OPCAT: Using refinery-wide simulation models for optimization

ASHLEY SMITH, Hydrocarbon Processing

Organizations use simulation tools for unit optimization and as an overall refinery model. The question that Prachi Chapman from KBC Advanced Technologies Inc. wanted to answer at one of Tuesday morning’s OPCAT sessions was simple: What are the capabilities of using a complex refinery-wide model, and then optimizing the model?

Ms. Chapman pointed out that recent advances in simulation technology have made it possible to investigate refinery-wide optimization.

“The refinery-wide simulation models have historically been used for setting economic points or process changes, such as re-routings, conversion changes, cut-point changes, introducing new units, or other process improvement studies,” Ms. Chapman said.

Exploring the idea of using models for refinery-wide optimization is an alternative to how linear programming (LP) is developed today. Schematic models are used to develop LP vectors, most commonly with rigorous kinetic reactor models. This information is then used in the development of the LP.

“While a lot of time and resources go into making sure an LP is valid and reasonable within a limited range,” Ms. Chapman said, “ultimately, LP is optimizing simplified representations of detailed kinetic reactor models.”

These same companies also have a set of simulation tools, and uses for these models include localizing unit optimization and utilizing refinery-wide simulation models for CAPEX and “what if?” studies.

“Can we put an optimizer around an entire rigorous refinery-wide simulation model to potentially assist in crude selection, or set the operational targets for an entire refinery?” Ms. Chapman asked the audience.

To test the theory and conduct a proof of concept test, Ms. Chapman explained that a hypothetical, 150-Mbpd conversion refinery was developed. It was then provided with five crudes of varying levels of density, sulfur, and varying volume fractions.

Two case studies were presented: the first study varied the crude composition, while the second case study varied operating conditions.

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Separating fact from fiction in ICS cyber attacks

ASHLEY SMITH, Hydrocarbon Processing

Industrial control system (ICS) cyber attacks seem to be more prevalent, and an increasing number of news stories are being published about them, increasing both awareness and concern. However, Robert Lee, CEO and founder of Dragos Inc., separated what is fact and what is hype during the Cyber security session Tuesday morning.

“ICS and cyber security are a little bit hyped-up at times,” Mr. Lee said. “We are either never going to go down, and everything’s perfect, and we can go back to manual operations for everything we do, and we do not need the Internet, or we are all going to die.”

Before delving into a specific cyber attack, CRASHOVERRIDE, Mr. Lee began setting the stage by explaining what the real concern is and how these attacks occur and offering takeaways that companies can use when implementing their own defenses.

While the industry is and will continue to be bombarded by numerous technologies, the basics are the best place to begin, he explained.

“It is always the basics that present the most challenges,” Mr. Lee said, “and the basics that we are able to master and utilize will make our industrial environments awesome.”

Before tackling the issue of cyber security, one of the most significant challenges to overcome, particularly with national security, is bias. “Everything about our livelihoods, backgrounds and experiences shape our biases, and we see the world differently because of that,” he said. “I find it interesting to hear people say, ‘Well, China is going to do this, or Iran will do this.’ I am a white guy from Alabama who served in the national security community and now has a startup. All of those things have shaped my bias.”

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In the context of these case studies, the process models included rigorous, first-principle based calculations for conversion units and detailed tray-to-tray calculations for distillation columns. Because of the rigorous models, they were able to capture nonlinear responses, such as the impact of feed and operational severity on catalyst deactivation, the impact of distillation overlap on product specifications, and pummparound duty or condenser duty constraints.

“Modeling is always a trade-off between how much rigor, robustness and speed we want to put into the model, particularly when you start looking at optimization,” she said.

For the test, they created a balance between more rigorous tray-to-tray columns, semi-rigorous distillation and component splitters. The two blenders used in this test were local, non-linear optimizations themselves, where the refinery was trying to maximize profit by picking the select blend component. Optimal cases in increasing levels of complexity were run. In the first case study, they varied the crude composition but kept the rate and all unit operating conditions fixed. The second case study had the crude composition fixed, and opened up several operating conditions, as well as the crude rate.

Ms. Chapman explained how they determined the validity of the results by running the exact same optimization more than 30 times from different starting points. This showed, depending on where a refinery’s operations started, the same optimum consistency was achieved.

CYBER ATTACKS, continued from page 1

As Mr. Lee explained, bias shapes the way we perceive the industry, and it can create an atmosphere—or an outlook of where the industry will go—that drives companies to security investments that may not always match what the industry needs or dictates.

“Ultimately, our threat landscape is mostly unknown,” Mr. Lee said, “and until we catch not just the threat, but the capability of the threat, copying and pasting best practices of IT and ICS simply will not cut it.”

The environment created by hype is what leads to bias and over-spend- ing on security investments. Hype is created and perpetuated by the shortage of personnel within ICS security who really understand their industri- al operations.

Hype is also created when metrics and numbers are misconstrued. Mr. Lee explained, especially when ana- lytics are left out altogether. “One of the things ICS-CERT always high- lights is specifying and tracking how much manufacturing was hit, and how much oil and gas was hit.”

Misconceptions. Mr. Lee explained the two most relevant misconceptions people have about those metrics. The first is, “What counts as an attack?” For example, when someone contacts ICS-CERT to report that they have received a phishing email, a trouble tick- et is opened. If that same person comes back and says, “Never mind, it was a mist- take,” it is still counted as an attack.

“This is not an accurate incident counter,” Mr. Lee said. “It is a trouble ticket counter.”

The second misconception in the industry is not about the number of people who have been attacked, but rather the number of people that are reporting it. The one metric that never gets highlighted, he adds, are the at- tack factors.

In 2015, there were a total of 295 in- cidents, and the majority (the same ev- ery year, according to Mr. Lee) are un- known. “If we even detect the threats, the media might say that it is because IT caught it going into the ICS. If we caught it only in the ICS, we have no idea how it got there,” Mr. Lee said.

To break down how security is viewed, Mr. Lee has developed a slid-

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For the purposes of the case studies, the constraints were kept simple, simi- lar to LP constraints, but more detailed constraints are possible with a refinary- wide simulation model. The constraints used for testing are representative of column flooding limit, feed or product pump limits, heater limits, etc.

The tests were run on multiple standard desktops, each with similar results. A nonlinear algorithm was also used. Runtime for the first case study was around half an hour, while the second case study had a runtime of 4.8 hours.

Several takeaways were revealed from the case studies. The practical ap- plication is in planning. After the crude slate is set by the LP, the refinery-wide simulation model can then optimize the operations of the process units.

“This takes advantage of the detailed nonlinear reactor models and the more differentiating hydrocarbon stream characteristic detail,” Ms. Chapman said. Another practical application is that, rather than LP directionality, a refinery can potentially make a more precise operational plan, depending on how confi- dent the user is with the results.

Refinery-wide optimization is showing promise, but its development might still be too slow to completely replace LP for crude selection. Refinery-wide optimization is more rigorous, and it can augment LP as well as double-check crude selection results.

At KBC Advanced Technologies Inc., Ms. Chapman specializes in kinetic reactor model development for FCC, delayed coker and furnace units. •

Actual knowledge in power. Information sharing is also important to becoming more proactive with cyber security, and not just against an adversary, but also against the techniques and meth- odologies used.

“Real information sharing says, ‘Here is the adversary and attribu- tion does not matter; here is their tradecraft and what is novel about it; here is how they are challenged when responding to it; here is where we failed as an organization, or did really well; and here are the lessons we have learned.’” Mr. Lee said.

