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ISA certification enhances end-user cybersecurity; industry resilience built with cyber insurance

ADRIENNE BLUME, *Hydrocarbon Processing*

During Tuesday morning's Cybersecurity session, Kenny Mesker of Chevron USA spoke about ISASecure certification from an end-user perspective. He noted that ICS cyber attacks are accelerating. "We live in a world where that is just a reality now; you have to live with it and get used to it," Mesker said.

However, just because a cyber attack has not happened at a company or facility does not mean that vulnerabilities do not exist. It is dangerous for companies to adopt a nonchalant attitude toward cybersecurity, Mesker noted. The number of hackers with advanced skills is increasing, and tools that simplify hacking, such as Metasploit and breach codes, are readily available.

The International Electrotechnical Commission (IEC) 62443 Standards, of which Mesker is a principle author of one section, address industrial security. The four key components of the Standards are policies and process for the system integrator, secure development lifecycle for the vendor, component specification for the vendor, and system specification for the vendor/integrator.

At the base, vendors create products that are secure by design, using a cybersecurity lifecycle. At the next level, system integrators design, deploy and integrate automation solution products. At the top level, risk assessors at asset owners assess operational and maintenance capabilities.

"The idea here is that you are closing risk gaps, not safety gaps," Mesker said. "You are looking for the minimum required security level to close the gap you have."

The security properties Safety Integrity Level (SIL) 1 through SIL 4 can be compared to the security offered by an inexpensive padlock (SIL 1), a heavy-duty padlock (SIL 2), a cabinet safe (SIL 3) and a bank vault (SIL 4). SIL 1 protects employees and contractors, while SIL 2 considers cyber crime and hackers. SIL 3 incorporates hacktivists and cyber terrorists, and SIL 4 protects at the nation-state level.

ISASecure certification scheme. ISASecure, backed by the ISA Security Compliance Institute (ISCI), is a nonprofit organization created to facilitate IEC 62443 standard certifications, including end-users, government agencies, suppliers, consultants

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KENNY MESKER of Chevron USA notes that just because a cyber attack has not happened at a company or facility does not mean that vulnerabilities do not exist.

Hydroprocessing challenges and advancements

STEPHANIE CANO, *Hydrocarbon Processing*

The Monday afternoon Hydroprocessing Q&A session was led by six industry panelists: Travis Beltz from Marathon Petroleum Corp., Jeff Caton from Axens North America, Jeff Crouch from DuPont Clean Technologies, Neil Howard from Chevron Lummus Global, Robert Steinberg from Motiva Enterprises, Travis Beltz from Marathon Petroleum Corp. and Wendy Wildenberg from Flint Hills Resources.

Questions for the Q&A sessions covered topics that included utility costs in hydrotreating units, changing optimization strategies for the entire hydrocracker, considerations for designing a hydrocracking reactor and other processing issues.

Attendees worked in groups to complete an assigned scenario using candy as catalysts.

The session also included audience poll questions and commentary, before concluding with a group challenge activity. Attendees were asked to work in groups to maximize cycle length, while taking into consideration dP protection, silicon guard and activity. Each team worked with a quart jar, tape measure and five types of "catalysts" (candy) to complete an assigned scenario and blank-loading log sheet.

Q: What constitutes adequate quench reserve when you process cracked feedstocks in hydrotreating units? In hydrocracking units? What if a mixture of both gas and liquid quench is used?

Wildenberg responded with an analogy about the way a child walks a dog. A large dog might seem obedient and under control when on a walk but can easily become distracted and create havoc for the owner. "The child is not really in control, and it is the same thing with the hydroprocessing reactor. Maintaining control means that a dog-walker must be able to hang on to that dog, even if it starts to bark or run away. It requires adequate reserve strength and early detection and response when the dog just begins to become distracted, or when we feel the pull on the leash," Wildenberg said. "Hydrocrackers can be very big dogs that are ready to pull and run. Hydrotreaters will walk away, until the temperature reaches greater than 425°C (800°F), and then they will 'run away.' Therefore, hydroprocessing units require reserve cooling, and good detection and control to regain control of a reactor

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INSIDE THIS ISSUE

A Better Perspective
on Hydroprocessing Solutions

In the refining industry, market conditions are always evolving with new regulatory requirements, global demand shifts, and the use of heavier feedstocks among other factors. ART Hydroprocessing can help you take a better perspective on these challenges based on our deep understanding of refinery operations and a full spectrum of hydroprocessing catalysts solutions that maximize profits by balancing run length, severity, feed flexibility, contaminants, and operating constraints.

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Case study: Optimization of refinery middle distillate system

ADRIENNE BLUME, *Hydrocarbon Processing*

At the Monday afternoon Operational Planning, Control and Automation Technologies (OPCAT) session, Vikram Gokhale and James Gunderman of Chevron USA talked about the closed-loop, real-time coordination of a refinery middle distillate system in California.

Project scope. Gunderman first explained the process flow for the refinery's middle distillate system. The two crude units are under advanced process control, as are the coker, the fluid catalytic cracker, the diesel hydrotreater and the jet fuel hydrotreater. The goal of the project was to coordinate APC applications across several units to diesel production, while staying within specifications on the key properties, including sulfur and distillation 90% point for diesel and freeze point and pour point for jet fuel.

The optimization operations assistant (OOA) worked with console operators to implement the short-term plan and optimize the refinery, based on current conditions. The new refinery optimization center (ROC) was a major enabler for the project.

Technology selection. Gokhale then spoke about the technology chosen for the project, which included APEX Optimisation's Generic Dynamic Optimization Technology (GDOT). APEX built the GDOT model with assistance from Chevron process control and planning staff, using elements derived from refinery planning models, simple first-principles models and APC models. GDOT was then used to optimize targets sent to selected APC variables.

"Ultimately, what the model is looking for is an end-to-end, front-to-back connection," from the crude header to the blend header, Gokhale explained. If the process units do not operate in a typical configuration, or if blendstocks are produced, then the model must be adjusted to accommodate these elements of the process.

Project benefits. Gunderman next discussed the benefits of the project. Sulfur giveaway was reduced by 70%, resulting in increased throughput to the hydrotreater. Furthermore, 90% diesel giveaway was reduced by 80%, leading to increased diesel production from gasoil, and jet smoke giveaway was decreased by 25%.

To sustain these benefits, refinery and centralized EPC staff were developed for post-project support, and daily and weekly routine checklists were initiated. Model maintenance procedures were documented, and offline simulations were conducted to improve understanding of the application. Additionally, new process control engineers and console operators are trained. Daily interactions are planned for schedulers and planners, and monthly application performance reviews are carried out with planners and process engineers.

Project takeaways. In closing, Gunderman and Gokhale shared tips from project experience. Ensuring that underlying APC applications have a strong support structure and show high uptime is important. Also, a pre-project benefits study helped involve oils planning and operations staff from the beginning. An extensive model review should also be conducted before and after commissioning and may encompass several sessions.

A final lesson learned includes a focus on the modeling and application integration philosophy. Classroom training is only a starting point, Gokhale explained, and site control engineers should budget time to seek answers to their questions from the GDOT commissioning team.

"To develop an understanding of how everything comes together can take time. You may have to ask the same questions three times," Gokhale said. "This is not somebody coming and installing a new refrigerator in your house … This is a much longer exercise, and the only way to ensure quality is to go in depth." ●

Data analytics support refinery process control during a hurricane

ADRIENNE BLUME, *Hydrocarbon Processing*

At Monday afternoon's OPCAT session, Onur Onel of ExxonMobil Research and Engineering Co. spoke about process control support with data analytics during abnormal events, such as a hurricane. During Hurricane Harvey in August and September 2017, heavy rainfall impacted industry operations in southeast Texas and along the Gulf Coast. Ship channels were closed, 10 refineries were shut down across the region and potable water was lost because the area received 50 inches of rain over a four-day period.

Onel explained the importance of evaluating and troubleshooting during an abnormal event. "You need to know what you need to do, and how fast you need to identify these issues to go back to normal production," he said. Potential damage to assets includes equipment being submerged and unknown equipment status.

Using data analytics for control assets. Control assets are the foundation of plant performance; up to 75% of physical assets are under advanced process control (APC). "It is important to use data analytics for performance monitoring to keep assets healthy, so that you can keep reliability," Onel said. In base control asset monitoring, a typical work process includes operator observation and notification, observation by the application engineer, waiting for a control asset to break, ad-hoc analysis and manual root cause identification.

Some sites have more than 2,000 base control assets that require automated monitoring, analysis and troubleshooting. "On regular day-to-day operation, you need to be able to monitor these assets successfully, before you can start to think about abnormal events," Onel explained.

Data analytics can be used to classify control asset performance. ExxonMobil used a plantwide SQL query before and after Hurricane Harvey. It also used existing KPIs from built-in software to deliver more insights about impacts to plant operations. Using this analysis, a "hit list" was created for items that needed to be addressed immediately during and after the hurricane.

Learnings from data analytics application. The main learnings derived from the use of data analytics for process control support include the provision of non-invasive, proactive monitoring support through data analytics; early detection of potential issues to prevent site-wide propagation; improved

► See HURRICANE, page 8

SCHEDULE OF SESSIONS AND SPECIAL EVENTS

WEDNESDAY OCTOBER 03, 2018

7:30–10 a.m.	**Registration**
8–9:30 a.m.	**Concurrent Sessions:** • Cybersecurity Exercise—See "CyberStrike" below • Principles & Practices—FCC • Principles & Practices—Fostering Profitability
8–11 a.m.	**Cyber Strike—A Cybersecurity Exercise—SOLD OUT** Coordinated by the Department of Energy
9:30–9:45 a.m.	**Coffee Break**
9:45–11 a.m.	**Concurrent Sessions cont.**

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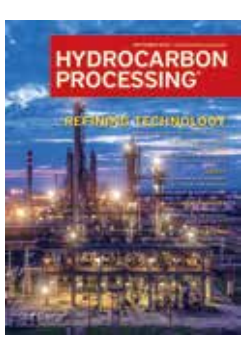

Next-generation catalyst sets benchmark for hydrogenation of acetylene to ethylene

Ethylene is one of the most widely produced petrochemicals and is a vital building block in the production of plastic products. Therefore, it is of critical importance to manufacturing.

