exchanger, in general, is inefficient from a thermodynamic viewpoint because it wastes much of the cooling provided. It is far more effective to cool affected process streams directly, for example, by replacing normal cooling water with a dedicated loop using either a temporary cooling tower or a refrigeration chiller. In other cases, a supplemental heat exchanger could be deployed to lower stream temperatures an additional 10°F–15°F. Installing rental heat exchangers, cooling towers or refrigerated mechanical chillers provides dramatic relief from summertime heat. Improvements from these engineered rental solutions are immediate, as they can be implemented safely in days or weeks.

**Benefits.** By reversing the effects of summer, it becomes feasible to return to normal winter capacity while maintaining product purities and observing environmental and process/equipment safety constraints.

Because these production problems occur only during the summer months, it is generally difficult to justify capital projects (such as expensive mechanical refrigeration equipment, heat exchangers or cooling towers) and the hiring of the required operation and maintenance specialists.

Aggreko has delivered such seasonal solutions to refineries and petrochemical plants for more than 2,000 projects over the last 20+ years.

Rental cooling solutions deliver anywhere from a 5:1 to 40:1 return on investment (ROI). The equipment is incorporated safely into a running plant in a few days, without the need for a shutdown and without creating a discontinuity of any kind. A few examples are described below.

**FCC coke burning capacity.** The oxygen available for burning coke in fluid catalytic cracking (FCC) regenerators is diminished anywhere from 4%–8% with high summertime ambient air temperature and humidity. This hurts refinery profits at a time when product demands and margins are high. Chilling the regenerator inlet air increases air density, maximizing unit capacity by restoring the coke burning capacity.

**Distillation column overheads.** Inadequate summertime cooling of distillation column overhead condensers causes one or more of the following problems that result in lower throughput, increased tower pressure, insufficient overhead reflux and poor fractionation.

In a vacuum distillation unit, increased flash zone pressure reduces the feed vaporization—and, therefore, the feed to the FCCU—while also worsening the properties of the bottoms asphalt product.

**Alkylation reactor and distillation columns.** In alkylation units, insufficient reactor cooling causes high reactor temperatures that lead to reduced throughput, lower octane-barrels and

increased acid consumption. Higher cooling water temperatures also cause loss of fractionation capacity in the downstream depropanizer and deisobutanizer towers.

**Product rundown.** Inadequate cooling of product streams causes higher-than-acceptable storage temperatures. In response, rundown rates are reduced that result in reduced unit throughputs.

**Fuel gas H<sub>2</sub>S.** High lean amine temperatures to the amine unit absorber lead to increased hydrogen sulfide (H<sub>2</sub>S) leakage into refinery fuel gas. This threatens violations of environmental limits.

In these examples, targeted supplemental cooling helps resolve cooling problems and returns unit operations to conditions seen only during the winter. Aggreko’s engineered solutions are backed by its excellent process engineering expertise. We use industry-standard equipment to enable you to:

- Optimize process operations
- Avoid losses during equipment outages
- Capitalize on short-term market opportunities
- Respond to equipment emergencies. ●

UMESH MATHUR and BRYAN MARKLAND are Technology Advisors for Aggreko Process Services based in Houston, Texas. Their combined experience covers more than 75 years in process technology, engineering design, plant operations, process control and real-time optimization. They have worked in major refinery, petrochemical, gas processing and fractionation plants in many countries. Visit [www.aggreko.com](http://www.aggreko.com) to learn more.

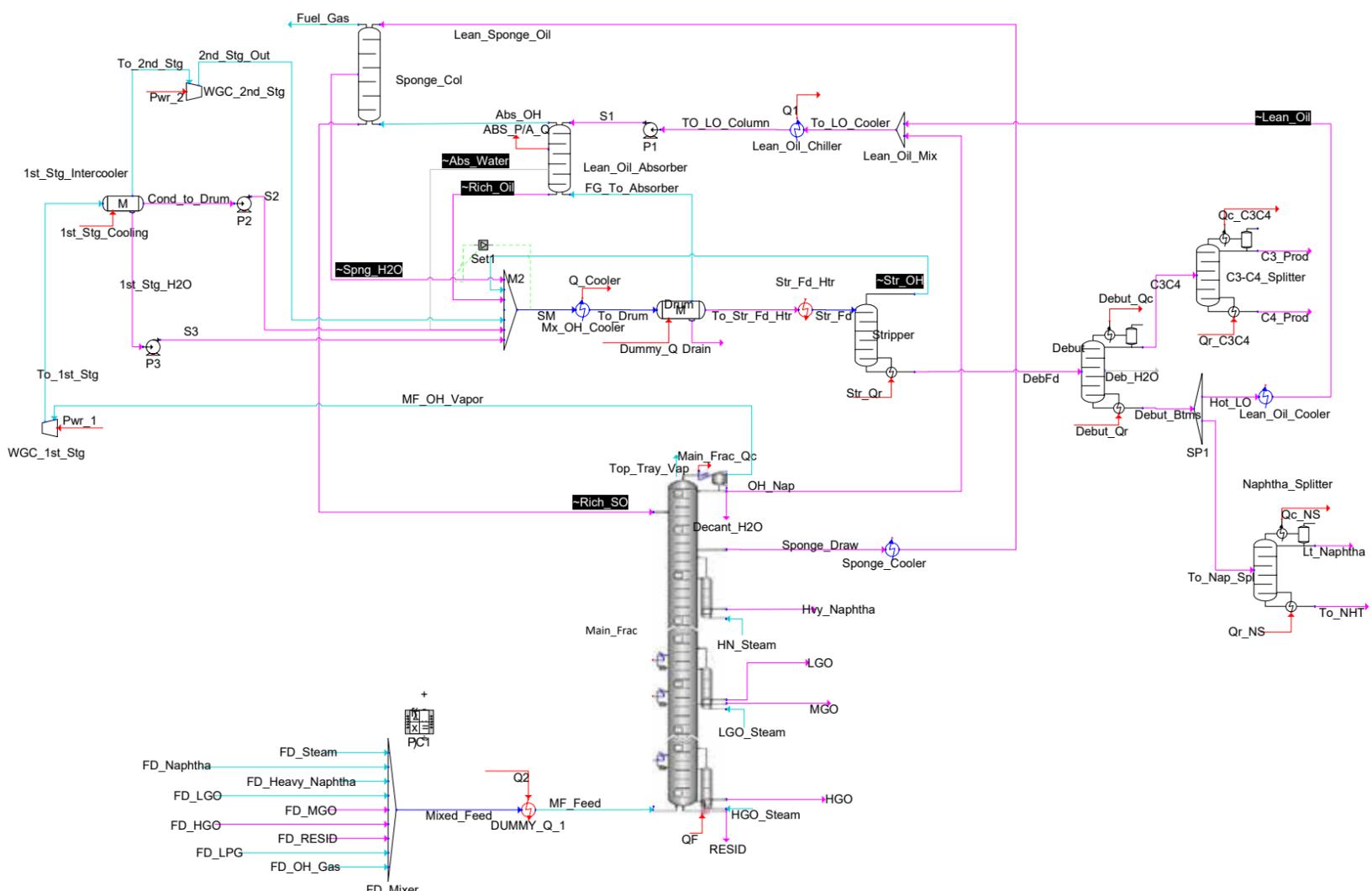


FIG. 1. Detailed process modeling enables reliable solutions and estimation of benefits.

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# Online H<sub>2</sub>O analyzer improves gas processing

W. GARY ENGELHART, SpectraSensors Inc.

Raw wellhead natural gas is a complex mixture of methane (CH<sub>4</sub>), hydrocarbon condensates, natural gas liquids (NGL), water, contaminants, hydrogen sulfide (H<sub>2</sub>S), carbon dioxide (CO<sub>2</sub>), nitrogen, mercury and other compounds. Natural gas processing involves separating CH<sub>4</sub> from NGL and removing entrained contaminants.

Plants designed to recover NGL utilize cryogenic processing. The operation and control of molecular sieve dehydration dryer vessels have a direct impact on cryogenic processing equipment in NGL recovery plants. Although this article focuses on NGL processes, many refineries have similar needs for online monitoring of H<sub>2</sub>O and other analytes, which can be improved by using online analyzers.

Three or four dryer vessels containing molecular sieves are typically operated in parallel with a piping system

that allows a saturated adsorbent bed to be taken offline for regeneration with heated gas, as shown in FIG. 1.