The major takeaways from the CRASHOVERRIDE cyber attack, he explained, include the fact that it was a framework rather than a single piece of malware that installs and exports, and there were no vulnerabi- lities. What it was doing is effectively using operational knowledge against the equipment.

“That matters for other industries because companies are probably pri- oritizing patching and firewall tun- ning,” Mr. Lee said. “The problem is, of course, that if they are using the equipment against you, you may not actually see that. You must be very proactive, and that human element needs to be added into the environ- ment to maintain vigilance.”

In addition to being the CEO and founder of the industrial cyber secu- rity company Dragos, Mr. Lee is also a non-resident National Cyber Secu- rity Fellow at New America, which focuses on policy issues relating to cyber security of critical infrastruc- ture. He has authored several courses on ICS, with accompanying certifica- tion. Previously, Mr. Lee served in the US Air Force as a cyber warfare op- erations officer and worked in various government organizations, including establishing the first ICS/SCADA cy- ber threat intelligence and intrusion analysis mission. •

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## OPCAT, continued from page 1

2017 Operations and Process Technology Summit | American Fuel & Petrochemical Manufacturers

Wednesday, October 4, 2017
The International Maritime Organization (IMO) recently confirmed that global refiners and shippers must comply with new regulations to reduce the sulfur content in marine bunker fuels by January 2020—five years earlier than widely expected. As a result, both the global refining and shipping industries will experience rapid change and significant cost and operational impacts, according to new analysis from IHS Markit, a leading global source of critical information and insight.

“While the IMO is taking positive action to address the environmental impacts of air pollution from ships, the rapid change creates significant disruption for both the refining and shipping industries,” said Kurt Barrow, Vice President of downstream research at IHS Markit. Mr. Barrow, along with Sandeep Sayal, Senior Director of refining and marketing research at IHS Markit, are two authors of an IHS Markit report, “Refining and shipping industries will scramble to meet low-sulfur requirements.”

The report asserts that both the shipping and refining industries are “vastly unprepared,” and that neither have made the necessary investments to achieve compliance. “The 2020 implementation date will result in a scramble,” said Mr. Sayal. “Both industries are taking a wait-and-see approach until firm signals are in place by the IMO for compliance with the regulation.”

Both industries will face significant costs. Shippers will have to upgrade equipment or switch to more expensive fuels, and refiners will experience significant price impacts as they shift production to deliver more low-sulfur fuels to the market and, at the same time, find a market for the higher-sulfur fuels they produce. Mr. Barrow said, “Refiners, like ships, do not turn on a dime, so it takes significant investment and market demand to retool a refinery to deliver new supply.”

Compliance options. According to IHS Markit, shippers will have numerous options to meet the new IMO regulations, including low-sulfur bunker fuels—primarily for smaller vessels—and liquefied natural gas (LNG) for newbuilds. However, it is expected that onboard ship scrubbers, which clear harmful pollutants from exhaust gas, will be the primary compliance path for ships, which could continue to burn higher-sulfur fuels.

IHS Markit estimates that approximately 20,000 ships account for around 80% of heavy fuel oil bunker fuel use (Fig. 1). As there is presently no economic incentive for the ships to add scrubbers, only about 360 ships have installed scrubbers. However, based on the price spreads between low-sulfur bunker fuel and high-sulfur fuel oil during the scramble period, it will be economic for many of them to install scrubbers. According to Kripseen Atkinson, Senior Consultant, IHS Markit Maritime & Trade research, “The payback period for installing a scrubber on the largest vessels would be two to four years in 2022–2025, and less than one year based on peak price spreads in 2020.”

A key uncertainty also lies in the actual level of compliance to the IMO regulation in 2020. “Not only is it hard to enforce compliance in the open seas, but it is still uncertain if sufficient supplies of compliant bunker fuels will be broadly available in all ports,” Mr. Sayal said.

Disrupting the refined products market. Overall, the installations of scrubbers and some level of noncompliance will not be in time to halt the disruption on refined products markets, IHS Markit said. The primary challenge with the bunker fuel quality change (which requires sulfur content to be reduced from 3.5 wt% to 0.5 wt%) is the disposal of high-sulfur residual fuel, and not the production of low-sulfur bunker fuel (Fig. 2).

“When we account for the supply and demand factors for the sour residual balance, including new conversion projects, capacity creep, scrubber and LNG capacity, as well as quality compliance, our bottom line is that a sizable portion of today’s fuel oil will be pushed into lower-price tiers, notably oil-fired power-generation plants,” Mr. Barrow said. “Refining capacity will most likely exist in 2020 to produce the low-sulfur bunker fuel, but higher overall crude runs will be required.”

The largest refinery margin disruption will be significant but fleeting, according to the IHS Markit report, with impacts felt most notably in 2020 and 2021. IHS Markit expects an unprecedented light-heavy price spread among distillates, when pricing for high-sulfur fuel oil (HSFO) will have to be near thermal parity with coal to clear into the power market—a very low price relative even to today’s fuel oil prices. Refiners respond to the large-scrubber investment incentive, high-sulfur bunker fuel demand will rebound, although not to prior 2020 levels. Due to increasing demand and the addition of desulfurization capacity for residue conversion, IHS Markit estimates that price spreads will moderate within a few years, depending on a number of variables.

Refiners to benefit. Refiners will produce more distillates (higher-value components derived from crude) as new demand arises for these products during the disrupted years, IHS Markit said. With HSFO priced at coal-thermal parity and demand for middle distillates (kerosene, jet fuel, diesel) increasing to blend to low-sulfur bunker fuel, refining margins will benefit, but in different ways.

“Refiners of sour crude will be negatively impacted by the nearly valueless sour crude residue, while refiners of sweet crude conversion will experience modestly higher margins, but sweet crude prices will reflect the low-sulfur residue value,” Mr. Barrow said. “It is the high-conversion refiners of sour crude that are expected to have extraordinary margins.”

According to the report, highly complex refineries benefit the most from the IMO specification change, as these refineries will produce the least amount of residual fuel oil and the highest amount of distillate and gasoline compared to low-complexity refiners. Crude price relationships, specifically between light-sweet and heavy-sour crude, will widen around the same time frame, IHS Markit said. Assuming the specification change implements as announced on a global and instantaneous basis with no phase-in timing or quality transition allowances, the margin uplift will be acute in the compliance period from 2020–2021.

INNOVATING ALARM MANAGEMENT

PAS Global, LLC, a leading solution provider of ICS cybersecurity, process safety and asset reliability in the energy, power and process industries, has released PlantState Suite™ (PSS) 8.3 featuring Alarm Mechanic. This new feature helps improve process plant safety and console operator performance, minimizing nuisance alarms through automated analytics and recommendations.

PlantState Suite makes power and process plant operators more effective at identifying, evaluating and managing alarms. The company says that PSS is the industry’s most comprehensive, integrated abnormal situation management software platform designed to optimize independent protection layers (IPLs), such as process control loops, alarms, safety systems and pressure relief systems. With PSS, companies gain:

• Improved operator situation awareness and effectiveness
• Greater speed and accuracy in detection and response to abnormal situations
• Reduced severity of process upsets
• Safer, more profitable plant operations.

With the addition of Alarm Mechanic, PSS 8.3 fully automates complex alarm delay time settings. Delay time is a critical method for solving nuisance alarm problems. Leveraging decades of PAS project experience and the knowledge of its team for over 2020–2021, Alarm Mechanic replaces manual calculations and guesswork with automated, deterministic recommendations that ensure consistent and optimal settings. PSS 8.3 also enhances support for corporate operational excellence programs and risk-tracking dashboards. The software enhances integration and enables custom alarm analytics.