Ethylene is the primary product of thermal cracking, which also results in numerous byproducts. Acetylene is a particularly problematic byproduct, as it negatively affects downstream applications by acting as a poison to the catalysts used for making polyethylene from the ethylene product. Polymer-grade ethylene must contain only the minutest trace elements of acetylene, which can be successfully converted to ethylene via the process of selective hydrogenation. Selectivity is key, as non-selective hydrogenation destroys the valuable ethylene product. High selectivity results in acetylene being almost entirely converted to ethylene, resulting in millions of dollars' worth of additional yield and value.

Latest generation. In May, Clariant, a pioneer in the development of innovative catalysts for an extensive range of industrial applications, introduced the latest generation of hydrogenation catalyst with high ethylene selectivity and operational stability. OleMax® 260, which has been specially developed for ethylene producers with "front-end" process configurations, delivers near-perfect selectivity (close to 100%), resulting in significant economic benefits to the operator.

Front-end process configurations are not without operational challenges, including excess hydrogen (H_2) and carbon monoxide (CO) fluctuations, both of which have the potential to result in thermal runaway conditions that lead to unplanned production outages and potentially hazardous situations. One of the most important advantages of the OleMax 260 catalyst is that it delivers ultra-high stability, impeding thermal runaway reactions. The selectivity and consequent stability of OleMax 260 ensures reliable, on-specification performance across a wide operating range, even at the extremely low CO levels typical of new cracking furnace technologies.

A further advantage of OleMax 260 is a faster, more sustainable start-up. The catalyst's simplified streaming procedure significantly reduces normal startup-related hydrocarbon flaring and time to on-specification ethylene production. OleMax 260 is optimized to operate in deethanizer overhead hydrogenation process configurations and can be used in a newbuild or as a drop-in solution in an existing facility.

The first commercial startup of OleMax 260 was successfully undertaken during the latter part of last year at The Dow Chemical Company's new, world-scale ethylene production plant in Freeport, Texas (**FIG. 1**). With a nameplate capacity of 1.5 metric MMt (million metric tons), the plant is a central component of Dow's $6-B US Gulf Coast investment program designed to strengthen the competitiveness of the company's downstream consumer-led businesses. The new state-of-the-art catalyst has made a major contribution to the plant's ethylene yield, delivering the expected performance and benefits.

"Following extensive lab and pilot-scale testing at internal R&D facilities, Dow Hydrocarbons chose to implement Clariant's new OleMax 260 acetylene hydrogenation catalyst," said Doug May, Business President of Dow Olefins Aromatics and Alternatives. "In 3Q 2017, Dow successfully started up a new world-scale ethylene production facility with this catalyst, and operations have subsequently ramped up to full capacity as planned. OleMax 260 has shown robustness and resilience to process variability while providing expected raw material yields and selectivity."

While Clariant has extensive experience in catalysts for ethylene production and offers a range of leading products for purifying chemical feedstock, OleMax 260 means that virtually 100% hydrogenation of acetylene to ethylene is no longer a goal, but a proven outcome. ●

FIG. 1. Successful industrial startup of OleMax 260 catalyst at a world-scale ethylene production plant of The Dow Chemical Company. Source: The Dow Chemical Company.

HYDROPROCESSING TECHNOLOGY STARTS UP AT PROCESSING FACILITY

DuPont Clean Technologies has successfully started one of the world's first IsoTherming® hydroprocessing technology applications to treat diesel from a transmix processing facility.

Transmix is a mixture of refined products that forms when transported in pipelines. This mixture is typically a combination of gasoline, diesel and/or jet fuel. The IsoTherming hydrotreater, located at the Gladieux Processing (Gladieux) transmix facility in Huntington, Indiana, has successfully completed the performance test, certifying that the unit is exceeding performance guarantees and producing 5,000 bpd of ultra-low sulfur diesel (ULSD) containing less than 10 ppmw sulfur.

Capital cost advantages, as well as comparatively lower utility consumption, were key drivers for Gladieux's selection of the IsoTherming hydroprocessing technology for this project.

The IsoTherming hydroprocessing technology utilizes a novel liquid-phase reactor system and uses the hydrogen and catalyst more efficiently. The DuPont technology is suitable for a wide range of applications, including kerosene hydrotreating, transmix hydrotreating, diesel hydrotreating, FCC feed hydrotreating (VGO hydrotreating), mild hydrocracking, dewaxing, gas-to-liquid (GTL) upgrading, and heavy oil upgrading for both grassroots and revamp configurations.

To date, DuPont has 26 IsoTherming hydroprocessing technology licenses globally, with 15 of these in commercial operation. These licensed units include a diverse set of applications ranging from 100% kerosene to 100% light-cycle oil (LCO), and various mixtures of distillates and heavy gasoils, including coker blends, with capacities ranging from 1,500 bpd–80,000 bpd. ●

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EXCITING CHANGES
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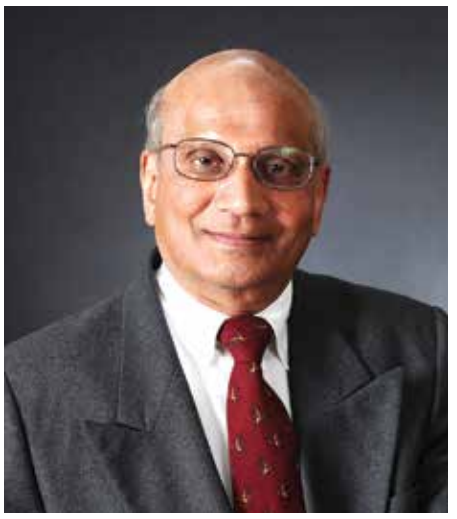
Straight talk on a hydrocracker revamp

SARAH MCFARLAND and **MALLORY TAYLOR,** BP; and **PANKAJ DESAI,** Shell Global Solutions

SARAH MCFARLAND is a Commercial Optimization Engineer performing retro-analysis at the BP-Husky Toledo refinery. She has been with BP for 13 years and has eight years of hydroprocessing experience, ranging from process engineering to project development, execution and commercial optimization.

MALLORY TAYLOR is the Process Engineer for the hydrocracker at the BP-Husky Toledo refinery. She has been with BP since 2012 and is the technical contact for operations. Ms. Taylor has been supporting the unit operation with performance monitoring and daily problem-solving since the last startup.



PANKAJ DESAI is the Licensing Sales Manager in the Americas and Global Business Manager for Hydroprocessing Reactor Internals for Shell Global Solutions (US) Inc. He has 37 years of professional experience with refining and petrochemical process technologies, catalysts, reactor internals and other proprietary hardware, as well as software, such as process technology models.

The key conversion unit at the BP-Husky Refining Toledo refinery in Oregon, which BP operates as part of a joint venture with Husky Energy, is the 31,000-bpd hydrocracker.

The unit was built in the 1960s when feeds were easier to process and catalysts were less active. Over the last few years, the feeds had become more difficult to treat and were causing increased differential pressure and radial temperature spreads, which were curtailing the catalyst cycle length and causing potential safety concerns.

Working closely with Shell Global Solutions, the refinery's technologists removed the internals from two reactors, reconfigured them and installed latest-generation internals. Revamping very old reactors is technically demanding.

AFPM and *Hydrocarbon Processing* had the opportunity to ask process engineers from the site to explain the challenges and how the team overcame them. Sarah McFarland, Project Process Engineer at the BP-Husky Toledo refinery, was involved throughout the project. Mallory Taylor, Process Engineer at the BP-Husky Toledo refinery, is responsible for the unit's ongoing performance. Pankaj Desai, Licensing Sales Manager for Shell Global Solutions, was BP-Husky Refining's account manager for this project.

AFPM/*HP*: Can you provide details of the project's objectives?

MCFARLAND: The hydrocracker has two five-bed reactors: a first-stage (hydrodenitrification) reactor and a second-stage (cracking) reactor, each with its own individual commercial drivers.

The first-stage revamp aimed to extend the catalyst cycle length from two or three years to four years. We had high radial temperature differentials across the beds, so we thought we had a loss of catalyst utilization. We were also having trouble utilizing the bottom of the reactor, owing to the 1960s-era design that lacked a bottom quench.

AFPM/*HP*: What about the second-stage reactor?

MCFARLAND: There, we had been having issues with poor distribution and high radial temperature differentials. We were overcracking and producing light ends, so the objective was to reduce the fuel gas make and produce gasoline, kerosene or diesel.

Poor thermal distribution has safety implications, too. It can lead to the increased likelihood of temperature runaways. We were keen to reduce the risk of that occurring.

AFPM/*HP*: Why were Shell reactor internals selected?

MCFARLAND: Shell became part of the mix because BP uses its reactor internals in six other hydrocrackers worldwide, where they have established a strong track record. Shell has a reputation for being very involved in the design and engineering work, the delivery of parts and the manufacturing process.

AFPM/*HP*: Did the age of the reactors present any challenges?

MCFARLAND: It really did. Our inspection department ruled out welding any new nozzles due to the risk of cracking, so all penetrations for thermometry and quenching are in the trays. Other vendors did not have similar experience with that type of retrofit, whereas Shell could provide numerous similar references.