To improve upon this process, SpectraSensors, an Endress+Hauser company, conducted an evaluation of a tunable diode laser absorption spectroscopy (TDLAS) H<sub>2</sub>O analyzer at Enterprise Products' Meeker plant in western Colorado. The plant has two natural gas processing trains, each equipped with three molecular sieve dehydration vessels.

The Meeker plant has used aluminum oxide (Al<sub>2</sub>O<sub>3</sub>) electrochemical sensors to measure H<sub>2</sub>O on the outlets of its molecular sieve dryer vessels. The molecular sieve adsorbent beds are regenerated on a time basis, with the sensors being used for trending measurements rather than for process control.

While aluminum oxide sensors are

relatively simple instruments, they have some limitations for trace-level H<sub>2</sub>O measurements in natural gas and other streams. Because of this, many natural gas processing plants and refineries have transitioned to TDLAS analyzers. TDLAS analyzers are designed to selectively and specifically measure H<sub>2</sub>O and other analytes [H<sub>2</sub>S, CO<sub>2</sub>, acetylene (C<sub>2</sub>H<sub>2</sub>) and ammonia (NH<sub>3</sub>)] in hydrocarbon process streams.

In operation, process gas from a sampling probe is introduced to the sample cell of the TDLAS analyzer. A tunable diode laser emits a wavelength of near-infrared light that is selective and specific for the target analyte into the sample cell, where it passes through the gas and is reflected by a mirror to a solid-state detector. A window isolates the laser source and solid-state detector components from the process gas.

This design allows measurements to be performed with absolutely no contact between the process gas and entrained contaminants, and critical analyzer components.

**Trace-level H<sub>2</sub>O measurements.** Under normal operating conditions, gas exiting a molecular sieve dryer vessel has only trace-level (sub-ppm) concentrations of H<sub>2</sub>O. The TDLAS analyzer performs a sequence of steps to obtain a "zero" spectrum and "process" spectrum that are used to calculate analyte concentration.

Performance of the SpectraSensors TDLAS analyzer was evaluated in side-by-side testing with an existing aluminum oxide sensor at the common outlet of a three-bed molecular sieve drying system. Comparison of the data showed the aluminum oxide

sensor generated erroneous readings, missed some H<sub>2</sub>O spikes, and was less accurate than the TDLAS analyzer.

**Increased adsorbent life.** By using process optimization software and data from the TDLAS analyzer, the Meeker plant expects to extend the operating (drying) time of each molecular sieve dryer bed from 34 hr to 48 hr before regeneration. Operating on this basis will extend the life of the adsorbent by 40%. This translates into an annual savings of \$70,000 for a three-bed dryer system based on an estimated adsorbent replacement cost of \$500,000 per dryer and the existing 6-yr replacement cycle.

Extending the operating time of each molecular sieve dryer from 34 hr to 48 hr decreases the regeneration time to dry the adsorbent by 40%. This results in an estimated annual fuel consumption reduction of 9,332 MMBtu/yr, equating to \$11,200.

The evaluation conducted at the Meeker plant demonstrated that the more accurate and reliable data obtained from a TDLAS analyzer, used in conjunction with an online molecular sieve optimization software program, can deliver significant operational cost savings. In this case, the combined annual cost savings are estimated to be more than \$230,000. ●



**GARY ENGELHART** is the Product Line Marketing Manager for SpectraSensors. He is responsible for TDLAS analyzer applications in the hydrocarbon processing industries including natural gas processing, LNG, refining and petrochemicals. He has 25 yr of experience in analytical instrumentation and chemical process equipment.

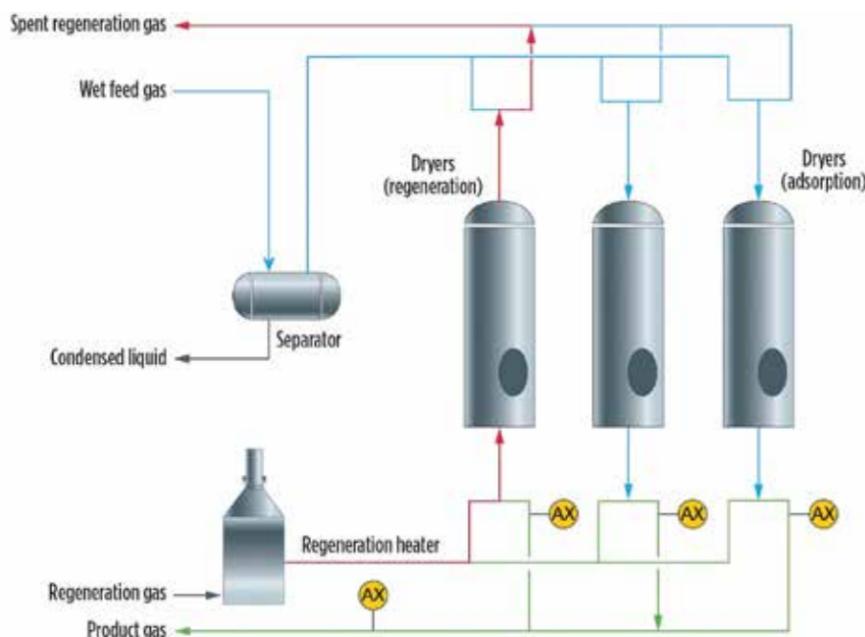


FIG. 1. Molecular sieve dehydration system with three dryer vessels.

# ProcessMD: Machine learning expertise

WILL HANLON, Air Products

Air Products' ProcessMD is the next generation digital platform that applies machine learning to both equipment and industrial gas processes. Development began in 2008 and it was first deployed at Air Products operating plants and assets in 2009. ProcessMD combines codified knowledge from subject matter expertise, engineering principals and advanced modeling and statistics in a machine-learning context to reduce costs, increase margins, improve operating efficiencies and increase reliability of industrial gas processes.

The comprehensive digital platform is available to Air Products customers that can benefit from the same proprietary software and engineers that

Air Products uses to monitor and improve its fleet of more than 700 facilities. ProcessMD differs from other machine-learning platforms because it not only recognizes patterns in operation and learns from multiple data sources, but it also diagnoses the root causes of the upset or aberrant condition and links them to solutions in a transparent manner. This provides operations and management teams a concise and timely action plan that can be implemented weeks or months before the process upset becomes serious enough to cause a plant shutdown or key equipment failure.

**Adaptive, smart levels.** ProcessMD uses "adaptive, smart levels" (FIG. 1) based on process models that adjust for variables, such as ambient temperature, feed composition, spec power, production rate, etc., to determine when a key process variable exceeds anticipated variations. An automated alert is then sent to a dedicated team of Air Products engineers that can diagnose the problem and provide solutions to the site. Customers can also view their own ProcessMD trends and alerts through a cloud platform to see their plant's performance in real time.

The predictive alerts result in earlier warnings than the fixed alarm limits that are set by OEMs at a much broader range. This allows for a faster response to operating inefficiencies and ample time for planning and allocating resources for future repairs and upgrades. Air Products has recorded significant operational improvements and costs savings as well as increased production from ProcessMD implementation across our fleet of plants, and now our customers can realize those same benefits, as well.

To learn more, attend the "Cybersecurity and Data Export for Data Analysis and Machine-learning Platforms" presentation, session ID 579531, from 4:45-5:15 on Monday, October 14th. ●

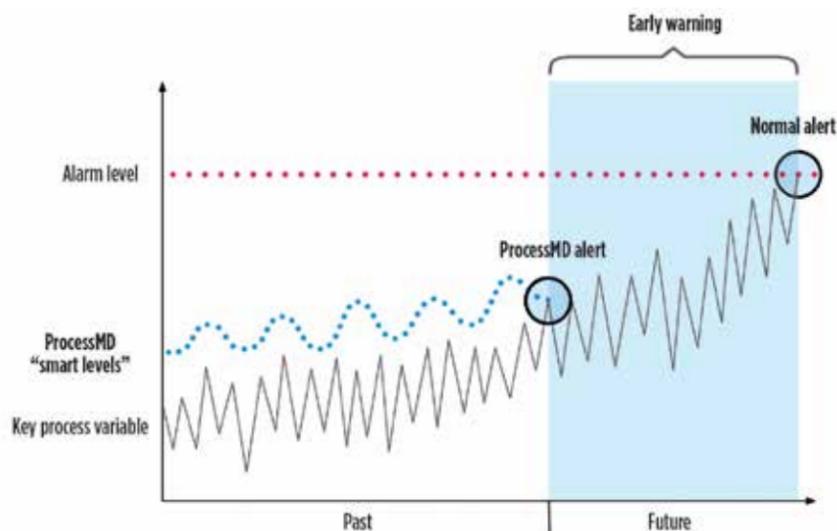


FIG. 1. How ProcessMD alerts provide early warning.