PAS technologies are deployed throughout 13 of the top 15 chemical companies and 10 of the top 15 refining companies in the world.
OPCAT: Advanced predictive analytics for column flooding events

In Monday morning’s OPCAT session, Dr. Jose Bird, Director of Advanced Analytics for Valero, and Jill Brown Burns, Director of Process Technology for Valero, presented their paper, “Use of Advanced Predictive Analytics for Early Detection and Warning of Column Flooding Events.”

In this paper, they implemented a methodology to predict crude distillation tower flooding events based on key process variables, including product yields, column pumparound flowrates, column temperatures and overhead reflux flowrate. A logistic regression model was selected as the predictive tool due to its ability to differentiate flooding events from non-event data, as well as the ease of implementation.

As column flooding events occurred very infrequently with an incidence rate of about 0.25% for the distillation tower considered, an over-sampling technique was used to improve the model sensitivity to flooding events. Several models were constructed using different time lags of the predictor variables and compared using receiver operating characteristic (ROC) curves, which provide the relationship between the model event detection rate and the model false alarm rate. The final model selected was validated against a stationary monitoring study and radioisotope scans of the column. The model was then implemented in the data historian system to provide early warning to engineering and operations of potential flooding events for corrective action.

In Monday morning’s OPCAT session, Valero’s Dr. Jose Bird (pictured) and Jill Brown Burns presented their technical paper.
Digital transformation: Field operations meet terminal management

The digital transformation of business continues to progress, and the downstream segment is no exception as demand increases for solutions that can replace the remaining paper-based processes.

The Implico Group has developed a software solution for hand-helds that makes mineral oil loading faster, simpler and safer, enabling tank terminal operators to take the next step toward embracing the Internet of Things (IoT). The new, mobile solution connects employees in the field directly to the OpenTAS terminal management system to ensure that important information is immediately available everywhere. It also supports staff in the visual inspection of tank trucks and railcars.

With its new software solution for hand-helds, the Implico Group is now enabling digitalization in an area that was previously almost inaccessible: product loading in relation to railcars, ships and pipelines.

**Easy recording of incoming railcar and tank truck data.** Operations staff at refineries or tank terminals can digitally record incoming railcar and tank truck data using handheld devices and the new software, eliminating the need for manual notes into the terminal management system. The solution is faster, more cost-efficient and avoids typical errors associated with manual data entry.

The application uses a predefined checklist to guide employees step by step through the handling process, increasing process safety by preventing staff from forgetting steps.

**System-based visual inspection.** The checklist also supports the visual inspection of vehicles and loading, as prescribed by hazardous materials for the transportation of dangerous goods. A history function in the application permits the entry of details such as earlier damage to a vehicle, enabling personnel to carry out tank inspections of such areas.

In many countries, vehicle compartments are sealed with special steel seals once loading is complete. Instead of painstakingly writing down complex seal ID numbers, employees need only a few seconds to scan in the numbers with the handheld application. This data is then stored immediately in the terminal management system.

**Transparency and quick access.** The new handheld application closes the previously existing digital gap between operations (Fig. 1) and the terminal management system. Refinery or tank terminal personnel can access the OpenTAS terminal management system during their work in the field, which results in substantial efficiency gains. For example, if the vehicle data is already stored in OpenTAS, then it is shown to the employees as the default entry, so they do not need to enter the data again. Conversely, all data input by the operator is relayed back in real time, which means that the latest process information is visible immediately to the other team members.

**Close cooperation.** Development work performed by Implico involved close collaboration with hardware makers Honeywell and ECOM, as well as with several petroleum companies. Future implementations will also require close collaboration with the companies that will adopt the solution.

The solution is compatible with any make of device, including those intended for use in explosion hazard areas. Back-end functionality is provided by the OpenTAS Web Application Server. The handheld clients are connected in real time and access the solutions via a browser. This enables true real-time transparency for logistics processes.

**IFS: 84% of industrial companies face gap between IoT and ERP**

IFS, the global enterprise applications company, has released a primary research study on how the Internet of Things (IoT) affects readiness for digital transformation in industrial companies. According to a survey of 200 decision-makers at industrial companies in North America, only 16% of respondents consume IoT data in enterprise resource planning (ERP) software. That means 84% of industrial companies face a disconnect between data from connected devices and strategic decision-making and operations, limiting the digital transformation potential of the IoT.

The study posed questions about degrees of IoT sophistication, and explores how well companies’ ERP, enterprise asset management (EAM) or field service management (FSM) software prepares them for digital transformation and to consume IoT data within enterprise software.

Respondents were divided into groups, including IoT “leaders” and IoT “laggards,” depending on how well their enterprise software prepared them to consume IoT data—as well as digital transformation “leaders” and digital transformation “laggards,” depending on how well their enterprise software prepared them for digital transformation.

The two leaders groups overlapped, with 88% of digital transformation leaders also qualifying as IoT leaders, suggesting that the IoT is a technology that underpins the loose concept of digital transformation.

Digital transformation leaders made more complete use of IoT data than digital transformation laggards; leaders are almost three times as likely to use IoT data for corporate business innovation or to monitor performance against service level agreements.

Digital transformation leaders were more likely than digital transformation laggards to be able to access IoT data in applications used beyond the plant floor. They were more than four times as likely to have access to IoT data in EAM software, twice as likely as digital transformation laggards to be able to access IoT data in services applications used beyond the plant floor.

The study indicates a real need for more IoT-enabled enterprise applications designed to put data from networks of connected devices into the context of the business.

In reviewing the findings, IFS Chief Technology Officer for North America, Rick Vagneau, commented, “Are your planning and maintenance systems robust enough to make real-time decisions using IoT-sourced data? Many are facing the reality of having to answer ‘no.’ We’ve seen examples of companies coming to us because their incumbent software is not able to administer and use IoT data to achieve the gains they want to realize.”

Steve Andrew, IFS Vice President of Marketing for North America added, “Long before the term IoT was coined, IFS was committed to introducing machine data into enterprise applications. With the release of the IFS IoT Business Connector, we are in a better position than ever to help our customers operationalize their IoT data. This study data shows that this technology is required to connect the IoT with strategic data from around their organization. The life sciences market is well aware of the importance of IoT not just for cost avoidance strategies like condition-based maintenance, but to add new or enhanced product or service lines, increase enterprise agility and realize the growth and revenue benefits of digital transformation.”

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**OLIN LIFTS FORCE MAJEURE FOR PRODUCT SHIPMENTS FROM FREEPORT, TEXAS**

Olin Corp. is lifting the force majeure declared on August 31 for all product shipments—except phenol, acetone, methyl chloride, methylene chloride and chloroform—from its Freeport, Texas facility.

Olin was forced to reduce production at the facility due to supply and logistic constraints from truck, railroad and marine transportation caused by severe flooding resulting from Hurricane Harvey. Olin’s 3Q 2017 adjusted EBITDA will be reduced by approximately $40 MM, representing incremental costs to continue operations, unabsorbed fixed manufacturing costs and reduced profit from lost sales.