AFPM/*HP*: Can you provide details on the installation and startup?

MCFARLAND: The whole project took just 10 months and, I am pleased to say, the unit started up successfully, on time and within budget.

AFPM/*HP*: What were the most important steps taken to achieve those benchmarks?

MCFARLAND: We did an excellent job of inspecting everything, with multiple inspections and sign-offs from Shell's onsite support (day and night shifts) and refinery engineers.

It was crucial that the new internals were installed correctly the first time, without rework, for the project to remain on schedule. Redundancy dictated our approach, but we felt that this was acceptable given the high strategic importance of executing the project smoothly and on time.

AFPM/*HP*: How is the unit operating now?

TAYLOR: Very well. One of the most significant improvements is the reduction in differential pressure across the first-stage reactor. The reduction is 20%–30% lower since the revamp, even with an increase in the total barrels processed.

In the run before the revamp, the differential pressure limit was reached at 650 days. The first run after the revamp was still not limited by differential pressure after 1,100 days. Reducing that constraint has enabled the unit to run longer and process more total barrels over the catalyst lifecycle.

AFPM/*HP*: Has the project improved safety?

TAYLOR: Yes, and that has been one of the most striking achievements of the project. I am pleased to say that we have reduced the high radial temperature differentials that contributed to coking and overreacting, thereby reducing the potential for temperature runaways. There have been numerous other safety benefits, as well. For example, the manways are now larger, and the maintenance required is easier, so confined space residence time is shorter.

AFPM/*HP*: Have your shutdowns been shorter since installing the new internals?

TAYLOR: We have not yet had a shutdown—we keep pushing it back. Our initial goal was to extend it to achieve a four-year cycle, but we now think it is going to be a five-year run instead. For a treating reactor, that would be huge.

However, we do expect shorter future turnarounds. The new internals have a wedge-pin design, which removes the need for cutting and welding. This has reduced the total catalyst change-out time at other BP sites, and we expect it to shorten turnarounds here by two days.

AFPM/*HP*: Do you view the project as a success?

MCFARLAND: Absolutely. It has helped improve our performance and mitigated potential safety risks, for a relatively minor capital expenditure.

AFPM/*HP*: From Shell Global Solutions' perspective, what was the key to the project's success?

DESAI: Ms. McFarland, Ms. Taylor and their colleagues were particularly proactive. They were able to identify the issues that were constraining performance; had a clear idea of their objectives; understood the benefits of improving catalyst utilization and minimizing the radial temperature differentials; and provided all necessary process and mechanical data.

There was a particularly open, collaborative culture between both parties, which is often key to pushing the boundaries of what a business can achieve. ●

TOTAL FINALIZES PLANS TO EXPAND TEXAS BAYPORT POLYMERS IN PETROCHEMS PUSH

According to French oil and gas major Total, the company has made a final investment decision to expand its Texas Bayport Polymers joint venture to double polyethylene production capacity to 1.1 MM metric tpy. Total aims to become a major player in the US polyethylene market when it announced the joint venture in March 2017 with Borealis and Canada's Nova Chemical.

The Bayport project is in line with the company's $3-B program that began a year ago with a $1.7-B investment to build an ethane steam cracker at its Port Arthur refining complex in Texas.

The cracker will process ethane, which is abundantly available from US shale gas at competitive prices and will supply Bayport polyethylene units. Production is expected to start in 2021. The new unit is expected to have a capacity of a 625,000 metric tpy that will be added to the existing 400,000-metric tpy unit.

The Bayport unit engineering, procurement and construction (EPC) has been awarded to McDermott, Total said. ●

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From the ICS frontlines: Approaching OT cybersecurity

EDDIE HABIBI, PAS Global; and **JACOB LAAS GLASS,** Total

To secure industrial facilities and ensure safe and reliable production, operational technology (OT) and information technology (IT) security—traditionally two separate disciplines with different priorities—must collaborate to share cybersecurity and risk management best practices. We recently reached out to a panel of industry experts focused on OT cybersecurity risk mitigation and asked them to share their strategies for making industrial control systems more secure. The firsthand experience collected comes from experts across a diverse range of industries, including oil and gas, chemicals and refining, and power generation. Their essays illustrate the importance of understanding similarities and differences between IT and OT environments.

In this article, we share an excerpt of the Ebook, *Advice for CISOs: How to Approach OT Cybersecurity.* Despite the title, the information presented is useful for anyone involved in protecting OT environments.

As the industrial control system (ICS) industry gives more consideration to cybersecurity, vendors must develop a more holistic view. For now, many companies must contend with an OT environment that is complex and difficult to secure. Several practices have greatly improved cybersecurity environments.

Begin with a technical standard of critical security elements. OT control systems often require multiple components to work together to perform a control function. Every device in that control system can have a critical safety impact on the overall system's function. When a device is installed, all the ways it can negatively impact the system must be evaluated. The same strategy should be applied to evaluating an ICS from a security perspective.

Begin with a technical security standard that the system and its components must meet. One industry security expert said, "Every time we install something, we apply a Swiss cheese model against the standard. We look at it to see what can be set up initially, what we can prevent, what we can detect, what we can respond to and what we can recover. If there is something we cannot do, we look for what we can alternatively do in the system to cover for that security element." When something is added to the system, one way or another, the system must still meet the standard of critical security elements.

When in doubt, assume a protection is not there. Systems are usually well-documented from a cabling standpoint. However, documentation of device configuration is often poor. New technology that detects OT devices and their configurations has been a tremendous help in providing greater visibility, but areas of uncertainty remain. For example, it may be unclear if a device is configured with a host firewall. In this scenario, it should be assumed that it is not there, and then a plan for hardening that device or network must be developed. This involves a lot of work and help from vendors. Some vendors know how to protect their own systems, but others do not get involved in industrial security. A company may have to fulfill this requirement on its own.

Establish an OT department that works closely with the IT department. This gives OT personnel access to IT personnel, who typically have more detailed technical knowledge about cybersecurity issues. In one organization, the OT department resides in the IT department but is still responsible for operations and OT security. The proximity to IT personnel has numerous benefits. Every time a device is connected, different information from the vendor states what is possible and what is not. This helps create good, secure solutions.

Having a security standard for control systems and working with IT to help implement them has proven very effective. "Someone can just sit in their security officer chair and say, 'No, that is impossible,'" the industry security expert said. "We have to make it possible. That is the whole point with OT. We have to make it possible because a significant amount of money is involved."

Stop by the PAS booth (#19) in the exhibition hall to meet the team and learn more about PAS Cyber Integrity™. ●

EDDIE HABIBI is the Founder and CEO of PAS Global. He is a pioneer and a thought leader in the fields of industrial control systems (ICS) cybersecurity, the Industrial Internet of Things (IIoT), data analytics and operations management. In 2017, PAS was recognized in CRN's 15 coolest industrial IoT companies, and Mr. Habibi was listed by CRN as one of the 30 Internet of Things Executives Whose Names You Should Know. He is the co-author of two popular best practices books on operational risk and safety management: *The Alarm Management Handbook* and *The High Performance HMI Handbook.* Mr. Habibi holds an engineering degree from the University of Houston and an MBA degree from the University of St. Thomas.

JACOB LAAS GLASS is the Head of Industrial IT and Infrastructure for Total TEPDK. His first position at Maersk Oil, recently acquired by Total, was as an Instrument/Automation Engineer in 2006. Since then, he has been involved in numerous projects, including the installation of ICS on oil-producing platforms. He has also worked in the telecom and manufacturing execution systems (MES) side of ICS, moving to OT security. He played a key role in establishing guidelines and corporate standards for the company. In 2017, he was asked to lead a team of OT specialists dealing with OT security, critical infrastructure, real-time data, analytics and predictive maintenance. In 2018, he became Head of Industrial IT and Infrastructure, completing the discussion around IT/OT convergence. Today, both the OT and IT specialists are within the same team.

HURRICANE, continued from page 3

site reliability and stability; and detection of technical and software gaps in current software for data analytics.

The technical gaps discovered include effective benchmarking for prioritizing bad actors, advanced filtering of potential bad-acting assets, data analytics for mechanical and equipment issues, automated diagnostics and root cause identification, and automated recommendations for improving loop performance.

Software gaps include more effective time series and before/after visualization, on-demand comparative analysis of process control assets, context visualization and filtering for instrumentation and equipment and valve monitoring, and enterprise-wide benchmarking for prioritization. ●

ThruPlus coke drum dual-feed inlet technology

RICHARD HENIFORD and **MIKE SPALDING,** Bechtel Hydrocarbon Technology Solutions Inc.

Historically, the activities with the highest risk to personnel safety on a delayed coker unit have been opening and working around the bottom of a full coke drum. Innovative bottom coke drum unheading valve technologies have made an extraordinary contribution to improving safety by essentially removing operators from the bottom of the coke drum as it is being opened, and by eliminating other preparations prior to returning it to service, further mitigating risk to personnel. However, some of the required equipment changes to install bottom unheading valves have also introduced undesirable consequences affecting personnel safety, operability and reliability in many coker units, as described here.