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# Creating an actionable roadmap for digital transformation

MARCELO CARUGO, Emerson

What are industry leaders feeling about one of the biggest buzz phrases in the industry: digital transformation? We often hear manufacturers ask questions like:

- Where do we start?
- How do we quantify the expected business impact, and how do we know if we have accomplished it?
- How do we ensure that digital transformation is not a distraction that prevents us from doing our primary job: safely and profitably running the production process?
- How do we even *define* digital transformation?

In a recent study Emerson conducted with the leaders charged with digital transformation within their companies, 98% of respondents said that having a clear and actionable roadmap was critical for success. However, only 20% said they had such a roadmap—hardly confidence inspiring.

By collaborating with refiners and petrochemical producers around the world seeking their own digital transformation, we have found four critical elements to success:

1. A clear and focused business case for investment.
2. A scalable methodology that lets

you “transform” at your pace, based on the value you achieve.

3. A flexible technology platform that allows you to effectively “start anywhere.”
4. A strategy that includes people and work practices.

**Designing for top-quartile performance.** When looking at equipment reliability, we see six stages of digital maturity in this area. Level 1 is a traditional run-to-failure mindset. There are few, if any, equipment diagnostics. Related maintenance practices are reactive: intervening after an incident has occurred. While most organizations feel they are well past this mode, they are often surprised to find that these practices persist.

As an organization moves through its digital maturity to Levels 2 or 3, it invests in handheld diagnostics tools that provide high quality data, which is only available upon infrequent manual inquiry. This preventative mindset typically follows a scheduled routine of inspection according to manufacturers’ recommendations, regardless of actual equipment condition. Studies suggest that as much as two-thirds of a maintenance crew’s time is wasted inspecting equipment with no issues or repairing equipment that does not need it.

Eventually, an organization evolves into condition-based monitoring, where they possess real-time or near-real-time visibility into equipment health. This enables an organizational shift to predictive maintenance. No longer controlled by a calendar, maintenance personnel increase effectiveness and efficiency by focusing time only on assets that require attention. Equipment failures are minimized, and maintenance costs are slashed.

To reach their full potential in reliability, we see organizations designing for top-quartile performance from the start. They bring operations into the project team and set their design philosophy on top-quartile reliability, rather than on the third-quartile that most projects usually target. This establishes a culture of reliability that delivers returns for decades, and includes how organizations plan turnarounds, as well.

**A focused investment.** For example, let’s look at one relatively small but critical asset. It is increasingly common for refiners to process “opportunity crudes,” offering low-cost feedstock and improved margins. However, there are unintended consequences with discounted crude oils, such as extremely rapid heat exchanger fouling. Outdated maintenance practices would have crews wait until the exchanger is fouled with an obvious production impact before cleaning it. Conversely, real-time, condition-based monitoring can tell you when the exchanger is compromised before it fails, and guide maintenance and operations to take action. Production is maximized and the threat of equipment failure and downtime is eliminated. Applied to all exchangers across a facility, this can deliver huge savings.

This type of investment is, on its own, a small digital transformation—a focused investment for a specific business goal that is scaled across the operation with the right technologies and work practice changes.

The point is this: Everyone’s road-

map of digital transformation is different. Each processing facility needs a customized plan that allows it to start at different places, because no two operations are truly the same. Across many different operating categories, every operation is at a different stage in its digital maturity. Understanding where you are and where you need to go—for measurable business benefit—is the most important part of creating a digital transformation roadmap.

To make this possible, Emerson has developed a very effective workshop methodology that enables refining and petrochemical operations teams to target the highest value opportunities and create an action plan that is scalable while minimizing risk. Emerson has implemented this method in dozens of refineries around the world (FIG. 1), and manufacturers are finding it to be an extremely effective way to not only get started in their digital transformation, but also achieve measurable improvement quickly with low risk.

The reality is that digital transformation is not that complicated; it is predictable. With a clear and focused business case, a scalable methodology, a flexible technology platform and a thoughtful plan about updating work practices and behavior changes to take advantage of rich and timely information, you can be well on your journey to top-quartile performance. ●



**FIG. 1.** During a site visit, Emerson consultants discuss various options for improving the reliability of a reactor.



In his role as Vice President, Global Refining and Chemical Programs, **MARCELO CARUGO** leads the Industry Solution program with a team of experts across Emerson Automation

Solutions business. He has 30 years of experience in the chemical and refining process control industries. His expertise includes developing solutions for operational excellence, regulatory compliance and improved reliability. Mr. Carugo earned an MS degree in electronic engineering from NUFFIC, The Netherlands, and a BS degree in electronic engineering from the University of Buenos Aires, Argentina. Contact him at [marcelo.carugo@emerson.com](mailto:marcelo.carugo@emerson.com), and learn more about Emerson Automation Solutions by visiting their hospitality suite on Monday evening.

## MOST IT SECURITY PROS WILLING TO SHARE THREAT INTEL FOR COLLECTIVE DEFENSE EFFORTS

A new report by IronNet Cybersecurity reveals a large majority of security IT decision makers are willing to share threat intelligence data to help the industry make more informed decisions when it comes to cyberattacks.

To compile the report, 200 U.S. security IT decision makers across many industries—more than half of whom serve in C-level positions—weighed in on issues ranging from confidence and efficacy around their cybersecurity solutions and perceived vulnerabilities, to artificial intelligence (AI) and machine-learning (ML) investment decisions and attitudes on collective defense and threat sharing.

Key findings include:

- Almost all respondents’ organizations (94%) invest in some form of collective defense, including threat sharing of IPs,

file hashes, domains and other signature-based indicators.

- The same percentage stated that they would be willing to increase the level of threat sharing with their industry peers if it demonstrably improved their ability to detect threats.

**Disconnect between confidence levels and actual vulnerability and system maturity.** While 55% of IT decision makers are confident that their cybersecurity capabilities are advanced, in a 12-month span, respondents on average experienced four attacks on their organization, and 20% of respondents were hit six or more times.

Nearly a quarter of respondents identified the following issues: the lack of real-time visibility across

industrial control systems and the IoT (27%), a lack of timely threat intelligence information (25%), and too many cybersecurity tools and poor integration between them (24%). Almost 80% stated that their organization has had a cybersecurity incident so severe that it required a C-level/board meeting after.

**AI and ML investment is robust, but maturity is key.**

Respondents (73%) stated that their organization has invested in AI or ML in the past year. Of those that had not made those investments, 35% said their reason was that they were simply unsure of the value.

The report states that, “Threat actors are increasingly sharing techniques to make attacks more profitable for them and more damaging to organizations. Collective offense is testing the integrity of cyber defenses everywhere.” ●

# Deep in the heart of Texas

Welcome to San Antonio! The city's independent spirit and varied culture make it an ideal gateway to the region's scenic beauty, restful retreats and historic legacy. First settled as a colony of Spain, the city has grown up as a territory of Mexico, part of the independent Republic of Texas, and finally a key city in the greatest of the United States (well, that's what we Texans think).

The Old World charm of San Antonio is represented everywhere you look. The influence of Spanish, Mexican and German cultures, among others, is apparent in the city's art, museums, architecture, cuisine and music. With such a variety of attractions, it is little wonder why San Antonio is the most popular tourist destination in Texas.

**The Texas Hill Country.** Settled by Germans and East Europeans, the Hill Country has a culture all its own. Storybook farms and ranches dot the countryside, and you may still hear long-time residents speaking German in Fredericksburg, Boerne and New Braunfels. You'll also find quaint B&Bs, antique shops on old-fashioned main streets and celebrations with deep roots. Floating down cool rivers, strolling quaint main streets in search of unique bargains, playing a round at one of many championship-quality golf courses, or hiking and

biking through rolling, scenic terrain are all within driving distance.

**The Missions and the Alamo.** In the 18th century, Franciscan priests from Spain established five Catholic missions along the San Antonio River. Today, the five missions (San Antonio de Valero, Mission San José, Mission Concepción, Mission San Juan and Mission Espada) represent the largest concentration of Spanish colonial missions in North America.