Isolated transportation, raw material and customers’ issues will continue to be experienced in both the Chlor Alkali Products and Vinyls and Epoxy segments into 4Q 2017. The impact on 4Q 2017 adjusted EBITDA is expected to be significantly less than the 3Q 2017 impact.
DSG system pilot test addresses operational, equipment issues

Critical to ethylene production in chemical plants, dilution steam helps reduce the partial pressure of hydrogen (H₂) and shifts the equilibrium of the chemical reaction toward an increased cracked gas yield. Dilution steam generators (DSG) are large columns filled with trays or packings and act as saturators. Smooth operation of the DSG is one of the most important process objectives in chemical plants, as it can have a huge impact on the cracker furnace yield. Challenges to this operation arise from the quality of feed water that is recycled from the quench towers after pretreatment, which consists of conventional filtration and coalescers, but is typically ineffective in removing the highly emulsified hydrocarbons and coke fines from feed water.

Test and validation. The first step began with an inline pilot test at the facility that involved a pre-filter and coalescer. The test results doubled the run length and online life by 100%, despite operational issues concerning level control in the coalescer vessel. It was also discovered that the technology held a constant HP steam flowrate through manual control. The results of this pilot test are represented in FIG. 1. Prior to conducting the pilot test, the plant had never seen any dP buildup on the pre-filters or any hydrocarbons in the top drain of the coalescer. Both the top and bottom drains of the coalescer vessel were completely blocked and had to be dismantled to enable free flow of recovered hydrocarbons. Pentair’s work at the customer’s facility included helping with the resolution of these operational issues and optimizing the drainage of hydrocarbons from the top of the coalescer vessel.

The success of this pilot test validated that Pentair separators and filter elements are protecting critical equipment and dramatically save operational costs and resources. Due to the success of this pilot test, the customer chose Pentair to upgrade the entire existing DSG system with highly efficient separation equipment. These technologies are used to help facilitate balanced systems that are highly stable, reliable and robust, increasing throughput, reducing operating cost and minimizing waste. The company’s technologies help solve the most critical separation and extraction issues for the gas, refining, chemical and power generation industries.
Operational excellence: The path to world-class performance

PHIL MURRAY, Petrotechnics

Why is operational excellence (OE) increasingly being recognized as the path to world-class performance? A recent, industry-wide survey across health, safety and environment (HSE), maintenance and operations professionals has provided a real insight into the industry’s thinking on the opportunities and challenges associated with OE.

The overwhelming majority of those surveyed recognized that OE success means that everyone in their organization is able to make better-informed decisions that reduce risk, improve productivity and reduce costs. OE starts with a more integrated approach to operations management. Productivity, risk and cost are intrinsically linked, and the key to OE is to enable everyone, from the boardroom to the frontline, to better understand how their decisions impact their part of the business. The challenge is that company personnel are struggling to get a view of operational reality through what can be a blizzard of complexity.

Senior executives are learning the same painful lessons as NASA—that the myriad of key performance indicators (KPIs) provide little insight into the reality of their operations. The NASA Space Shuttle program was collecting 600 metrics per month (right before the loss of the Columbia space shuttle), none of which turned out to be helpful in predicting the loss or identifying the clear migration of the program to states of increasing risk. The author found a similar story in Texas City, when he worked on the team brought in to oversee operational stability immediately after the refinery explosion incident.

If OE is about better decisions, then a simpler approach is required that connects disparate processes and people in a way that allows everyone to visualize and manage risk and operations in a new way.

The survey recognized the role of digital technology in OE, with over 92% agreeing that it is a key enabler. What is required is a shared view of operational reality where everyone knows what is happening, where it is happening and when it is happening. A recent whitepaper detailed that companies that implement best-practice OE programs see an average increase in production by 29%, are able to reduce costs by up to 43%, and improve asset uptime/availability by 29%. Additional benefits that can be gained by leveraging OE are shown in TABLE 1. The author’s company’s survey and the industry whitepaper present a strong argument that OE has never been more necessary; and with technology, it has never been more achievable. As the whitepaper points out, “With new technological advancements, we have the potential to improve business functions across the industry … technology has caught up with the industry’s needs.”

The value of technology is seen when it connects people and processes with data-derived insight. This idea is not just about spending billions more on integrating maintenance management systems and planning systems, while wrench-time and plan attainment remain stubbornly resistant to improvement. The right technology does not replace skilled, knowledgeable or experienced people. Instead, it enables everyone in an organization to manage activity in a practical, joined and routine way. It empowers people to consistently make the best possible operational decisions.

Top-performing companies arm everyone, from the CEO to the person working in the plant, with the right information to understand the wider impact of their actions. This is the foundation for delivering on the true potential of OE. Only a connective enterprise can achieve OE. If the industry wishes to achieve world-class performance that current conditions demand, organizations must be more connected. By replacing silos with an enterprise platform and by connecting data horizontally, every person can be given the information required to make better, safer, smarter operating decisions.

OE in practice. This approach to OE offers context for key operational decisions at various levels, in support of strategic objectives for oil and gas operators around the world. As an example, in preparation for running a large onshore operation in the Middle East, one hydrocarbon operator is using an OE platform as a risk advisory and activity management tool. The platform is integrated with the operator’s maintenance management system (MMS) and equipment status historian. For short-term schedule optimization, the platform displays high-risk areas in future shifts (14 d ahead) based on deviations captured from the historian and planned activities based on the maintenance schedule. This schedule is optimized based on resource utilization.

Within the OE platform, the execution of maintenance and other activities associated with the maintenance schedule, are managed, such as removing equipment from service, depressurizing, draining and purging, and installing energy isolations. Also included are ancillary activities, such as scaffolding erection and crane utilization. Once built, the full schedule of work can be checked, and where necessary, optimized based on expected risk levels. The revised schedule is then synchronized with the MMS.

The OE platform helps manage operations activities, permitted and non-permitted work, while providing real-time visualization, and those activities associated with the maintenance schedule, are managed, such as removing equipment from service, depressurizing, draining and purging, and installing energy isolations. Also included are ancillary activities, such as scaffolding erection and crane utilization. Once built, the full schedule of work can be checked, and where necessary, optimized based on expected risk levels. The revised schedule is then synchronized with the MMS.

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While the benefits of digitalization in the oil and gas industry are profound, they are also causing cyber risks to increase. Almost 68% of oil and gas companies were affected by at least one significant cyber incident in 2016, and many attacks are assumed to have remained undetected or unpublished. Based on a joint industry project, DNV GL is now launching a globally applicable recommended practice (RP), DNVGL-RP-G108, addressing how oil and gas operators, system integrators and vendors can manage emerging cyber threats.

Critical network segments in production sites (FIG. 1), which used to be kept isolated, are now connected to networks, making operational technology (OT) more vulnerable. According to recent research, 59% of oil and gas companies surveyed believe that the risk is greater in the OT segment than in the IT environment. Managing threats toward OT requires knowledge beyond general information security, such as oil and gas operational domain competence, in particular related to automated, unmanned, integrated and remote operations that are accessible online.

The new DNV GL recommended practice, “Cyber security in the oil and gas industry based on IEC 62443,” is the result of a nearly two-year joint industry project (JIP) with partners Shell Norge AS, Statoil, Woodside, Lundin Norway, Siemens, Honeywell, ABB, Emerson and Kongsberg Maritime. The Norwegian Petroleum Safety Authority has observed the work and exchanged experiences with the JIP group from a regulatory perspective. The RP is based on the IEC 62443 standard, international practice and professional experience, and takes into account HSE requirements and the IEC 61511 functional safety standard. It outlines a tailored approach for the oil and gas industry on how to build security, with the emphasis on OT.