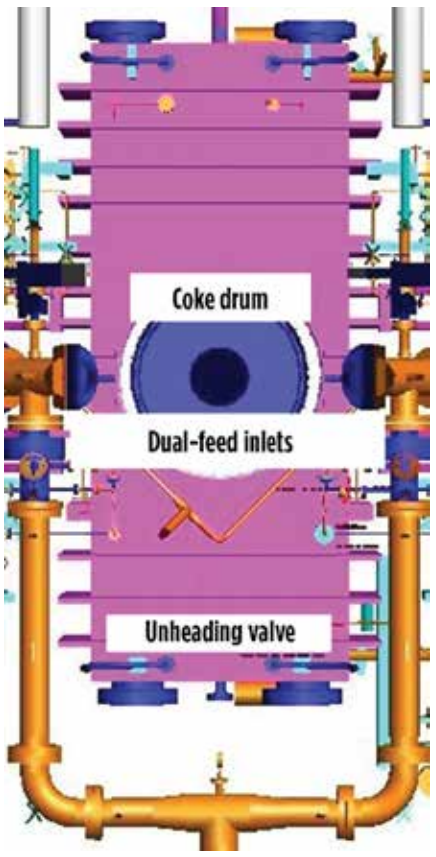

FIG. 1. General arrangement of the BHTS dual-inlet technology.

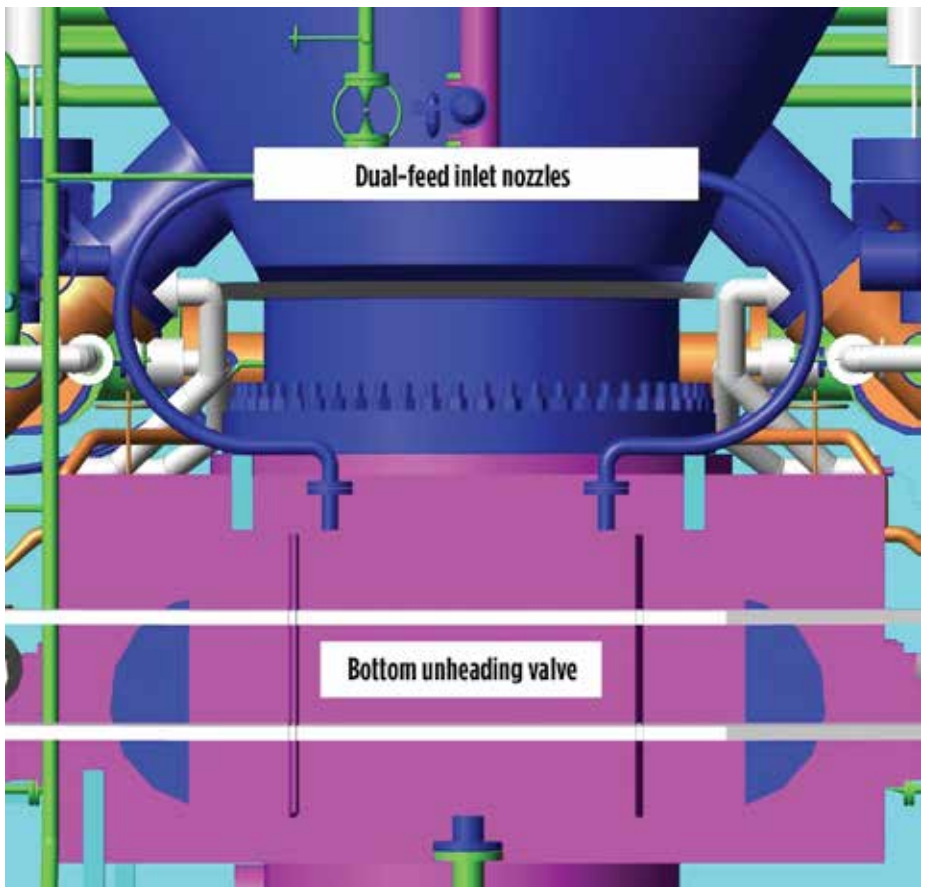

FIG. 2. Dual-inlet elevation plan.

Safety and operability issues. Installing a bottom unheading valve requires relocating the coke drum feed entry from the typical bottom dead-center nozzle to a side-feed entry. The use of a single-side entry has had a detrimental impact on safety and operations in many units. Undesirable and significant changes in the behavior of the coke bed were noticed immediately upon startup of some drums; on others, the effects on the coke drum became apparent after a few years of operation with the single-side feed entry. These changes have included:

- Increased frequency of coke bed hot spots, hot water and steam releases (blowouts) when cutting
- Reduction in quench efficiency and repeatability

▶ See ThruPlus, page 12

Making a digital "leapfrog"

PHIL MURRAY, Petrotechnics

Today's digital innovation is reshaping industries, disrupting business models and operating practices, and transforming business ecosystems.

Organizations that can increase their digital fluency create value throughout the enterprise, and they typically dominate in most markets. The Boston Consulting Group says, "…companies with high technology intensity have high gross margins." Global management consulting and professional services firm Accenture reports that companies that understand digital transformation earn 26% higher profits than others. Most executive teams understand this and recognize the power of technology to change the rules of engagement for businesses.

Digitalization is the engine fueling the growing adoption of operational excellence (OE) in the hazardous industries. Technology is at the heart of a rapidly accelerating effort to deliver unparalleled transparency, efficiency and intelligence into operational decision-making (**FIG. 1**).

More than 73% of industry leaders recognize the power of digitalization to accelerate and deliver sustainable OE. A reduction in operating costs, broader operational efficiencies and fundamental transformation of the business are expected. However, while the benefits are clear and tools are available, the ability to realize actual results is not.

Leapfrogging ahead of the digital transformation curve. Companies in hazardous industries have long struggled to deliver desired levels of operational efficiency and effectiveness. Increasing levels of scrutiny on process safety and risk management have further exacerbated the challenge.

Over the past decade, industry's answer has been the adoption of off-the-shelf software to streamline and automate processes. Point solutions succeeded in improving business functions, but they siloed organizations.

Industry then made significant investments in integrating systems, specifically maintenance management and planning solutions. Unfortunately, this approach failed to recognize two missing components: operational risk management and the reality of how work is executed and managed, which factor into wrench time and plan attainment.

Hazardous industry operators still have time to make a leapfrog to get ahead of the digital transformation curve. Rather than digitizing existing paper processes, an opportunity exists to deliver tangible business process improvements that drive toward OE. Operators must first rethink the business process to achieve a successful digital transformation strategy.

An integrated approach to operations management. Think about the evolution of communications systems in Africa, which skipped an entire age of development and infrastructure to support landline communication, and then moved straight into mobile communication.

Changing the way companies operate does not require years of investment to deliver safer, more efficient operational decisions. Rather, progress toward OE requires only an integrated approach to operations management.

A first step in delivering integrated operations management is to recognize the gaps between activity planning, maintenance management, operations and the reality of how work is executed. The planning process can never be granular enough in terms of both detail and the time window to provide an executable

▶ See **LEAPFROG,** page 15

FIG. 1. By bringing together disparate data and creating an integrated view of all operational activities and risk, companies realize greater levels of transparency, efficiency and performance.

Implementing the IoT in oil and gas

MICHAEL KANELLOS, OSIsoft

While the oil and gas industry has become one of the driving forces in the Internet of Things (IoT), it is also challenging to separate reality from hype.

To the information technology (IT) industry, the IoT often means collecting and analyzing machine data to achieve a business goal, such as reduced energy consumption. To people in operations, the IoT means putting in a secondary network on top of the so-called IoT network that is already reducing energy.

This distinction is important, as it helps avoid confusion and redundant or overlapping efforts. IT and operational technology (OT) must be on the same page, and the first step is a common vocabulary.

Potential data siloes. It costs much less and takes much less time to link new or stranded assets through wireless technologies and IoT gateways than to retrofit existing SCADA or DCS systems. Connecting untethered devices with IoT gateways and stick-on sensors can feed data into something other than a SCADA system, creating data siloes and an incomplete picture of operations. Whatever the architecture, data sources should be merged.

The business case. The IoT typically delivers three macro benefits: cutting costs, increasing revenue or reducing regulatory risk. These are worthy goals, and it is best to begin with predictive maintenance and reducing uptime, and then determine ways the IoT can increase the productivity of existing capital. DCP Midstream has created an interesting program that provides plant operators visibility into production, potential production and market pricing, showing them how to wring more out of the plant. Once those are established, many transition to tasks such as emissions monitoring. Trying to tackle these goals concurrently increases the chance of failure.

Data access. With the Industrial IoT (IIoT), not only is data being collected, but a system is being created that will encourage more people to use that data. That requires additional thinking about the user experience. Mobile access to contextualized operational data from all data sources is an absolute necessity. Operational data will be accessed by operators and maintenance technicians in the field responding to emergencies, as well as executives that want to compare production with pricing forecasts.

Providing easy-to-use, contextualized data in a mobile, self-serve environment is fundamental.

Analytics. Analytics is often envisioned as data scientists leveraging algorithms to sift through mountains of data in the cloud. Significant problems are being solved with IoT data in the cloud. For example, MOL, a large refiner in Hungary, for example, is conducting analytics on its machine data to determine how and when it can utilize less-expensive, higher-sulfur opportunity crudes without introducing risk to its operating parameters.

However, many analytics challenges are being addressed directly by people looking at a few finite data streams; this can be viewed as "human analytics."

Companies should think about taking a layered approach to analytics that take into consideration edge vs. cloud capabilities and costs, whether human analysis or algorithms might work better, and the feedback loop between these systems, to ensure that insights become operationalized.

Each future case cannot be anticipated, but if a broader view of what analytics means is taken, an analytical framework can be created that can take care of the unknowns. ●

MICHAEL KANELLOS is a Technology Analyst at OSIsoft. He has worked as a reporter, analyst and marketing exec in Silicon Valley for more than 20 years covering energy, semiconductors and startups. His work has appeared in the *New York Times,* CNET, *Forbes, Newsweek, Newsday,* the *Chicago Tribune* and *National Geographic,* among other outlets. Mr. Kanellos is a graduate of Cornell University and the University of California.