The Alamo (Mission San Antonio de Valero) was founded in 1718 as the first mission in San Antonio, serving as a way station between east Texas and Mexico. In 1836, decades after the mission had closed, the Alamo was the site of one of the most notorious battles in American history, becoming an inspirational symbol for liberty during the Texas Revolution.

For 13 days, 150 "Texians," including state folk heroes William Travis, Jim Bowie and Davy Crockett, died defending the Alamo against more than 1,000 of Mexican General Santa Anna's troops.

**The River Walk.** No visit to Texas is complete without strolling or riding a boat along the San Antonio River Walk, a verdant oasis of cypress-lined paved paths, arched stone bridges and lush landscapes. Steps away from the MRC and MRW hotels, it gently

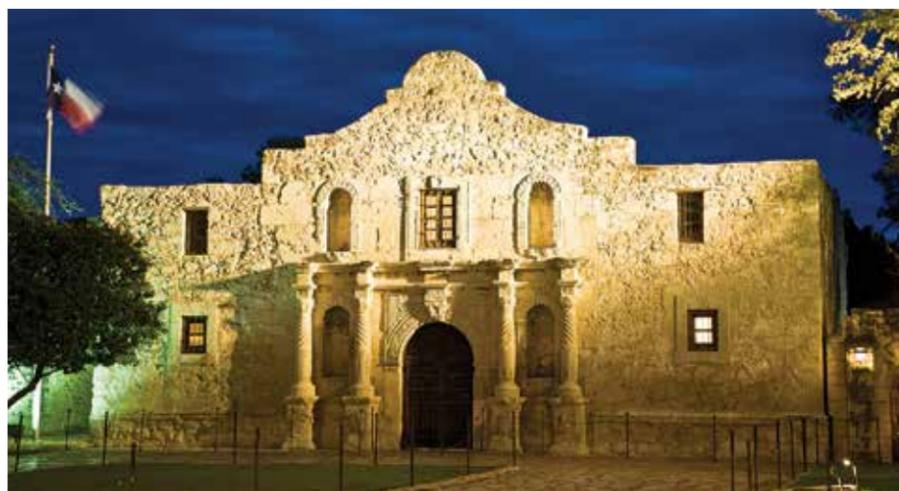
winds through the city center, providing easy access to the city's cultural hot spots, authentic restaurants, local shops, nightclubs and historic sites. Visitors and locals can dine aboard river cruisers while the sounds of mariachis echo from above.

**Dining.** Perhaps nowhere is the city's diverse culture more evident than in its cuisine, which reflects the heritage and innovation of European and Mexican influences. The variety of options, including the famed Tex-Mex with its aromas of spices and fresh cilantro, are unmatched in the state and accompanied perfectly by local wines, beers and tequilas.

Many of our acclaimed chefs who studied elsewhere bring their world-class training back to our culinary landscape. And the barbeque? This

is Texas, partner. Enough said.

Music flourishes here: country western, mariachi, rock, blues and folk can be heard throughout the city. Art comes alive in outdoor murals, gardens, parks and sculptures. The confluence of cultures is everywhere and in everything, especially the open, friendly faces of the people who call San Antonio home. Thank you for visiting San Antonio, and we hope you enjoy it as much as we do. ●



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# 2019 SUMMIT PANELIST BIOS

## Q & A SESSIONS—GASOLINE PROCESSES PANELISTS

**Peter Eckels**, Technology Specialist, Honeywell UOP, has been working with platforming and other gasoline technologies since 2007. His experience in UOP's field services group includes fixed-bed reforming reloads, regenerations and restarts, work on 11 new CCR platforming unit startups in five countries, troubleshooting and turnarounds. This also involved training refinery operations staff and engineers in the function and control of all aspects of unit feed preparation, plant operations, and catalyst regeneration and protection. Since 2014, Eckels has been a part of UOP's Gasoline Technology Service group. His responsibilities have included monitoring catalyst performance for customer sites throughout the world, participating in new unit designs, contributing to development projects that push technology forward, and teaching training classes around the naphtha complex.

**Dr. Bill Kostka**, Senior Technical Advisor, Reforming and Isomerization, Axens North America, began his career as a Research Engineer for Mobil Research and Development Corp., where he acquired extensive R & D, pilot plant testing and technical support experience in a variety of refining processes with major emphasis on catalytic naphtha reforming and isomerization. In 2000, he became part of ExxonMobil Research and Engineering Co., where he progressed through leadership assignments in reforming and isomerization before retiring from ExxonMobil in 2013 as Global Commercial Technology Leader for reforming and isomerization. Dr. Kostka joined Axens North America as a Senior Technology Advisor for reforming and isomerization, with a primary focus on the global promotion of Axens Symphony™ reforming catalysts. He has developed and delivered numerous well-received reforming seminars around the world. Dr. Kostka holds BS and MS degrees and a PhD in chemical engineering from Purdue University.

**Davinder Mittal**, DGM-Operations, HPCL, Mittal Energy Ltd. (HMEL), is the Operational Lead at the 250,000-bpd Guru Gobind Singh refinery of HPCL-Mittal Energy Ltd. (HMEL). His experience includes operations management of the FCC-PRU (deep catalytic cracking unit), and polypropylene, delayed coker and crude units. He is also a core team member for the identification and implementation of artificial intelligence and IIoT-based solutions at the HMEL refinery. Since joining GGSR, Mittal has played a key role in the configuration, value engineering, design, inspection, precommissioning, commissioning and troubleshooting/simulation of the gasoline block through its successful operation at peak capacity. He served as Process Team Leader for the gasoline block (naphtha hydrotreater, isomerization, continuous catalytic reforming regeneration unit), delayed coker, FCC-PC, hydrogen unit, sulfur block (sulfur recovery unit, sour water stripping, amine regeneration), crude unit, fuel gas/LPG/ATF treating units, ETP and utilities. As Technical Service Manager, he conceptualized and implemented numerous process improvement schemes, worked with multidisciplinary teams and successfully led refinery efforts to identify and implement zero- and low-investment GRM improvement projects.

**Thomas Porritt**, Chevron U.S.A. Inc., is a Senior Process Engineer at Chevron in Pascagoula, Mississippi. He has 20 years of industry experience, 13 of those working for Chevron. He has held positions in operations and technical services, and supports various technologies including reforming (semi-regen and CCR), isomerization and paraxylene. He holds a BS degree in chemical engineering from Brigham Young University.

**Abigail Slater**, Process Engineer, HollyFrontier Corporation, has worked as a Process Engineer in the refining industry since 2015, after spending time in the medical industry. In her career as a process engineer, Slater has covered several different technologies, including utilities, crude, kerosene, gasoline, and diesel hydrotreaters, hydrofluoric acid alkylation, continuous catalyst reformer units, gasoline blending, and planning and economics. She lives in Artesia, New Mexico and works for HollyFrontier at the Navajo refinery. Slater graduated from Texas Tech University with a BS degree in chemical engineering.

## Q & A SESSIONS—FCC PANELISTS

**Todd Hochheiser**, Senior Technical Service Engineer, Johnson Matthey, is a Senior Technical Service Engineer with Johnson Matthey and is responsible for providing technical assistance to Johnson Matthey's customers on the use of FCC catalyst additives and catalyst addition systems. Prior to joining Johnson Matthey, he held engineering, operations, and planning and economics positions with Valero Energy and ExxonMobil. Hochheiser obtained his BS degree in chemical engineering from the University of Delaware and an MBA from the University of California Irvine.

**Kimberly Odell**, Technical Services Manager, Louisiana Refining Division, Marathon Petroleum Company, has 26 years of experience in refining and refining processes, all with Marathon Petroleum Co. She serves as the Technical Services Manager at Marathon's Louisiana Refining Division in Garyville, Louisiana, where she

leads a group of 70 process engineers, controls engineers and major capital projects engineers. In her 26 years with Marathon, Odell has filled various roles in technical leadership, asset development and major capital project execution. She received her BS degree in chemical engineering from Louisiana State University.

**Dharmesh Panchal**, Principal FCC Technologist, Honeywell UOP, is a member of UOP's FCC/Alkylation/Treating Technology Services group in the UK. He joined UOP in 2012 from KBC, and has responsibility for providing troubleshooting and unit optimization, startup support for new and revamped FCCUs, and turnaround support for the EMEA/FSU region. Panchal has more than 25 years of experience in the industry focused on commissioning, startup, operations, optimization, revamp and troubleshooting of FCCUs, including positions held at Reliance and Essar Refinery. He previously served at KBC as a Senior Consultant working on a range of design projects, simulation, unit optimization and troubleshooting. Panchal is a chemical engineer and earned his BS degree from the Indian Institute of Technology, Kharagpur, India.