The scope of the RP encompasses guidance on how to use the IEC 62443 series of standards for projects and operational phases, including good practices and a reusable approach, and is tailored for oil and gas onshore and offshore operations. The IEC standards define what to do, while the RP describes how to do it. Implementation will result in:

• A reduced risk of cyber security incidents
• Cost savings for operators by reducing the resources needed to define requirements and follow up
• Cost savings for contractors and vendors based on standardized design requirements from operators
• Simplified audits for authorities and auditors due to common requirements and common conformance claims.

A joint statement from the vendors involved in the RP states, “Our customers in the oil and gas industry are, to a large extent, facing the same types of cyber threats found in information technology systems. Being able to standardize what we deliver to our customers is important in reducing cyber risks and lowering costs. The RP will increase the safety, availability and reliability of operational technology systems. The organizations operating the systems can also manage cyber risks by following and implementing the identification, protection, detection, response and recovery steps defined in the standards to withstand cyber attacks. In the process of defining this RP, we have collaborated with both our competitors and our customers on guidance to the IEC 62443 series of standards.”

Pål Børre Kristoffersen, JIP Project Manager for DNV GL–Oil & Gas, says, “Industry players need confidence that security countermeasures can deal with more frequent and sophisticated cyber attacks, which are becoming increasingly costly and harder for companies to recover from. While the awareness of cyber security requirements that must be in place is growing, there has, until now, been a lack of guidance for the oil and gas industry on how to implement these requirements. The new RP, developed in collaboration with key players, puts OT and IT in the limelight, so that the oil and gas industry can protect their operations.”

DNV GL is a technical advisor to the oil and gas industry, bringing a broader view to complex business and technology risks, and setting standards for technology development and implementation. •

FIG. 1. Managing cyber threats toward OT requires knowledge beyond general information security.
A new dimension in pipeline safety

HARTMUT LEISTNER, HIMA

Leak detection and localization systems monitor critical parameters in pipeline operations and allow leaks to be detected and located as quickly as possible. Operators have traditionally used conventional monitoring systems without safety orientation for this purpose. The world’s first hybrid solution from HIMA, composed of an SIL3 safety controller and a leak detection and localization system, significantly boosts pipeline safety and profitability within refineries and petrochemical facilities.

Pipelines must fulfill strict requirements for safety, availability and environmental protection, and leaks pose considerable risks (FIG. 1) to personnel, the environment and the potential loss of reputation. In many cases, the losses from cleanup tasks and fines are much greater than the actual loss of resources.

Pipeline operators should utilize a leak detection system for their facilities. In many countries, the implementation of best business practices for plant operation is prescribed. If an incident occurs, the operator is always jointly responsible and, depending on the legal scenario, management can even be held liable if they operate a pipeline without a modern leak detection system. Insurance companies can amend their policies according to the leak detection technology, reduce premiums or refuse coverage if a suitable system is lacking.

Growing statutory requirements. Pipeline operators are also confronted by growing statutory requirements of the safety integrity level (SIL) and cyber security. A variety of international standards for pipeline integrity management must be taken into account: the two main standards are the US standards API 1160, which provides general guidance on overall pipeline integrity management, and API 1130, which focuses specifically on leak monitoring.

New compliance topics arise with regard to leak detection systems are excessive false alarms, failure to detect leaks, the lack of leak localization and costly or complicated maintenance.

A horizontal pipeline has a steady flow with a constant volumetric flow rate and a linear pressure drop along its length (FIG. 2). A leak changes the hydraulic behavior of the pipeline: the flowrate is greater before the leak than after the leak, resulting in a pressure drop ahead of the leak location that is steeper than after the leak. The pressure also declines slightly at both ends of the pipeline. A leak detection system attempts to recognize these features and determine whether an unplanned outflow is present and where it is located.

In practice, conventional leak detection systems using only pressure sensors often generate false alarms, as a detected pressure drop in the pipeline does not always mean that a leak is present—it can also result from operational factors. These systems are generally prone to measurement errors and are dependent on sensor positioning.

A new hybrid solution for reliable leak detection. The new FlexSilon PMC pipeline management solution, the first to combine leak management with emergency shutdown, not only protects the facilities concerned but also controls and manages safety-relevant processes (FIG. 3). The key components of the integrated hybrid solution are the SIL3 safety system and the leak detection and localization system.

Flowrate monitoring runs directly in the SIL3-capable HIMax safety hardware, with pressure and temperature data transmitted to the control center for visualization via the SafeEthernet protocol developed by HIMA. The HIMax systems are also connected to each other over SafeEthernet, so each system knows the state of the overall pipeline. If a leak occurs, the HIMax controller automatically adjusts the flow and, in an emergency, shuts down the pipeline immediately, enabling the system to prevent or significantly reduce damage. The safety controller is based on HIMA’s XMR technology, which combines SIL3 safety hardware and software with a scalable, fault-tolerant architecture to avoid nuisance trips.

An important part of FlexSilon PMC is the FLOWorX software for leak detection and localization, which enables operators to constantly monitor flowrates, pressures and temperatures in their pipelines. Anomalies are reliably recognized. The system also supports pressure and temperature correction calculations. In addition, the FLOWorX software can detect pipeline rupture and ensure that the damaged pipeline section is automatically shut down in the event of rupture.

Operators can flexibly adapt the detection algorithms to their specific needs. Unlimited changes and even prescribed verification tests during ongoing system operation according to the SIL3 standard are possible. Thanks to open interfaces, the system can be integrated into virtually every automation environment. Along with the automation components necessary for management, control and monitoring of gas and liquid pipelines, the package includes customer support and service.

Precise leak localization. The SIL3-capable leak localization system conforms to the relevant standards, including API 1130. To ensure continuous system availability, leaks are analyzed and localized by several methods: the enhanced pressure wave method, the volume/weight balance method and the pressure drop method are used either individually or in combination, depending on the nature of the damage and the operating state of the pipeline.
These methodologies ensure reliable detection of even the smallest leaks and minimize false alarms. For example, the enhanced pressure wave method increases the detection sensitivity of the system, allowing the detection of leaks with a pressure change as low as 0.35% (Fig. 4) and eliminating more than 80% of false alarms.

Safety systems also address security. Pipelines are increasingly being targeted by hackers, and very few safety systems are prepared for this. By contrast, FlexSILon PMC hybrid solution meets all relevant requirements for cyber security. The safety controller offers several protection options for secure communication. For example, CPU and communication tasks are structurally partitioned. Using HIMA’s own hardware and software with the proprietary operating system makes access considerably more difficult for hackers. In addition, there is no need for the time-consuming patches commonly required with standard software.

The FlexSILon PMC hybrid solution allows pipeline operators to implement both safety and critical control applications in compliance with all essential standards, while significantly increasing the safety and profitability of pipelines by quickly and accurately detecting and localizing leaks. This also reduces false alarms and downtime. Operators benefit from higher availability over the entire pipeline lifecycle, as well as a lower liability exposure and risk of consequential costs; and avoid environmental damage and loss of reputation. The combination of functional safety and information security increases the overall safety and security of the facility.

Athlon Solutions has a proven history of working with refiners to identify, deliver and document process improvements and cost avoidance. Athlon Solutions is redefining water treatment — turning what has traditionally been viewed as an expense into an investment. Let us help you uncover additional ROI, visit www.athlonsolutions.com/valuedelivery

HIMA’s hybrid leak detection and localization system monitors critical parameters in pipeline operations and allows leaks to be detected and located as quickly as possible.