DIGITAL TRANSFORMATION

Digital Transformation has been a major topic of conversation throughout the refining and petrochemical industries. During Tuesday's Digital Transformation Town Hall, a panel of subject matter experts agreed that integrating digital technology into all areas of a business has been an ongoing task for years. The key to digital transformation is not thinking of it as a one-time IT task, but as an ongoing business solution.

ThruPlus, continued from page 9

- Previously unseen pressure spikes during quenching and draining
- Poor coke bed stability, higher frequency of cave-ins, collapses, stuck drill stems
- Leaks and deformation at the coke drum cone modification transition flanges
- Increased frequency and severity of coke drum "banana effect," causing the drums to impact and damage the steel support beams in the structure
- Significant, permanent deformation of the coke drums.

Coke drum feed distribution. These operational and safety issues are attributed to unequal distribution of the feed fluid mass, as well as the supply of heat delivered to the reacting fluid into the coke drum, with a single-side feed inlet. It was recognized in the 1950s that uniform distribution of the feed and heat input to the coke drum were critical to sustainable and safe operation, and this concept has been further corroborated by modern computational fluid dynamics (CFD) modeling by Bechtel Hydrocarbon Technology Solutions Inc. (BHTS) and others. CFD models show that the single-side entry arrangement can introduce a significant bias in the distribution of the feed and a large temperature gradient in the cone that are not present with the bottom dead-center entry or dual-feed entry. Actual temperature measurements on operating coke drums with bottom-center feed and dual-feed vs. single-side feed validate CFD model predictions. These mass and temperature biases persist through a large part of the coke bed and can result in operating and safety problems, such as channeling of quench water, high coke drum skin temperature differentials, unstable coke beds, hotspots, etc.

Attempts to alleviate these undesirable consequences with new technologies have been underway since the early 2000s, most of which have proven unsuccessful or mechanically complicated. One exception is the ThruPlus® coke drum dual-feed inlet technology offered by BHTS, shown in **FIGS. 1** and **2.** This system evolved from a dual coke drum inlet nozzle and piping system that has been used successfully in multiple cokers for more than 60 years.

Dual-feed inlet technology benefits. The BHTS dual-feed inlet technology has been successful in achieving uniform feed and heat distribution in all cases, both grassroots designs and retrofits. Benefits include:

- **Dependable, proven concept:** The dual-feed inlet configuration has demonstrated long-term, successful operation since the middle of the last century.
- **High reliability:** The equipment items utilized are standard and proven coker service valves, actuators and piping; no new complex mechanisms are required. Coker refinery operations and maintenance personnel are already familiar with the systems.
- **High onstream factor:** Failure of a valve actuator, or plugging of one of the inlet branches, does not require an emergency feed slowdown or outage. Instead, it can be scheduled and addressed during the next offline cycle for the affected coke drum.
- **Feed flexibility:** The design works with the wide range of feeds and operating conditions that many cokers experience daily, without tuning or adjustments.
- **Low cost:** All equipment and piping utilized in the technology are standard, off-the-shelf items. ●

EIA: US NOW THE LARGEST GLOBAL CRUDE OIL PRODUCER

The US likely surpassed Russia and Saudi Arabia to become the world's largest crude oil producer earlier this year, based on preliminary estimates in the US Energy Information Administration's (EIA's) Short-Term Energy Outlook (STEO). In February, US crude oil production exceeded that of Saudi Arabia for the first time in more than two decades. In June and August, the US surpassed Russia in crude oil production for the first time since February 1999.

Although EIA does not publish crude oil production forecasts for Russia and Saudi Arabia in its STEO, the organization expects that US crude oil production will continue to exceed Russian and Saudi Arabian crude oil production for the remaining months of 2018 and through 2019.

US crude oil production, particularly from light sweet crude oil grades, has rapidly increased since 2011. Much of the recent growth has occurred in areas such as the Permian region in western Texas and eastern New Mexico, the Federal Offshore Gulf of Mexico, and the Bakken region in North Dakota and Montana.

The oil price decline in mid-2014 resulted in US producers reducing their costs and temporarily scaling back crude oil production. However, after crude oil prices increased in early 2016, investment and production began increasing later that year. By comparison, Russia and Saudi Arabia have maintained relatively steady crude oil production growth in recent years.

Saudi Arabia's crude oil and other liquids production data are EIA internal estimates. Russian data mainly come from the Russian Ministry of Oil, which publishes crude oil and condensate numbers. Other sources used to inform these estimates include data from major producing companies, international organizations (such as the International Energy Agency), and industry publications, among others. ●

DuPont Clean Technologies wins *HP* Awards' "Best Refining Technology"

Nearly 150 of the downstream processing industry's leading players gathered recently to celebrate the winners of the 2018 *Hydrocarbon Processing* (*HP*) Awards. At the awards ceremony, which recognizes and honors the midstream and downstream processing industries' top innovations and innovators, DuPont Clean Technologies was recognized as Best Refining Technology for its ConvEx℠ HF alkylation conversion technology. Accepting the award for DuPont was Shane Presley, Technical Service and Development Manager. Mr. Presley and Jason Nunez, Senior Technical Service Engineer, were instrumental in developing the award-winning technology.

At a gala event in Houston, Texas, honorees received awards in 12 categories that recognized the latest technological advances and individual achievements. Category winners were singled out for their influential roles in enabling refinery, petrochemical and gas processing/LNG operators to optimize their operations.

Eli Ben-Shoshan, Global Business Leader, DuPont Clean Technologies, said, "We have worked with the refining industry for decades and understand the pressures our customers and the industry face. Refiners must meet present clean fuel demands while ensuring a safe operating environment for employees and the surrounding communities. We are thrilled to win this prestigious award, and we are even more excited to bring this cost-effective HF alkylation conversion and expansion technology to the market."

With worldwide demand for higher-octane fuels growing, petroleum refiners increasingly look to alkylate as the gasoline blending component of choice. Due to a worldwide shortage, the ability to produce alkylate onsite locally is extremely beneficial for refiners and offers a host of advantages including high octane, low sulfur, low vapor pressure and the elimination of aromatics and olefins.

More than 40% of the existing alkylation facilities in the world employ hydrofluoric acid (HF) as the catalyst for the alkylation reaction. Concerns with the toxicity of HF are pressuring refiners to reconsider its use. The new DuPont ConvEx technology is the first to offer refiners a significantly safer and cost-effective option for producing alkylate by converting existing HF alkylation assets to sulfuric acid alkylation units. The DuPont ConvEx technology has the added benefit of allowing for an increase in the design capacity of existing alkylation units by 100% or more at 40%–60% of the cost of a grass-roots sulfuric acid alkylation unit, which is lower than any other option available on the market. ●

Representatives from DuPont accept the HP Award for Best Refining Technology. From left to right: Mike Cherry, Joe Schwarzbach, Shane Presley, Jeannie Branzaru and Eli Ben-Shoshan.

CYBER, continued from page 1

and certification labs. ISASecure has been certifying since 2010.

Accredited certification labs include CSSC Certification Laboratory, EXIDA and TÜV Rheinland. These certification labs are accredited, which means they have undergone a rigorous process by the American National Standards Institute (ANSI) to be allowed to conduct certifications. At these labs, security capabilities are independently assessed and certified by experts. This reduces end-user efforts to validate and verify security capabilities; at present, talented cybersecurity expertise is scarce.

Three ISASecure certifications are available: Embedded Device Security Assistance (EDSA) product certification, System Security Assurance (SSA) product certification and Security Development Lifecycle Assurance (SDLA) system certification.

Four factors are driving certification. The first, Mesker noted, is that end-users are demanding it. "Part of my evangelical mission is to get more end-users to say: We need this; this is part of our process now, and if you want to play, you need to get certification," he said. "I feel that certification will have a slower takeoff if you cannot get end-users into it."

The second factor driving certification is that regulators are demanding compliance testing, with some countries proposing standards. The third factor is that vendors are certifying solutions for differentiation and to remain competitive, and the fourth is that major events are forcing change.

At Chevron, cybersecurity is integrated in the beginning of the procurement process. "We have added [certification requirements] to a lot of our engineering," Mesker said. He also noted that the US government will be more likely to adopt ISA certification if the electricity sector buys in. "The electricity sector is kind of the 800-pound gorilla in terms of cybersecurity," he noted.

ISA certification is "a chicken-and-egg situation and costs money," but progress will be dictated by the demand for certification, Mesker said. "We are getting attacked a lot, and we have systems in place to defend some of that. With ISA certification, we can be assured that we are doing something about it."

Resiliency with cyber insurance. In the next session, Stephen Viña, Senior Vice President and cyber advisor at insurance broker Marsh, discussed the reinforcement of industry resilience with the help of cyber insurance. Critical infrastructure is being targeted through highly organized and deliberate attacks that develop over months, as well as by mass-scale, self-spreading malware, Viña said. Cyber threats can also include unintentional attacks.

For company executives, the biggest concerns regarding cyber threats have transitioned from privacy breaches to business interruptions and reputational damage. Most companies place cyber risk at the top of their corporate agendas; however, a more holistic approach to cyber risk and cyber safety is needed, Viña asserted. "We need to look at what happens *after* an event and build cyber resilience—most companies have not put into place a real risk quantification system from a cyber perspective."

Steps to better manage cyber risk include buy-in top from management, working with IT to find solutions, translating risk into dollars through risk quantification, and taking a comprehensive approach to the lifecycle of a cyber event. For many organizations, this where cyber insurance comes in.

"Cyber insurance is starting to play a much bigger role in pre-incident [operations]," Viña noted. "Insurance companies are recognizing that if they provide services [to mitigate cyber risk for their clients], then it will cost them less money in the long run."