**Ryan Person**, TechnipFMC Process Technology

**Michael Wardinsky**, Motiva Enterprises LLC, joined Motiva in 2018 as the Manager of Alkylation and FCC Technology. He began his career with the Phillips Petroleum Co. in Bartlesville, Oklahoma as a Research Engineer developing FCC process models. He then took an assignment at the Phillips Sweeny refinery, where he held the position of Production Engineer providing support for two resid feed FCCUs. He returned to Oklahoma as an FCC Specialist in the Corporate Engineering group with Phillips Petroleum Co. After the Conoco-Phillips merger, he held positions as the FCC Network Lead and Senior FCC Engineer for ConocoPhillips and Phillips 66, supporting 15 FCCUs in the U.S. and UK before transitioning back to the Phillips 66 Sweeny refinery as the Cat/Alky/Sulfur Lead Process Engineer. Dr. Wardinsky holds a BS degree in chemistry from the University of Washington in Seattle, Washington, and an MS degree and PhD in chemical engineering from Brigham Young University in Provo, Utah.

## Q & A SESSIONS—HYDROPROCESSING PANELISTS

**Christy Anderson**, Technical Sales Account Manager, Hydroprocessing Technologies, Albemarle Corporation, is a member of the North American Technical Sales group for Albemarle Corporation Refining Solutions Division, based in Houston, Texas. As part of the technical sales team, she provides technical and commercial sales support for various refinery clients through unit monitoring, troubleshooting, pilot plant test analysis and catalyst system design. Most recently, Anderson was a Technical Service Specialist in distillate technologies, collaborating with an international distillates team to grow Albemarle's technical expertise and bring value to its customers. She has 17 years of experience in the refining industry. Prior to joining Albemarle eight years ago, she worked for Flint Hills Resources in Corpus Christi, Texas. Her background at the refinery was as a process engineer with experience on hydrotreaters, hydrocrackers and licensed specialty chemicals processes, as well as experience in planning and economics. Anderson holds a BS degree in chemical engineering from the University of Kansas and an MBA from Texas A&M University.

**Amit Kelkar**, Global Distillate Application Manager, Shell Catalysts & Technologies LP, is primarily responsible for managing Shell C&T's distillate application by coordinating business and portfolio development activities for ultra-low sulfur diesel (ULSD) technologies. Previously, Kelkar was a Technical Service Engineer providing unit monitoring, troubleshooting and startup support for distillate and VGO units. He has a total of 20 years of industry experience, including process design, licensing, startup and technical support for hydrotreating, hydrocracking and resid hydroprocessing technologies. He earned a BS degree from the Indian Institute of Technology, India, and an MS degree in chemical engineering from the University of Texas at Austin.

**Ken Koziol**, Senior Key Account Manager-Hydroprocessing Catalyst, Haldor Topsoe Inc., is a Hydroprocessing Senior Key Account Manager for Haldor Topsoe, based in Houston, Texas. He has more than 30 years of experience in the refining industry, including 12 years with Haldor Topsoe focusing on hydrotreating catalyst and technology with management, sales and technical service roles. His prior experience includes six years with UOP as a Hydrotreating Global Sales Support Manager, 10 years with Baker Petrolite/AMOCO in technical service and specialty chemical sales, and three years as a process engineer at CITGO's Lake Charles refinery.

**Joseph Rydberg**, Process Engineer, CITGO Petroleum Corporation, has 18 years of experience in the refining industry. He serves as the Operations Process Engineering Group Leader at the Lemont Refinery. Rydberg is responsible for technical support for daily refinery operations and project process development. His experience is primarily in hydroprocessing technical support, optimization and troubleshooting. Rydberg holds a BSChE degree from the University of Illinois at Urbana-Champaign.

# 2019 SUMMIT PANELIST BIOS (CONT.)

**Syed Hassan Shah**, Process Specialist, Hydroprocessing & Renewables Technology Service, Honeywell UOP, is a Senior Technical Service Specialist in the hydroprocessing and renewables group at UOP LLC, a Honeywell Company, where he is responsible for providing technical support for hydroprocessing and heavy oil operations worldwide. Prior to joining UOP in 2014, Shah gained refining experience in hydroprocessing technical service and refinery operations planning at the BP Texas City Refinery (now Marathon Galveston Bay Refinery). Shah holds a BSChE degree from the University of Texas at Austin and has more than 12 years of experience in the refining industry.

**Robert Steinberg**, Manager, Hydroprocessing Technology, Motiva Enterprises LLC, assists the process engineers and supports operations for all of Motiva's hydrotreaters and hydrocrackers, and is responsible for catalysts, technology and projects for these units. He has design and operating experience with hydrotreaters, hydrocrackers and lube oil production in North America and Europe. Mr. Steinberg holds BS and MS degrees from MIT and has more than 37 years of experience in the refining industry.

## Q & A SESSIONS—CRUDE/VACUUM DISTILLATION & COKING PANELISTS

**Maria Aldescu**, Consultant, KBC Advanced Technologies Inc.

**Tim Olsen**, Consultant, Emerson Automation Solutions, is an AIChE Fellow with 29 years of experience in the refining industry, 21 of which have been with Emerson Automation Solutions. He serves as a refining consultant within Emerson's global refining industry solutions group, where he supports the company's technical and business strategy. Previously, he was with UOP for eight years as a technical advisor on refinery startups around the world. Olsen is active with fuels and petrochemicals organizations in leadership positions. He is a past Chair of AIChE's Fuels and Petrochemicals Division and was the Overall Meeting Program Chair for the 2014 AIChE Spring Meeting in New Orleans, Louisiana. He now serves as an elected board member on the AIChE board of directors. He is a past board member for Emerson's Global Users Exchange board of directors, and the North America Emerson Exchange

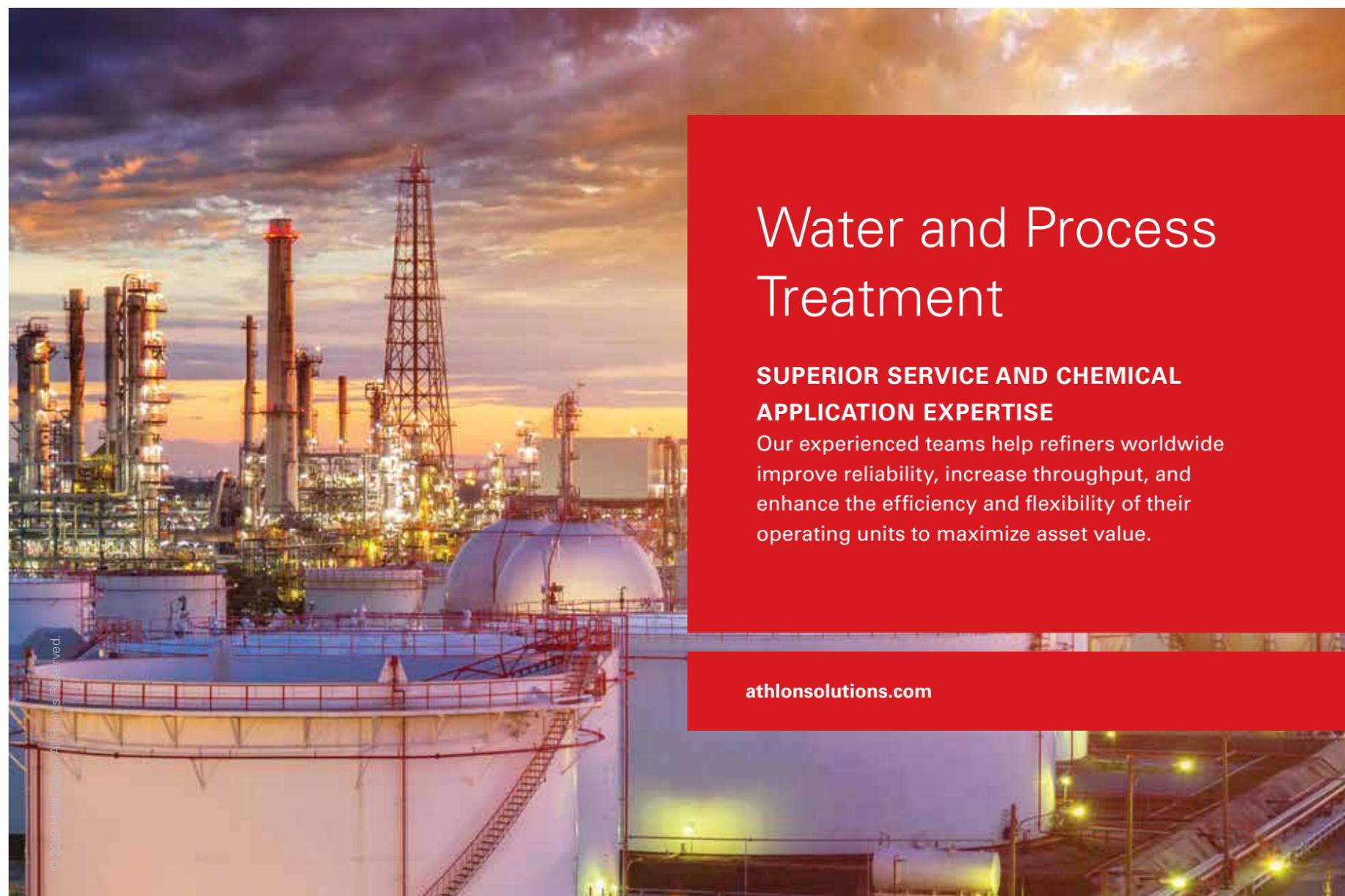
Industry Forum Moderator (Refining and Petrochemical) since 2009. Olsen is also an active member of AFPM's OPCAT Committee.