MODERNIZING INDUSTRIAL CONTROL ROOMS

Honeywell Process Solutions (HPS) has introduced its Experion® Local Control Network (LCN) solution. This new offering enables the incremental upgrade of the company’s legacy TotalPlant™ Solution (TPS) control system to allow for a secure, seamless integration with Experion® PKS. With Experion LCN, industrial facilities can gradually move their legacy control system forward while leveraging existing automation assets.

Today, users of TPS are dealing with compliance issues related to new safety regulations, as well as with increasing system support challenges. As every industrial organization is under pressure to reduce costs while improving performance, plants running outdated control systems must avoid obsolescence by employing the latest automation technology. The Experion LCN solution provides users with standards-based functionality, regulatory support capabilities, and integrated operations from the field through the plant to the business level.

Honeywell’s on-process incremental upgrade to Experion LCN modernizes the control system infrastructure and enables deployment of the Industrial Internet of Things (IIoT). Existing control strategies, field terminations, applications, history and graphics can be retained, allowing users to focus on high-value improvements.

Using Honeywell’s proven Experion Fault Tolerant Ethernet (FTE) infrastructure, the new Experion LCN bridge connects Experion to Classic Coax LCN. Once this connection is established, the LCN coax connection can be removed one LCN node at a time. Instead of a hardware connection for every Experion TPS node, only one redundant Experion LCN bridge pair is needed to enable virtualization.

Honeywell’s TPS modernization solution minimizes operating disruptions and maintains overall consistency, delivering significant lifecycle advantages. After modernization, the control system can have a common human-machine interface (HMI) and unified physical control network, enabling control devices to easily integrate/expand with the latest generation of Experion PKS controllers and safety systems. The advanced control solutions and new functions within Experion PKS controllers can additionally improve the effectiveness of plant operations.
The benefits of going wireless

MOAZZAM SHAMSII, Emerson Process Management

Installing new instruments in an existing process plant can provide innovation and improve the performance of steam traps, heat exchangers, pumps and other equipment. However, it can be difficult to justify these projects with conventional wired instrumentation due to high cost, lengthy installation time and required downtime. Traditional wired control networks using 4-20 mA, HART, Foundation Fieldbus, Profinet PA or other solutions require power and signal wiring. The conduit, cable tray and other infrastructure needed for this wiring are a major cost component.

This wiring infrastructure is not needed for battery-powered WirelessHART installations, as it is replaced by a wireless mesh network consisting of a gateway base station and repeaters. Including wireless can help justify a project as the incremental solutions and applications that can be added to the wireless network can demonstrate benefit beyond the original project scope.

The WirelessHART communications protocol is officially designated by the IEC 62591 standard. Ensure that the existing or proposed new process control system is able to support native integration of WirelessHART on its network. If not, the WirelessHART gateway will have to connect to the process control system via some other method, typically a protocol converter.

Project design. A WirelessHART project typically involves two or three parties: the end user, the systems integrator designing the system and installing the equipment, and the equipment vendor supplying the wireless instruments and communications infrastructure. The systems integrator and wireless equipment vendor may be the same company (FIG. 1).

The end user typically produces a functional requirement specification that describes applications, wireless instrumentation and the necessary infrastructure for the wireless network. The end user must determine what points are to be measured, and then work with the wireless instrument vendor to ensure that appropriate devices are selected for both process and diagnostic measurement functions. Because each WirelessHART instrument does not require wires for signals or communication, and often neither for power (FIG. 2), the financial calculations determining whether a measurement should be made are very different than with wired instruments. The significantly reduced cost for a wireless measurement should be taken into account when deciding whether or not a particular parameter should be monitored.

In addition to flow, pressure, level and temperature measurements in conventional applications—such as on tanks, vessels, reactors, pipes and similar process equipment—WirelessHART makes it possible to consider applications previously too expensive to implement with wired instruments. These include measurement in remote places, or those previously considered uneconomical for monitoring, such as:

- Pressure relief valves with an environmental impact can employ a wireless acoustic device to monitor venting
- Steam traps can be prioritized, with high-value traps monitored with a wireless acoustic device
- Heat exchangers can be instrumented with wireless pressure and temperature devices
- All pumps and motors requiring routine assessment can be equipped with wireless diagnostic sensors

Infrastructure and equipment. After the functional requirement specification is completed, equipment must be selected. Wireless field instrumentation can be used for all non-critical process measurements, and for control loops that are not fast acting. WirelessHART devices can also be used in hazardous locations. The devices that are certified to the relevant protection level for the hazardous area reduce or eliminate the amount of supporting wired infrastructure installed in the hazardous area.

All non-SIL independent protection functions can be implemented with wireless. These will form part of any layers of protection analysis (LOPA) assessment. Consider the need for redundant gateway devices for applications requiring high availability, such as process control loops.

Many wired process measurements requiring redundancy may be better served by providing this functionality with wireless instruments, as this provides a second and completely independent source of measurement. This determination should be made during the HAZOP study.

Ensure that security best practices are used in the design of the wireless network and gateways. If a separate Wi-Fi infrastructure is not part of the project specification, then the installation contractor may benefit from temporary Wi-Fi access points to aid field commissioning using mobile worker client applications, such as Emerson’s AMS Device Manager.

API: US PETROLEUM DEMAND HIGHEST FOR AUGUST SINCE 2007

Total petroleum deliveries in August increased by 1.3% from August 2016 to average 20.5 MMbpd, according to an America Petroleum Institute (API) report. Compared with July, total domestic petroleum deliveries (a measure of US petroleum demand) decreased 0.6%. For year-to-date, total domestic petroleum deliveries rose 1.3% compared to the same period last year.

Gasoline deliveries in August were down from the prior month, the prior year, and the prior year-to-date. Total motor gasoline deliveries, a measure of consumer gasoline demand, decreased 1.5% from August 2016, to average 9.5 MMbpd, but remained the fourth highest deliveries to date. For year-to-date, total motor gasoline deliveries decreased 0.3% compared with year-to-date 2016 to the second highest year-to-date level at 9.3 MMbpd. Distillate deliveries in August were up from the prior month, the prior year, and the prior year-to-date to reach the highest August deliveries in 10 years and the highest deliveries since March. Distillate deliveries averaged 4.1 MMbpd, up 6.5% compared with August 2016, and were up 0.7% compared with July. For year-to-date, distillate deliveries increased 3.2% compared to year-to-date 2016.

US crude oil production remained above 9.0 MMbpd for the seventh consecutive month. Domestic crude oil production in August decreased from the prior month, but was up from the prior year and the prior year-to-date to reach the second highest August output since 1972. •

FIG. 1. A WirelessHART project typically involves the end user, the wireless equipment vendor and perhaps a systems integrator.

FIG. 2. A battery-powered WirelessHART instrument requires no signal or power wiring, and no wiring support infrastructure.
Fired heater performance improvements

RYAN MCSHERRY, Yokogawa Corporation of America

Fired heaters are installed in a huge range of industries: any manufactur- ing process needing heat is likely to have one. Refineries account for thousands of fired heaters, and they tend to be particularly large, so performance improvements in this context deliver the biggest return on investment. Three areas tend to dominate discussions of how to improve a fired heater design and operation:

• Safety and operational practices
• Efficiency and minimizing emissions

Safety and operational practices. Users must ensure that their installations are in compliance with the latest National Fire Protection Association (NFPA) standards—including NFPA 85, 86 and 87—and others that may apply, such as FM 7605, API-556, OSHA 1910.110, PHA and ISA-TR84.00.05. Additional industry-specific or local requirements may be applicable, so consultation with an expert is important to ensure safety and compliance, particularly as less experienced workers are moving into many plants.