Cybersecurity, which focuses on risk mitigation, and cyber insurance, which deals with risk transfer, can be complementary and work together, Viña said. At present, cyber insurance is designed to protect first- and third-party loss and financial harm for a cyber incident that involves data only. It does not protect bodily injuries or physical events at plants, such as explosions, that result from a cyber attack; those types of damages usually fall under a company's property policy, at present.

A cyber policy can be triggered in several ways, including a security failure (e.g., virus, ransomware, malicious code); a privacy incident that involves actual disclosure of data or a violation of federal, state or local statutes; and business interruptions due to cyber extortion of data.

Viña noted that cyber insurance policies will continue to evolve. In the future, they may include bodily injury and property damage, if caused by equipment such as remote-operated drones or vehicles. They may also cover a quantifiable loss of reputation, the blockage or compromise of information transfer over the Internet of Things (IoT); supply chain risks; blockchain and cryptocurrency; and regulatory environments, among others.

Viña noted that many cyber attacks have come through vendors, so vendor risk management is a key element in underwriting cyber risk. The type of data stored, as well as company revenues, size, location and industry category, are other elements that cyber insurance brokers take into consideration. In 2017, growth of 10% year-over-year was seen in the purchase of cyber insurance by companies in the manufacturing and industrial sector, while 8% growth was seen in the electrical sector. ●

According to **STEPHEN VIÑA,** Senior Vice President and cyber advisor at insurance broker Marsh, the biggest concerns for company executives regarding cyber threats have transitioned from privacy breaches to business interruptions and reputational damage.

Q&A, continued from page 1

and stabilize the temperature in case of a higher heat of reaction."

Q: What factors do you consider when co-processing jet fuel in a distillate hydrotreater vs. processing the jet separately (including feedstock and unit considerations)?

Steinberg said several aspects must be considered when deciding if jet fuel and diesel should be co-processed or hydrotreated separately. "The most important consideration is whether the jet fuel will be blended into a diesel product or a separate product. The decision will depend on if you are looking at constructing new facilities or making the best use of existing equipment. If a refiner needs to build a new unit to increase distillate hydrotreating, then building a jet fuel unit and using existing units for diesel will normally be less expensive than building a new diesel hydrotreater," Steinberg said. "However, if the existing unit's pressure is too low to handle the diesel effectively, it may be preferable to build a new unit."

Q: In your experience, what operational factors contribute most to utility costs in hydrotreating units?

"Several operating factors can impact the energy efficiency of a hydroprocessing unit. One of the largest impacts on the hydrotreating unit's energy demand is the recycled gas rate," Beltz said. "Gas rate impacts energy demand, as well as the compressor itself and the fuel gas demands on the reactor preheater."

Beltz listed various advantages of additional recycle gas, including higher H_2 PP, better distribution, fewer hot spots, lower aging rates, longer catalyst life and less exchanger fouling. The disadvantages listed were additional comp HP and more heater firing.

Considering the advantages of product recycle, simpler operations, better distribution, lower exotherms and fewer hot spots were listed. Additional comp/pump HP and substantially more heater firing were cited as the disadvantages. ●

ANALYZING ISSUES WITH "CAMOUFLAGED" HMI

Bill Hollifield, Principal Alarm Management and HMI Consultant for PAS Global, opened Tuesday morning's OPCAT session with a presentation titled: Camouflage—Why some new "HMI Improvements" Are a Step Backwards. Hollifield spoke about issues with poorly designed human-machine interfaces (HMI) and the best practices for designing and assessing proper HMIs.

He stated that poorly performing HMIs are a trend throughout process industries and can be damaging to production and quality. According to Hollifield, camouflage is the enemy of HMI. He said that following guidance rules that advocate for extra white space and smaller graphics can have an adverse effect. Poor contrast, messy/cluttered graphics and elements that are too small make the interface hard to read. Hollifield provided several examples of HMIs that had small or difficult-to-read graphics to illustrate that visibility is key.

Optimize FCCU to maximize bottom-of-the-barrel conversion from resid feeds

CARL KEELEY, STEFANO RIVA and **ANKIT APOORV,** BASF; and **STEVE CHALLIS,** Chalcat Consulting

The fluid catalytic cracking unit (FCCU) is the main conversion process at many refineries, and the refinery discussed here has two FCCUs that are optimized to produce transportation fuels. The configuration for the two FCCUs is shown in **FIG. 1.**

FCCU 1 is operated to produce FCC gasoline, and the slurry from FCCU 1 is fed to FCCU 2. FCCU 2 is operated to maximize bottoms upgrading to produce enough distillate to fill the downstream hydrotreater. The refinery's objectives are to improve FCCU 2 bottoms upgrading to increase overall fuels production (diesel and gasoline) and to minimize fuel oil production. This configuration and objectives make catalyst selection for FCCU 2 more challenging. The refinery wanted to improve the performance of FCCU 2 and initiated a selection process for a new catalyst for the unit. Catalyst samples from all major suppliers were evaluated by refinery R&D, and a BASF bottoms upgrading catalyst was selected for a commercial FCC trial. The refinery saw an increase in overall fuels production with this catalyst and continued its use at FCCU 2.

Catalyst trial set up. The feed for FCCU 2 is a mixture of heavy components and is operated with a moderate conversion to produce a high distillate yield. The "base case" feedstock was heavy gasoil [95% pt around 580°C (1,076°F)] mixed with slurry recycle from FCCU 1 (**TABLE 1**).

The refinery's objectives are to improve FCCU 2 bottoms upgrading to increase overall fuels production (diesel and gasoline) and minimize fuel oil. The following constraints of FCCU 2 were preventing the refinery from achieving its objective:

1. Operating guidelines for minimum feed temperature and minimum regenerator temperature limited the ability to increase cat-to-oil ratio and improve yields.
2. Poor fresh catalyst loader reliability and performance prevented the refinery from increasing the fresh catalyst addition rate to increase activity and improve yields.
3. A frequently blocked equilibrium catalyst (Ecat) sample point prevented the operations team from collecting samples for analysis, making operation evaluation more difficult.

BASF provided continuous technical services to ensure that the new catalyst performed and delivered value. A detailed trial plan and trial protocols were developed based on discussions with the refinery. To overcome the constrained fresh catalyst addition, the bottoms upgrading catalyst was designed with a suitably high activity. BASF also analyzed samples and operating data, and benchmarked FCCU 2 operation, using this information to provide proactive recommendations to improve unit performance.

The catalyst changeover was monitored using limited Ecat data and daily unit operating data, and no unit upsets or problems occurred during the change. At 30% changeover, the catalyst circulation was stable and catalyst losses were in the normal range, so the refinery continued with the trial. At 60% changeover, the unit yield and performance showed improvement.

Bottoms upgrading catalyst performance. This catalyst was an ideal fit for FCCU 2 due to its optimized porosity to improve diffusion of heavy feed components, and a coke-selective matrix to improve bottoms upgrading. Furthermore, BASF optimized the zeolite-to-matrix ratio and rare earth on zeolite to deliver the desired yield pattern with minimum coke and gas penalty.

Upon switching to this BASF catalyst, the refinery achieved improved coke and gas selectivity and improved bottoms upgrading, which enabled the refinery to increase slurry recycle from FCCU 1 (i.e., worsening feed quality).

Because of improved coke selectivity, the FCCU 2 regenerator bed temperature decreased by approximately 5°C (9°F). The cat-to-oil, on average, increased for similar riser severity. Higher cat-to-oil favors improved bottoms upgrading and performance. The lower regenerator bed temperature reduced the riser mix-zone temperature and associated thermal cracking. This, coupled with reduced catalyst-induced overcracking, led to a significant reduction in FCCU 2 dry gas yield. The improved coke and gas selectivity unlocked the potential for the refinery to increase FCCU 2 riser outlet temperature (ROT) and cat-to-oil to improve bottoms upgrading and conversion. This allowed the refinery to increase FCCU 1 slurry recycle to FCCU 2, resulting in deteriorated FCCU 2 feed quality. Despite the worsening feed quality, the refinery maintained good FCCU 2 product yields with the coke and gas-selective BASF catalyst (**TABLE 2**).

Takeaway. By switching to a BASF bottoms upgrading catalyst, the refinery achieved improved coke and gas selectivity. This led to an optimized riser severity and improved bottoms upgrading, enabling the refinery to increase slurry recycle into the unit and improving its overall yields and margin. The overall margin improvement from adopting this new catalyst technology was +$0.37/bbl of FCC feed.

The authors wish to thank Tim Case, Kitty Cha and Charlotte Morrissey for their assistance in preparing this article. ●

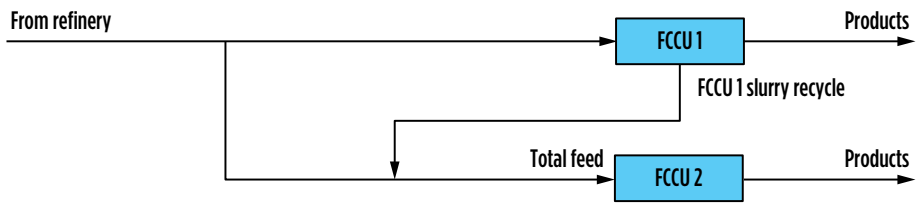

FIG. 1. Refinery FCCU configuration.