**Xiomara Price**, COE Global Leader-Fouling Control, SUEZ Water Technologies & Solutions, is the Global COE Leader for fouling control at SUEZ Water Technologies & Solutions. She has 22 years of refinery process treatment experience. Her areas of specialization include process chemical applications, refinery process troubleshooting, program and project management, heat transfer and fouling control. Price holds a BS degree in chemical engineering from Louisiana Tech University.

**Raul Romero**, Marketing Director, NALCO Champion, joined Nalco Champion as an Industry Technical Consultant for refinery processes in Latin America, supporting business, troubleshooting and implementing new projects for six years at refineries in Argentina, Brazil, Chile, Ecuador, Peru, Colombia, Venezuela and Mexico. He moved to the U.S. in 2018 to assume his role as Marketing Director for North America, providing technical support to sales teams in Canada and the U.S. He has 23 years of refining experience at XOM (Argentina and the U.S.) working in operations of crude and vacuum distillation, delayed coker and solvent hydrogenation units, among others. He has served as an Oil Loss Coordinator, and in project development (low-sulfur fuels), business analysis and SHE management at the Campana Refinery in Argentina. Romero earned a degree in chemical engineering at the Universidad Nacional del Litoral and an MBA at the Instituto para el Desarrollo Empresarial de la Argentina (IDEA) in Argentina.

**Tim Sawyer**, Operations Superintendent, CHS Inc, is a Zone Superintendent for CHS Inc. at the Laurel, Montana refinery. He has 16 years of experience as an engineer and is responsible for process technical support, asset management and turnaround planning for their coker, amine and sulfur recovery units. In addition, he manages two sour water strippers and the refinery's flare and flare gas recovery systems. He has provided engineering and operations support on large grassroots construction projects, day-to-day operations and small-scale improvement projects. Sawyer holds a BS degree in chemical engineering and an MS degree in nuclear engineering.

**Steve Williams**, Crude Vacuum Technologist, Marathon Petroleum Company



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# Innovative, high-temperature, water-gas shift catalyst

HENRIK RASMUSSEN, Haldor Topsoe Inc.

The water-gas shift reaction is the conversion of carbon monoxide (CO) with water to form carbon dioxide (CO<sub>2</sub>) and hydrogen (H<sub>2</sub>), shown in Eq. 1. High-temperature shift (HTS) catalyst is used today in H<sub>2</sub> and ammonia (NH<sub>3</sub>) plants around the world.

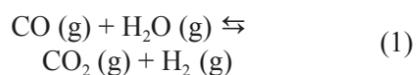


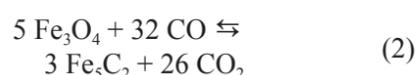
FIG. 1 shows a timeline of the major developments within HTS catalysis. Traditional HTS catalysts consist of iron (Fe) and chromium (Cr), and chromium oxide (Cr<sub>2</sub>O<sub>3</sub>) also functions as a chemical promoter, enhancing the intrinsic catalytic activity of iron oxide (Fe<sub>2</sub>O<sub>3</sub>). Another valuable promoter, copper (Cu), was discovered in the 1980s as demand began increasing for more energy-efficient plants. The addition of copper was found to increase cata-

lyst activity and selectivity, which reduced byproduct formation from Fischer-Tropsch reactions at lower S/C (steam to carbon) ratios.

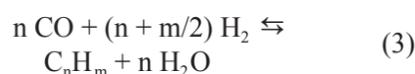
**Challenges of conventional Fe-based HTS catalysts.** The chromium promoter in fresh Fe-Cr catalysts is a Category 1 carcinogen and is water soluble, meaning that it can be washed out of the catalyst into the condensate stream during startups, resulting in an environmental clean-up issue, lower chromium content in the catalyst and, consequently, less stability. Cr(VI) is also very exothermic during reduction and can lead to very high catalyst temperatures that, in worst-case scenarios, may exceed the design temperature of the reactor. To avoid potential damage to the catalyst and the reactor, extra procedures must be performed during startup, adding to plant downtime.

Accidental leaks of the volatile Cr(VI) can be damaging to personnel safety and to the environment, and such incidents can be very costly for a plant due to unplanned downtimes and long-term liability issues. Catalysts containing Cr(VI) must be compliant with the European REACH regulations and spent catalysts must be disposed of in accordance with toxic waste regulations. Growing pressure from legislative bodies is increasing the demand for minimal levels of Cr(VI), and future regulations may require the complete elimination of chromium from HTS catalysts.

The risk of over-reduction of iron oxides in conventional HTS catalysts is also a major issue due to the limitation it puts on S/DG and, therefore, S/C ratios. At S/C ratios lower than approximately 2.8, the iron in conventional HTS catalysts will be reduced to lower oxides, metallic iron species or iron carbides (e.g., Eq. 2):



Iron carbides, in turn, are effective catalysts for the highly exothermic methanation reaction and Fischer-Tropsch reactions, shown in Eq. 3:



This production of higher hydrocarbon byproducts consumes hydrogen that would otherwise be used for valuable hydrogen or ammonia production, and results in physical damage to catalyst pellets. Loss of catalyst mechanical strength leads to increases in pressure drop as well

as premature catalyst unloading and replacement. The addition of copper promoters is effective in inhibiting the Fischer-Tropsch reaction at low S/C ratios, but it does not eliminate it.

To avoid the negative consequences of byproduct formation, it is important to maintain a minimum S/C ratio not only during normal operation, but also during reduction and activation. Fe-Cr catalysts require special considerations during startup to ensure that they are properly reduced, not only to avoid iron over-reduction but also to avoid damaging consequences of the exothermic reduction of Cr(VI) to Cr(III). The requirement of a minimum S/DG ratio in the HTS reactor represents a significant impediment for many producers wanting to remain competitive in the current market. Removing the S/DG limitation would allow producers to achieve better profitability through reduced energy consumption and increased production capacity, which is essential in today's economy of rising costs and rapid market fluctuations.

## A new formulation for HTS catalysts.

The previously discussed issues are eliminated with the introduction of Topsoe's innovative product, SK-501 Flex™ (FIG. 2). The new catalyst contains no iron or chromium and is based instead on a patented zinc aluminum spinel. This fundamental composition has long been known to have some degree of activity for the water-gas shift reaction. Topsoe's unique contribution is the addition of certain promoters and an effective preparation method that give the new catalyst an activity superior to the activity of conventional HTS catalysts, even after extended periods of operation. Furthermore, the notable absence of chromium makes SK-501 Flex much safer to handle and more environmentally friendly than current industrial HTS catalysts.

The performance of SK-501 Flex has been optimized as a result of meticulous, systematic studies of catalyst parameters by Topsoe's experienced research and development (R&D) division. The zinc (Zn)/aluminum (Al) ratio and the type and number of promoters in the catalyst have been adjusted to provide a very high catalyst activity and stability while maintaining a high level of poison resistance.