Efficiency and emissions. Efficiency and emissions must be treated together because one is dependent on the other. While secondary influences on efficiency exist, such as a coating of soot on the tubes, combustion management has the greatest direct determination on both efficiency and emissions. The most efficient and cleanest combustion occurs when the amount of air and fuel are in ideal stoichiometric proportions. For a natural gas-fired unit, ideally one molecule of methane (CH₄) and two oxygen (O₂) molecules react to form one carbon dioxide (CO₂) and two water (H₂O) molecules. Unfortunately, this is not always the case, and without adequate control, the mixture can become too fuel-rich or fuel-lean. In some cases, unburned fuel can simply be blown out the stack. However, the effect is usually subtler, with insufficient O₂ causing incomplete combustion. As a result, carbon monoxide (CO) and hydrogen (H₂) go to atmosphere, or worse, mix with trapped air outside the combustion chamber and burn where it is not desirable. In either case, fuel is wasted and emissions increase.

Most users run fired heaters with a fuel-lean mixture, allowing an overabundance of air. This generally ensures more complete combustion, but also has undesirable effects. Not only does excess air cause a loss of efficiency, it also promotes the formation of nitrogen oxide (NOₓ) compounds and, in severe situations, may cause a flameout. Low-NOₓ burners stage the combustion to spread out the mixture of fuel and air, but that still leaves too much CO and H₂. A flue damper combined with air registers may allow for a degree of regulation, but without instrumentation determining the actual mix, adjustments are largely guesswork.

Ideally, a fired heater would have instrumentation capable of working with the combustion control system to monitor the flue gas so that the controller could optimize airflow to match the fuel rate. Unfortunately, most fired heaters suffer from a lack of instrumentation, and the combustion control system is too rudimentary to perform such a calculation. To make matters worse, it is doubtful that any mechanism can control airflow with any degree of precision.

Many installations will have some sort of oxygen sensor. This is typically a zirconium oxide probe mounted in the stack, which must be heated to 500°C to operate. The probe provides a spot reading, which can at least warn of a serious imbalance, but this technology can be fooled in a fuel-rich environment because high levels of H₂ and CO can mask the true oxygen concentration.

Better instrumentation improves operation. The most effective place to gauge combustion performance is in the radiant section, but the temperature is too high for most technologies. However, it is possible to get a very accurate picture with a tunable diode laser spectroscopy (TDLS) instrument (FIG. 1), which sends a beam across the radiant section of the unit. The TDLS can be configured to measure O₂, CO, CH₄ or other specific gases. In most cases, two units are used in combination and provide a complete picture of the combustion. The O₂ sensor detects fuel-lean conditions, while the CH₄ and CO sensor detects fuel-rich conditions. Moreover, when the instruments are mounted in a cross-stack arrangement, both sensors read across the full width, so uneven gas distribution can be averaged out of the calculation.

TDLS technology is non-contacting and has no moving parts, so it is very durable and reliable. Many installations dating back 15 years continue to perform without incidents. Measurements are also unaffected by other gasses in the stream, so odd process conditions will not mask the critical measurement.

Taking control of the process. As mentioned earlier, a fired heater is governed by two systems: the burner management system (BMS) and the combustion control system. The TDLS system provides critical information to both systems.
Oil and gas companies have endured several challenging years since the collapse of crude oil prices, and they have made the necessary aggressive cost adjustments to their businesses to remain profitable and competitive. However, with low oil prices predicted to (potentially) remain that way in the foreseeable future, the continuous drive for further efficiencies and the need to utilize every drop of product has become the new reality. It is accepted that refineries must continue to pursue more cost-effective and environmentally sustainable ways to produce high-quality fuels, as well as feedstocks for essential plastics production.

One such fuel—polygasoline—can be produced through the use of catalysts to convert surplus fluid catalytic cracking (FCC) olefins into high-research octane number (RON) gasoline. With approximately 45 refineries around the globe applying this long-established technology in such a low-cost environment, it is vital to now utilize the latest catalysts to deliver those critically important efficiencies.

Additionally, the processing of propylene and butylenes derived from the same FCC process can be commercially leveraged to produce a broad range of products. These products can be used either as building blocks in the production of intermediate materials, or as end products, such as base materials for many consumer-oriented products (e.g., PVC and synthetic leather in cars or laundry detergents).

Profitable, sustainable and compliant. Catalysts are among the most powerful tools to create value for refinery owners by leveraging compounds produced in their processes. Catalysts leverage short-chain olefins derived from FCC—such as propylene and butenes—in polygasoline units, where they are converted into gasoline.

A new generation of phosphoric acid catalysts are now leading to not only increasingly profitable polygasoline production, but also more sustainable fuel upgrading in FCC refineries.

Sustainability and environmental compliance are another pressure on producers. Innovative, high-performance phosphoric acid catalysts, such as Clariant’s PolyMax® 850, can increase gasoline—as well as none and tetramer—yields at lower operating temperatures, reducing energy costs. The new catalysts have a high level of activity and selectivity, increasing the rate of reaction and optimizing both productivity and product quality compared to other existing catalysts. PolyMax® 850 has also been designed to minimize environmental impact across its lifecycle. From the outset, the catalyst is produced from diatomaceous earth and phosphoric acid in a process that does not even generate wastewater.

To minimize environmental impact across its lifecycle, Clariant’s PolyMax® 850 is produced from diatomaceous earth and phosphoric acid in a process that does not even generate wastewater. It can increase gasoline—as well as none and tetramer—yields at lower operating temperatures, reducing energy costs.

While oil and gas companies make the necessary aggressive cost adjustments to their businesses to remain profitable and competitive, refineries must continue to pursue cost-effective and environmentally sustainable ways to produce high-quality fuels and feedstocks for essential plastics production.

To learn more and to meet members of the Clariant team, visit booth #46 in the exhibition hall.

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A tale of two refineries

DAVID WILLIAMS and TOM BREWER, VEGA Americas

Alberta, Canada and northern Texas are not known for their similarities. Separated by thousands of miles, the two geographies experience different climates, have dis-similar population sizes and support varying cultures. However, one thing they do have in common is a robust refining industry, and two refineries share a common desire for maximum process efficiency.

One refinery processes heavy crude and the other light, and still operators had identical lists of challenges in their desalter vessels. Each plant reported sampling errors, costly process upsets due to grid shortages, water and salts in the downstream process, and underutilized process equipment. However, the worst of times quickly became the best of times as the refineries overcame their difficulties with the same technology: the Multi-point Density Array (MDA) system from VEGA.

Multi-point density array: How it works. The MDA system provides continuous density data at individual measurement points on a vessel, and each measurement is specific to a horizontal plane of elevation. With a source and a detector at individual elevation, operators can see exactly what is happening in real time and can make advanced control decisions, as necessary. For example, as the output from each detector changes, the operator can determine the height of the water level and the movement of the rag layer, allowing the operator to adjust on the fly to prevent the liquid from shorting the desalter’s electric grid. The system is low-maintenance because all detectors mount externally and have no direct contact with the process, eliminating the possibility of corrosion or detector damage due to temperature. Additionally, external mounting frees refineries from purchasing a cooling system and/or using exotic materials. Calibrating the MDA is relatively simple, requiring the collection of only two data points. The first point is collected while the vessel is empty, and the second point can be collected when the vessel is filled with a fluid of a known density, which can be either water or some type of hydrocarbon.