TABLE 1. Typical FCCU 2 feed properties, base case

Slurry recycle from FCCU 1	830 bpd
Combined feed density	19.2 API
Feed sulfur	1.5 wt%
Feed nitrogen	1,200 ppm

TABLE 2. FCCU 2 performance summary

KPI	Base catalyst	BASF (bottoms upgrading catalyst)
Feed rate	Base	Base, but with 13% more FCCU 1 slurry recycle
Dry gas, wt%	Base	–0.8, significantly less dry gas
Naphtha, wt%	Base	Similar or slightly more
Cycle oils, wt%	Base	Similar or slightly more
Slurry, wt%	Base	Similar or slightly less
Coke, wt%	Base	–0.3, improved coke selectivity
Margin[1], $/bbl FCC feed	Base	+0.37

[1] Assuming typical feed and product values

LEAPFROG, continued from page 10

schedule. All ancillary tasks (usually safety-related) required to perform planned activities are determined and managed by operational staff that are often separated from the macro-planning process.

The missing piece of the business process is engaging operations to make the schedule truly executable. By demonstrating how all ancillary tasks and interactions between work activities come together, all levels of the organization can manage the impact of operational activities in real time. The quality and detail of a 90-day plan is also closer to reality, enabling much better resource utilization and plan attainment.

Enterprise software platforms are fundamental to plugging the gaps between planning, maintenance and operations processes, and they help automate risk and activity management. Integrated operations management platforms provide decision support that significantly improves prioritization, scheduling and risk management. All levels of the organization can now participate in fixing more of the right things and more closely integrating the plan to achieve execution goals.

Everyone can have the context they need to support strategic operational efficiency and effectiveness goals. New platform technologies make it possible for operators to access a holistic view of their operational reality along with actionable insights that power excellent operations. Digitalization can drive horizontal and vertical integration and successfully automate major processes. When applied correctly, digitalization can make everyone's job safer, better and more efficient—a leapfrog from functional business improvements to excellent operations, enterprise-wide. ●

In 1989, **PHIL MURRAY** recognized the need to provide technology-based solutions to hazardous industries to reduce operational risk and move beyond compliance to optimize operational performance and drive continuous improvement. Founding Petrotechnics was the result. Today, he is responsible for managing and driving global teams to support Petrotechnics' customers. For 25 years, Mr. Murray has been instrumental in changing the way people work, giving them the tools to manage the relationship between operational performance and risk. Prior to founding Petrotechnics, he spent 10 years with BP in a variety of technical, operational and managerial roles. He has won numerous business awards and has authored articles in leading industry publications.

A breakthrough solid acid alkylation technology

A rapidly growing global population and rising income levels are driving record increases in demand for motor fuels amid a global refining scenario challenged by stricter environmental standards and stringent blend requirements for gasoline.

International policies, such as a push for greater adoption of Euro 6 emissions standards, place a high premium on low-RVP (Reid Vapor Pressure), clean-burning components for gasoline blending, such as alkylates, isomerates, ethanols and ethers. Among these, alkylates are the most ideal clean fuel components because they exhibit a higher octane rating, lower vapor pressure and sulfur levels, and contain no aromatics or olefins.

Industrial alkylation technologies have used hydrofluoric acid (HF) or sulfuric acid (H_2SO_4) as catalyst. Both liquid acid-based processes entail high capital and operating costs, challenges with acid handling, corrosion-induced accidents and potential health, safety and environmental (HSE) issues. As an alternative, solid acids have promised safer and cleaner alkylation in recent years. The poor stability of most solid acids, however, has resulted in expensive processes requiring complex reactors and large catalyst inventories, making them uncompetitive vis-à-vis liquid acid technologies.

High-performance, engineered catalyst. Based on years of research and development, ExSact™ is a new-generation, precious-metal-free, solid-acid catalyst offering the capability of outperforming liquid acids for alkylation. The ExSact catalyst forms the core of KBR's safe and efficient K-SAAT™ (KBR Solid Acid Alkylation Technology) process, which generates high-octane alkylate by combining light (C_2–C_5) olefins with isobutane (FIG. 1) without involving the challenges and costs associated with liquid acid technology. This engineered solid-acid catalyst has been designed to provide more than 24-hr alkylation cycle times, offer robust resistance to typical poisons and process a variety of feedstocks in a simple, adiabatic fixed-bed reactor design. The solid-acid catalyst is regenerated using hydrogen (H_2). In recognition of its outstanding qualities, K-SAAT was recently nominated under the Best Catalyst Technology category for the 2018 *Hydrocarbon Processing Awards*.

Revamp opportunities. K-SAAT is a highly adaptable technology that provides an opportunity to maximize the yield of motor fuels by enhancing production of an ultra-clean blendstock: alkylate (TABLE 1). The minimal capital requirements of this process offer opportunities to either replace, revamp or increase the capacity of existing liquid acid alkylation reactors while reusing their recovery system (DIB/debutanizer). The cost to revamp a liquid acid alkylation unit to replace or to increase capacity with K-SAAT is approximately 60% of the cost of a new K-SAAT plant with similar capacity, which is significantly below the cost of a new HF or sulfuric acid alkylation plant.

Advanced process benefits. The K-SAAT technology offers refiners the opportunity to make alkylation more efficient and profitable as it provides:

- **Feed flexibility:** It allows the flexibility to process different feeds, such as fluid catalytic cracking (FCC) offgas, LPG olefins (FCC and coker) and MTBE raffinate (ranging from C_2–C_5).
- **Superior product quality:** Alkylate produced is high-quality and has a higher research octane number (RON) compared to other liquid and solid acid catalyst alkylation technologies, under a wide range of process conditions (TABLE 2).
- **High product yield:** K-SAAT reduces the production of heavy hydrocarbon byproduct (no acid soluble oils) and has a higher yield of alkylate product per unit of olefin consumption.
- **Lower capital and operating costs:** Since brick-lined process vessels, acid containment and neutralization equipment, product treatment and refrigeration loops are not used, K-SAAT boasts much lower capital and operating expenditures relative to liquid acid-based technologies.
- **Low power consumption:** K-SAAT operates above ambient temperature, eliminating the requirement of power-intensive refrigeration.
- **Safety:** The ExSact catalyst is intrinsically safe and environmentally benign.

Commercialization. KBR's K-SAAT is a highly advanced technology with a high rate of return. Since its introduction, the technology has attracted wide interest from the refining industry as a low-cost and reliable process for alkylate production. KBR has licensed K-SAAT units to Haike Ruilin Petrochemical Co. Ltd. and Luoyang Aiyou Chemical Co. Ltd., both in China.

Takeaway. In the face of ever-stricter environmental mandates, every refiner is faced with the critical issue of selecting the most suitable mix of blends for producing high-quality, cleaner-burning gasoline product. With its high octane number and low vapor pressure, alkylate is the preferred blendstock. KBR's K-SAAT technology is a superior solid acid-based alkylation technology for production of high-quality alkylate. The use of finely engineered ExSact catalyst makes the process reliable and safe, while greatly reducing the capital and operating costs associated with traditional liquid and solid acid processes. ●

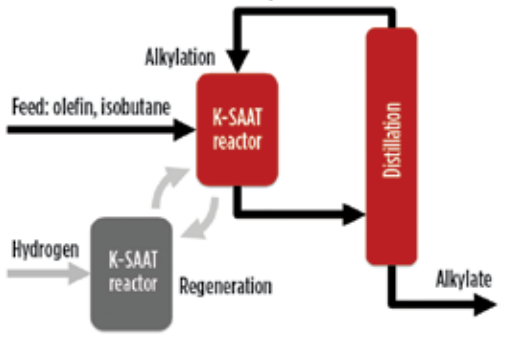

FIG. 1. K-SAAT conceptual scheme.

TABLE 2. Alkylate quality from K-SAAT process

	K-SAAT
RON	99+
RVP	0.35 bar / 5.08 psia
Reactors	2
Regeneration Cycle	24-hr regeneration cycle
Catalyst	No noble metal

TABLE 1. K-SAAT performance with various olefins

Feed	Ethylene	Propylene, 70% propylene	MTBE raffinate	FCC olefins, 30% isobutylene	Pure isobutylene	Amylene
RON	99	92	99	97	95	91
MON	95	90	95	93	92	89

*Octane number is for pure ethylene stream; actual will be contingent on the amount soluble in the olefin feed stream

PHILADELPHIA-AREA CRUDE RAIL TERMINAL REAWAKENED BY DISCOUNTED CRUDE

A rail terminal in Eddystone, Pennsylvania has begun taking deliveries of Bakken crude after going dormant for nearly three years, as refiners snatch up discounted North American crude barrels, according to Reuters.

The 90,000-bpd rail terminal has been getting routine deliveries of Bakken crude for the past month, the first significant deliveries since the site went dark in January 2016. Monroe Energy, a subsidiary of Delta Air Lines Inc., is using the terminal to help supply its 185,000-bpd refinery in Trainer, Pennsylvania.

The return of crude deliveries at Eddystone highlights the growing pains confronting US producers that are facing bottlenecks as booming production outpaces pipeline growth. It also shows how US refiners are trying to seize on the bottlenecks, doing whatever they can to access the distressed crude.

The Eddystone rail terminal was one of several facilities built on the US East Coast in the early part of this decade to take advantage of discounted crude out of North Dakota. However, business at this terminal and others slumped as the discount vanished and cheap imports came into favor.

North Dakota oil production hit a record 1.3 MMbpd in July, outpacing pipeline capacity, forcing producers to discount crude and making it attractive for coastal buyers.

The Dakota Access Pipeline, the key artery out of North Dakota, was nearly 100% full in August, according to energy industry intelligence service Genscape. Flows on the line, which runs from North Dakota to Illinois, are averaging just more than 500,000 bpd, and further expansion is expected.

US crude's discount to global benchmark Brent rose to more than $10/bbl this month, the widest in three months and near the biggest discount in more than three years.