TABLE 1. Comparison between Fe-Cr based catalyst and SK-501 Flex

	Fe-Cr based catalyst		SK-501 Flex	
	SOR	EOR	SOR	EOR
Age				
Steam carbon ratio, mole/mole	2.75	2.75	2.25	2.25
HTS inlet temperature, °F	626	658	583	635
H <sub>2</sub> amount, MMft <sup>3</sup> /d	100	99.4	104.4	103.2

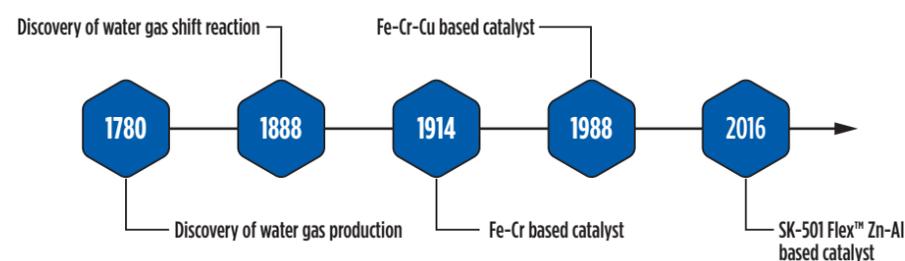


FIG. 1. Timeline of HTS catalyst development.



FIG. 2. The SK-501 Flex catalyst.

Topsoe's innovative HTS catalyst SK-501 Flex is chromium and iron free. The use of SK-501 Flex can increase the hydrogen production of a hydrogen plant without any CAPEX requirements. In addition, SK-501 Flex is significantly more active than a conventional HTS catalyst.

**Data from the industry.** Operating data with the new catalyst in a European H<sub>2</sub> plant is shown in FIG. 3. SK-501 Flex was installed to help the plant achieve higher efficiency by decreasing the S/C ratio to 2.5. With the previous catalyst, the minimum S/C ratio was much higher at 2.8. During more than 60 mos, SK-501 Flex has demonstrated its performance with low and stable pressure drops and delivered activity levels that exceed the expected activity of a standard HTS catalyst (FIG. 3).

**Catalyst formulation opens up increased production rates.** The higher activity will give a higher conversion in the HTS reactor throughout the catalyst lifetime. In a 100-MMft<sup>3</sup>/d H<sub>2</sub> plant, a production increase of 0.5% is estimated just by changing to the SK-501 Flex and maintaining the same operating conditions.

Even higher production gains can be achieved by lowering the S/C ratio. With the possibility of operating the plant at S/C ratios previously unattainable with commercial catalysts, producers can achieve unprecedented improvements in capacity increase. For example, a decrease in S/C ratio from 2.75 to 2.25 can result in 3%–5% more hydrogen production by simply reducing the steam flow to the plant and increasing the flow of hydrocarbon feedstock. TABLE 1 shows the comparison.

The use of Topsoe's SK-501 Flex catalyst is the most inexpensive revamp option for a plant to increase its production rate. It requires only a cat-

alyst replacement without additional capital expenditure (CAPEX).

**Applications of SK-501 Flex.** The use of SK-501 Flex is suitable in the HTS reactor at any modern ammonia, syngas or H<sub>2</sub> plant. The catalyst can be installed as a direct replacement of a conventional HTS catalyst and can play a vital role in revamps as well as new plants. When reducing the plant S/C ratio, the effects of reduced steam input and increased feed gas flow must be carefully considered, and a detailed assessment of the plant must be made. With the removal of the S/DG limitation, other factors that may determine the operating S/C ratio include:

- Feed gas composition and its possible fluctuations
- Steam requirements in the CO<sub>2</sub> removal section
- Distribution of duty between primary and secondary reformers
- Operating pressure
- Reformer firing rates
- The possibility of metal dusting in the waste heat boiler.

One advantage of SK-501 Flex over conventional Fe-Cr catalysts in any application is the opportunity to reduce steam addition and, therefore, benefit from significant energy savings. Another application is the gasification of carbon-based fuel to synthesis gas, a process that is made more efficient by utilizing the whole genome sequencing (WGS) reaction. Other applications for which SK-501 Flex is uniquely suited are those that

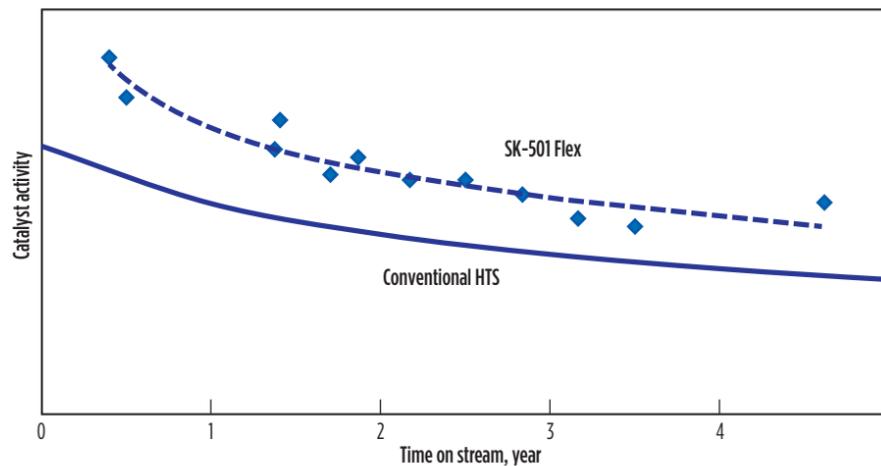


FIG. 3. Industrial performance of SK-501 Flex.

include a reverse WGS process. In such cases, it is not only the catalyst's ability to operate at low S/DG ratios that make it a good candidate, but also its excellent thermal stability.

**Takeaway.** Topsoe's latest development in high-temperature shift catalysis, SK-501 Flex, is now proven in industry. With this new catalyst, producers can operate at steam-to-carbon ratios that were unattainable until now, giving the producers more plant flexibility and the subsequent benefits of reduced energy consumption and increased production rates. Additional benefits of SK-501 Flex are a result of its iron- and chromium-free formulation and include improved personnel safety, reduced environmental impact, hassle-free startup and minimum by-product formation. The possible applications for the new HTS catalyst are numerous, ranging from H<sub>2</sub> plants,

ammonia and syngas plants, to cutting-edge projects such as biogas production, CO<sub>2</sub> capture and storage, and modern fuel cell power generation. No matter what the application, the introduction of SK-501 Flex opens new opportunities for production gains and efficiency improvements.

To learn more and to meet the Haldor Topsoe team, visit their hospitality suite on Monday and Tuesday evenings. ●



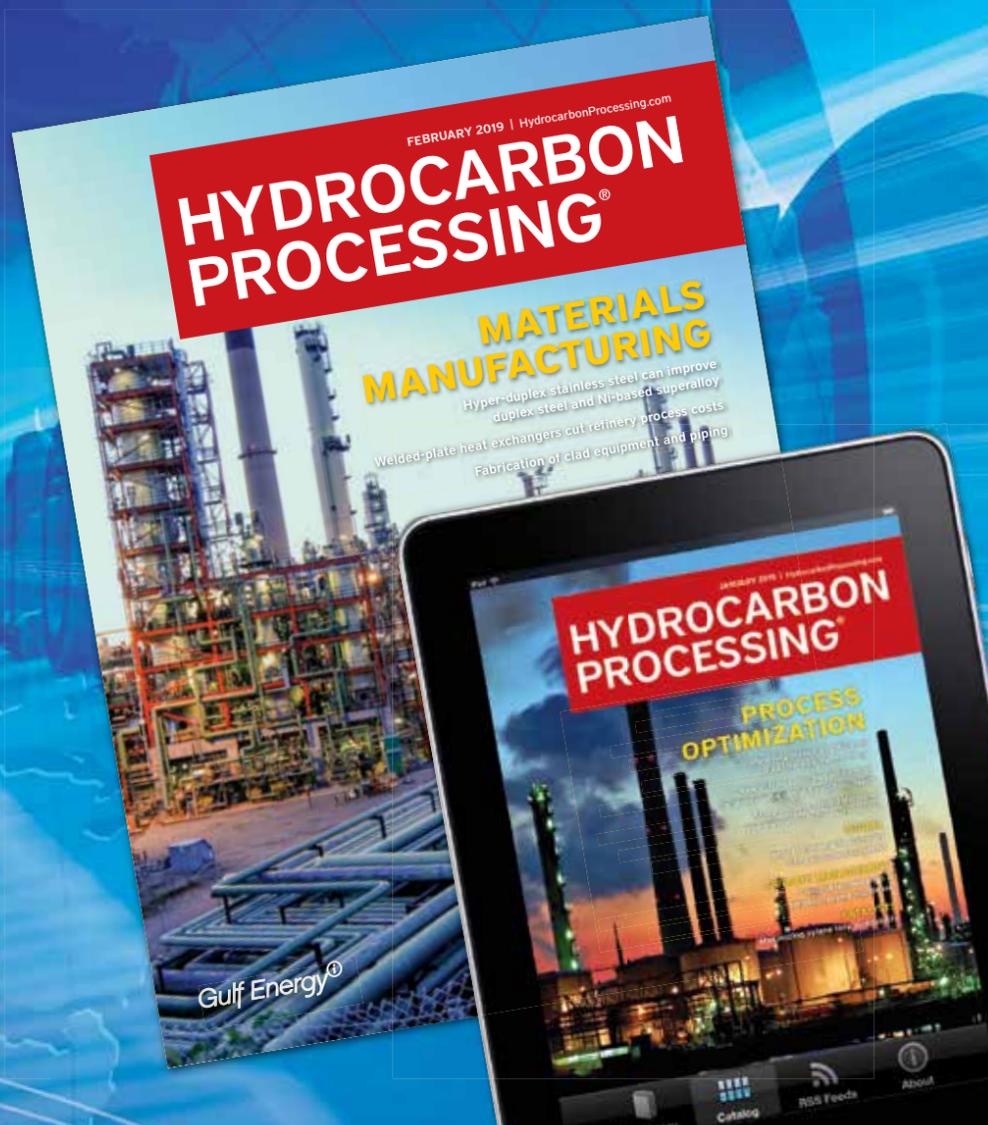
**HENRIK RASMUSSEN** is the Vice President of Catalyst and Technology and is responsible for Topsoe's catalyst and license technology business for the U.S., Canada and the Caribbean. He has worked at Haldor Topsoe for 30 yr and has held numerous technical and management positions for all Topsoe business units. Mr. Rasmussen graduated from the University of Copenhagen in 1989 with a degree in chemical engineering before relocating to the U.S. in 1991.

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# HOSPITALITY SUITES

This guide is a directory of the companies who host hospitality functions at the Operations & Process Technology Summit. Open hours are determined by the individual host in compliance with AFPM's policy not to conflict with regularly scheduled Association sessions and activities and to close by 1 a.m.

COMPANY	LOCATION	DATES
Albemarle Corporation	Conference Room 7	10/14
Axens North America, Inc.	Conference Room 8	10/14
BASF Corporation	Conference Room 8	10/15
Chevron Phillips Chemical Company LP	Conference Room 6	10/14
Dorf Ketal	Suite _____	10/13, 10/14
DuPont Clean Technologies	Suite _____	10/14
Emerson Automation Solutions	Conference Room 9	10/14, 10/15
Haldor Topsoe Inc.	Conference Room 15	10/14, 10/15
Honeywell UOP	Conference Room 5	10/13, 10/14, 10/15
Johnson Matthey	Conference Room 11	10/13, 10/14, 10/15
Matheson	Suite _____	10/14, 10/15
Shell Catalysts & Technologies	Conference Room 13/14	10/14
TechnipFMC	Conference Room 7	10/15
W. R. Grace & Co./ART Hydroprocessing	Conference Room 12	10/14, 10/15
Wood	Suite _____	10/13, 10/14

Suites are held on the sleeping room floors and numbers can be found in the AFPM Mobile App or the Hospitality Notice Board in the AFPM Registration area.

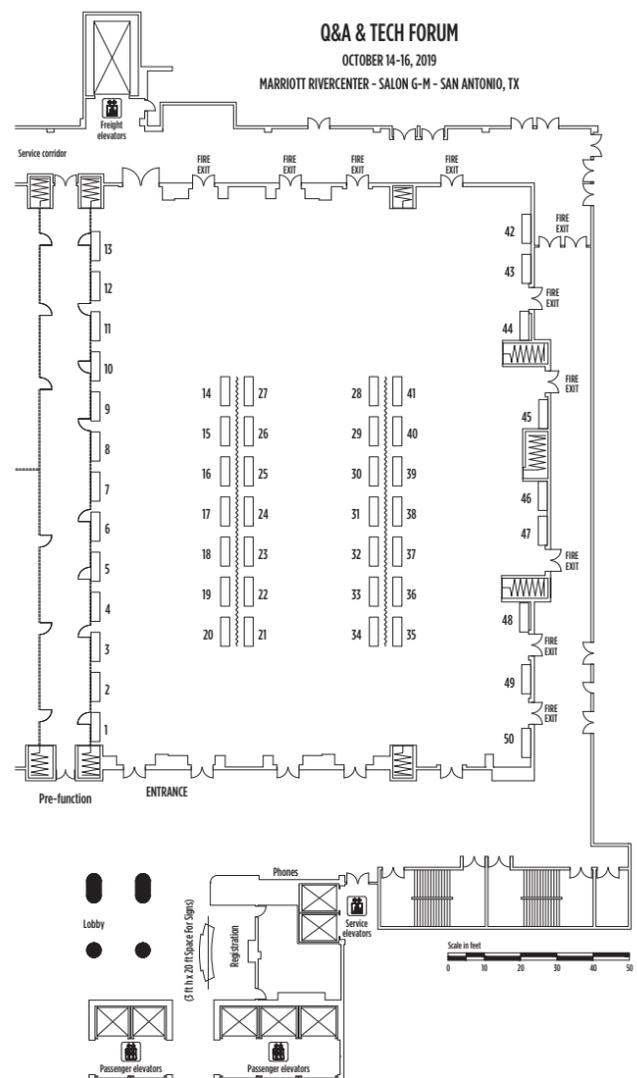
# MEETING ROOMS MAP



# LIST OF EXHIBITORS

EXHIBITOR NAME	BOOTH NUMBER
Air Products	24
AIS Software	30
Albemarle Corporation	42
Aqseptence Group-Johnson Screens	12
ARCOS LLC	45
Arkema, Inc.	15
Athlon, a Halliburton Service	14
AVEVA	25
Baker Hughes, a GE company	2
BASF Corporation	19 and 20
Becht Engineering Co., Inc.	43
Cameron Process Systems	44
Chem32 LLC	38
ChemTreat	37
Chevron Phillips Chemical Company, LP	5
Clariant	7
ClearSign Combustion Corporation	11
Crystaphase	1
Dorf Ketal Chemicals	49
DuPont Clean Technologies	3
Emerson Automation Solutions	16
Eurecat U.S.	18
G. W. Aru, LLC	29
Haldor Topsoe, Inc.	9
Hoover Ferguson Catalyst & Chemical Containers	8
Johnson Matthey	35
KBC (A Yokogawa Company)	17
KBR	34
Matheson	41
Merichem Company	36
Nalco Champion	21
PAS Global LLC	27
Petroval Inc.	33
Porocel International, LLC	28
Prosep USA	39
Quantum Technical Services	22
Refined Technologies, Inc.	13
Sabin Metal Corporation	50
Saint-Gobain NorPro	46
Seeq Corporation	40
SUEZ Water Technologies & Solutions	47
TechnipFMC	4
The Dow Chemical Company	32
Tracerco	26
Vapor Point	31
VEGA Americas, Inc.	23
WIKA USA	48
Wood	6
Woven Metal Products	10

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Austin, TX

**International Petrochemical  
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March 29 - 31  
New Orleans Marriott  
New Orleans, LA

**International Base Oils &  
Waxes Conference**

March 29 - 31  
New Orleans Marriott  
New Orleans, LA

**Security Conference**

April 13 - 15  
Westin Riverwalk Hotel  
San Antonio, TX

**Labor Relations /  
Human Resources Conference**

April 16 - 17  
Westin Riverwalk Hotel  
San Antonio, TX

**National Occupational &  
Process Safety Conference**

May 13 - 14  
Grand Hyatt San Antonio  
San Antonio, TX

**The Summit:  
Excellence in Plant Performance**

August 25 - 27  
Grand Hyatt San Antonio  
San Antonio, TX

**Board of Directors Meeting**

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The Meritage  
Napa, CA

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