That spread is key for East Coast refiners, since the Bakken grade is priced off US crude, while import grades are typically priced off Brent. Other factors, such as full pipelines, have also contributed to the pickup in crude by rail, traders said.

Rail volumes from North Dakota to the East Coast hit nearly 75,000 bpd in June, according to the latest federal data, up from near zero volumes in August and September of last year. At the height of the boom, more than 450,000 bpd ran from the Bakken to the East Coast.

Delta Air Lines used the Eddystone terminal to supply the refinery from 2013 until the contract collapsed in 2016. It is unclear whether the new deliveries are part of a new supply contract or represent spot purchases, Reuters reported. ●

A "smart" water solution for oil and gas operations

The water industry has been refining data analytics for several years to improve water treatment operations and guide business decisions in every market sector. The oil and gas industry is no exception. Water is necessary for oil and gas production and refining, and the cost of water management is a significant percentage of the overall cost of operations in both the upstream and downstream sectors.

To capture the power of the digital revolution, Veolia Water Technologies has launched a digital platform to improve water management and reduce risks associated with poor water quality. Minimizing operational costs for water management by using analytics to achieve process optimization lowers overall operating costs. Secondary benefits are the peace of mind that water management and treatment systems will run smoothly with AQUAVISTA™, while lightening the workload of operations personnel (FIG. 1).

AQUAVISTA was recently recognized as Best Digitalization Technology of the Year by *Hydrocarbon Processing* magazine as part of its annual awards program for the latest technological advances in the hydrocarbon processing industry. This comprehensive digital solutions package combines 160 years of water treatment expertise, process knowledge, experience from traditional and digital services, and information from a wide range of domestic and global references. This secure, cloud-based platform consists of four complementary components to meet the needs and objectives of facilities seeking to optimize operations and gain a competitive advantage:

1. **AQUAVISTA™ Portal** is an advanced monitoring and reporting tool that provides a complete overview of all the data. This offer provides a dashboard customized to meet the needs of any type of water treatment operation. The Portal enables remote monitoring in real time on any device, anywhere, with internet access. This capability is particularly useful for large facilities, multiple sites and remote locations.
2. **AQUAVISTA™ Insight** is a powerful data-driven performance optimization tool that applies algorithms and benchmarking metrics to the water treatment process to enable continuous process improvement. The results are typically cost savings through reduced energy and chemical consumption. Predictive maintenance can minimize downtime of water treatment systems and production processes. By combining process, operating and financial data, as well as plant external data into key performance indicators (KPI) dashboards, informed business decisions can be made.
3. **AQUAVISTA™ Plant** offers online, real-time, smart, automated optimization with full autopilot function. This suite of intelligent software and holistic solutions offers state-of-the-art online control, monitoring and forecasting to meet operational targets. Benefits include reduced overall capital and operational costs, increased hydraulic capacity, improved performance, easier operation, better system stability and a high level of safety.
4. **AQUAVISTA™ Assist** provides support from a network of experienced specialists. Veolia's experts provide feedback and troubleshooting in a timely manner thanks to real-time access to your operational conditions. AQUAVISTA Assist brings Veolia's experts closer to you to meet your operational needs.

FIG. 1. Veolia's secure, cloud-based platform meets the needs and objectives of facilities seeking to optimize operations.

Moving forward. Cloud-based data agglomeration, management and machine learning based on algorithms developed from real-life operations will change the way water is managed in the future, benefiting plant operations staff and managers alike. Cloud-based operations platforms like AQUAVISTA will become the core of smart, modern systems that will foster more flexibility, increased safety and more efficient operations.

Cost savings result from minimization of chemical consumption, power usage and labor requirements needed to monitor and effectively manage water treatment systems running at optimal performance. Customization will be the key to meeting the needs of various facilities from small operations to large, complex systems with the right-sized digital solution that provides a competitive edge.

As the Industrial Internet of Things (IIoT) grows and develops, and as machine-learning increasingly becomes part of our business environment, solutions such as AQUAVISTA are expected to be the foundation upon which the future of industry will be built. ●

Targeting low-throughput slurry oil production

General Atomics Electromagnetic Systems (GA-EMS) is delivering single-module and dual-module Gulftronic® electrostatic separator systems to support refineries and carbon black plants with low-throughput slurry oil production requirements. The single-module and dual-module Gulftronic electrostatic separator systems allow plants to purchase lower-cost feedstocks from refineries and to further clarify slurry oil onsite to meet specific requirements for various carbon black products. As worldwide demand for products such as carbon black continues to grow, plants can effectively utilize Gulftronic systems to reduce costs and significantly enhance quality and production controls.

Refineries around the world have been using multi-module Gulftronic systems to process higher-value, higher-quality slurry oil products for more than 38 years. The single-module and dual-module Gulftronic systems allow carbon black manufacturers and other low-throughput facilities to realize the same benefits that larger refineries have been experiencing for years, including reduced operation and maintenance costs, maximized yields and improved profit potential.

Utilizing di-electrophoresis, Gulftronic separators capture and remove solids and catalyst fines from the process stream to provide higher-value oil products with a clarity below 100 ppm, and often well below 50 ppm. Each Gulftronic module contains a high-voltage electrode surrounded by unique, patented glass beads. During the separation cycle, an electrostatic charge polarizes the glass beads in the module, capturing catalyst fines from the process stream down to the submicron level.

Removing catalyst fines. Feed enters at the top of the module, and clarified product exits at the bottom and is sent to inventory tanks. Once saturated, the Gulftronic modules backflush using raw fluid catalytic cracking (FCC) feed or customer-specified medium. During the backflush cycle, power to the module is shut off and flow is reversed. This results in a bead-scrubbing action that completely removes catalyst fines. The backflush product exits from the module. The automatic removal of the catalyst fines allows the unit to operate with a constant pressure drop, with no loss of FCC/RFCC production. The module can then return to the cycle of separation, backflush and purge, automatically continuing the process without interruption.

Gulftronic separators are impervious to fouling or blockage, resulting in greater throughput, less downstream contamination and significantly reduced maintenance requirements. Traditional mechanical filtration systems allow fine particles to escape capture, causing downstream blockages, buildup in filters, contamination and increased maintenance and downtime costs.

Gulftronic electrostatic separators are built to ASME standards and are proven reliable for continuous operation. There is no loss of FCC/RFCC product and less unplanned downtime. Gulftronic separators are delivered as compact, skid-mounted, preassembled units that require no onsite construction to reduce installation costs (FIG. 1). Designed for challenging applications and harsh environments, Gulftronic separators' robust technology is uniquely suited to meet present and future operational needs.

GA-EMS also offers thorough laboratory-scale testing and analysis of customer-provided slurry oil and other process fluid samples. By providing comprehensive sample test data, GA-EMS can help customers determine the level of catalyst and other particles content prior to system design. In addition, ongoing analysis of customer feedstock oil and clarified oil outputs is provided, as well as support for new application and experimental testing. ●

FIG. 1. General Atomics Electromagnetic Systems (GA-EMS) is delivering single-module and dual-module Gulftronic electrostatic separator systems to support refineries and carbon black plants with low-throughput slurry oil production requirements.

SCENES FROM THE 2018 AFPM SUMMIT

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1 Exhibitors and attendees alike know that the contacts made in and around the exhibition area are a valuable part of the AFPM Summit.

2 Tuesday morning's Q&A panel for Crude/Vacuum Distillation & Coking featured (left to right) **ROBERT BOETTGER** from HollyFrontier, **BILL CATES** from Hunt Refining, **MICHAEL KIMBRELL** from Becht Engineering and **BRANDON PAYNE** from SUEZ Water Technologies & Solutions.

3 **CARTER NESS** of Coastal Chemical Co. and **PAUL SZYMBORSKI** of Saint-Gobain NorPro reconnected in the exhibition hall to discuss industry trends.

4 The team from **ATHLON** kept busy talking about its products and services.

5 One of the most well-attended sessions was Tuesday's Hydroprocessing Principles & Practices: Sink or Swim? Renewable Fuels via Co-Processing or Block Mode? Moderators included **WENDY WILDENBERG** and **DIANA SHARPE** from Flint Hills, **PAUL TEMME** from Albemarle and **ANDREW MORELAND** (speaking here) from Valero.

6 Shine 'em up! The lively **JOHNSON MATTHEY** suite also featured a veteran magician and information about the company's latest products.

7, 8 **HALDOR TOPSOE'S** casino-themed hospitality suite provided its guests with all the fun of gambling and none of the risk.

9 Testing their driving skills was just one of the attractions enjoyed by guests of **CRITERION CATALYSTS & TECHNOLOGIES** and **SHELL.**

10 The **AXENS** hospitality suite on Monday evening entertained visitors with a hi-tech, virtual reality game.

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2019 AFPM MEETINGS

Annual Meeting
March 17 – 19
Marriott Rivercenter
San Antonio, TX

International Petrochemical Conference
March 24 – 26
Grand Hyatt
San Antonio, TX

International Base Oils & Waxes Conference
March 24 – 26
Grand Hyatt
San Antonio, TX

National Occupational & Process Safety Conference
April 24 – 25
The Gaylord Texan
Grapevine, TX

Security Conference
April 30 – May 1
Sheraton Austin at the Capital
Austin, TX

Labor Relations/ Human Resources Conference
May 2 – 3
Sheraton Austin at the Capital
Austin, TX

Reliability & Maintenance Conference and Exhibition
May 21 – 24
The Gaylord Texan
Grapevine, TX

Board of Directors Meeting
September 8 – 10
The Broadmoor
Colorado Springs, CO

Operations & Process Technology Summit
October 14 – 16
Marriott Rivercenter
San Antonio, TX

Environmental Conference
October 27 – 29
Grand America Hotel
Salt Lake City, UT

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