The detectors are easily accessible for maintenance; with multiple independent measurement points, one offline detector does not shut down operation of the entire system. This arrangement ensures high reliability and that detectors do not influence each other’s accuracy.

The low-activity Cesium sources used in the system allow VEGA to create process paths up to 26 in., minimizing the influence of buildup on the measurement. A distributed control system (DCS) algorithm implements level and density control without requiring a separate computer that represents a single point of failure. The system provides water level control with no extra equipment or risk. Taken together, these features create a reliable system that delivers real results for refineries around the world, including our two plants in Texas and Alberta.

Desalter efficiency improves entire refining process. The overarching impact of the MDA on desalters inside the two refineries is optimizing all process equipment, beginning with the desalters themselves, where greater water level control has several benefits. The MDA measurements allowed users to keep the emulsion below the electric grids, eliminating the risk of expensive and process-crippling grid shortages. Additionally, enhanced water control reduced corrosive salts out of the desalters, which aids in preserving the life of downstream equipment. Greater water level control also reduced under-carry, which can harm the environment and lead to hefty regulatory fines. Both refineries report a near elimination of crude unit upsets and rate reductions since installing the MDA system.

Receiving a consistent interface measurement from the MDA also uncovered sampling errors that neither refinery knew about. Each facility used this discovery as an opportunity to retrain operators in the art of sampling. A panel operator in the Canadian refinery stated that the VEGA MDA system made sampling easier, and he felt it was more accurate than operating a desalter based on sample spins and grid amps because VEGA’s solution makes it easier to distinguish water, oil and rag layers inside the desalter. The operator expressed that he would not want to be without the MDA system. After retraining, operators take samples once per month rather than once per shift, representing a paradigm shift in terms of time, effort and money saved.

Refinery operators in Texas also experienced significant process improvements as a result of installing the MDA system on its desalters. Most notably, they increased throughput by 17% without making any changes to the desalter. Without new configurations and/or recalibrations, the information collected from the MDA allowed the refinery to run consistently. Operators in the Texas refinery estimate that the VEGA MDA system paid for itself in approximately one year due to the elimination of product upsets and reduced maintenance costs.

VEGA’s Multi-point Density Array delivers independent measurements to create a density profile that allows refinery operators to exercise real control over the process level inside desalters. This unparalleled control is helping preserve the life of equipment in refineries in Canada and Texas, as well as improving both refineries’ production.
The refining industry has been considering incorporating dewaxing in ultra-low sulfur diesel (ULSD) and hydrocracking units to increase the flexibility of hydrosprocessing units and process more barrels by increasing the endpoint of the feed when diesel margins are favorable. Processing higher endpoint feed makes it more difficult to meet product specifications for cold flow properties and the T90. Dewaxing is one solution, but because today’s dewaxing catalysts also have a significant cracking functionality, some of the extra diesel barrels will be lost to naphtha and light ends, making dewaxing less attractive in many cases.

The key is to use a dewaxing cat-
alphatic and, consequently,
avy isomerization and activity toward cracking of the diesel molecules. These catalysts are called TK-910 D-wax™, TK-920 D-wax™, TK-930 D-wax™, and TK-940 D-wax™, and their application areas are shown in TABLE 1.

Cold flow properties. These catalysts will enable true molecule management while minimizing the economic penalty of losing valuable diesel yield. In other words, refiners can increase the endpoint of the diesel feed, even during the winter months, to produce extra diesel barrels and still meet the cold flow property specs, easily justifying the cost of the dewaxing catalyst. The ULSD cold flow properties are defined as cold filter plugging (CFPP) and cloud point (CP), or pour point (PP). These properties are negatively affected by the presence of waxy molecules, such as normal paraffins, in the diesel feed. The high melting point of the paraffins in the higher boiling range of the ULSD feed is what determines the cold flow properties.

Without the use of a dewaxing cat-
alysts to provide one-eighth of the yield loss per degree of temperature reduction and, consequently, a loss of barrels.

2. Kerosine blending: Diluting the wax molecules
3. Use of additives: An increased operating cost to the refinery. These options are often not commercially attractive. The case study here will show that the use of Haldor Topsoe’s new TK-930 D-wax catalyst in ULSD service provided the refinery with a substantial increase in profitability during both the winter and summer periods, easily justifying the cost of the dewaxing catalyst. Topsoe’s new dewaxing catalysts are based on a proprietary zeolite structure promoted with nickel and tungsten, or noble metals, to provide an unmatched selectivity toward isomerization and an exceptional yield structure of the product.

Another key feature of the new TK-930 D-wax and TK-940 D-wax catalysts is that they exhibit good desulfurization (HDS) and denitriﬁcation (HDN) activity in their sulfided state, which means that they work well in a sour environment. Therefore, the volume occupied by these catalysts will help meet product sulfur specs and saturate aromatics for additional volume swell. Since the catalysts work in a sour environment, they may be installed in the same reactor as the hydrotreating catalyst.

FIG. 1. shows that the new DW-series catalysts generate only one-eighth of the yield loss per degree of CP improvement, compared to Topsoe’s previous-generation dewaxing catalyst. Furthermore, 90% of the diesel yield loss experienced with the D-series is lost to naphtha—which still provides value for the refiner and 10% is lost to light ends (C2–C7).

Case study. A U.S refinery operating a 25-Mbpd ULSD unit selected a load of Topsoe new NiMo catalyst TK-611 HyBRiM™ on top of a layer of TK-930 D-wax for use in the higher pressure ULSD unit. This was based on a detailed pilot plant study confirming the high activity of TK-611 HyBRiM and the selectivity of the dewaxing catalyst. The feed properties of this unit are listed in TABLE 2.

Using the TK-930 D-wax cata-
lyst enables the refinery to increase the feed rate during the five winter months by more than 600 bpd while still meeting the cold flow property specifications. In addition, the catalyst system reduces the T90 point of the product by 12–15 degrees, depending on the level of dewaxing. Most refineries are limited on the feed endpoint because they are up against the T90 spec in the product. The reduction in the T90 enabled the refinery to process an additional 1.5 Mbpd during the summer months and still meet all ULSD specifications.

The additional proﬁt from the enhanced winter and summer modes of operation correspond to approximately $6 MM/year–$8 MM/year or ~$30 MM over the catalyst cycle. The additional cost of the dewaxing catalyst compared to using all NiMo catalyst is paid back in a matter of weeks.

Renewable fuels dewaxing with TK-920 D-wax. Renewable diesel generated by the hydrotreating of triglycerides are mainly n-paraffins and will have very poor cold flow properties. Unless the renewable diesel is used in a very warm climate or as blendstock, it is necessary to dewax the product signiﬁcantly. Since the renewable feedstocks are typically very sweet, the use of Topsoe’s noble metal-based TK-920 D-wax is recommended. This catalyst is already installed in several renewable fuels reactors and provides the required cold point reduction with a very low diesel yield loss.

Topsoe’s new dewaxing catalysts are proven to provide one-eighth of the yield loss experienced with a traditional dewaxing catalyst per degree of cloud point improvement. The outstanding selectivity allows refiners to maintain high feed endpoint during the winter months and, due to a reduction in the T90 point of the product, it is also possible to process more barrels in the summer months. The use of the D-wax series catalyst of enables a much higher degree of molecule management to significantly increase the profitability of existing assets.

TABLE 1. Topsoe new generation dewaxing catalyst, TK-900 D-wax

<table>
<thead>
<tr>
<th>Sweet mode</th>
<th>Sour mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diesel/renewable</td>
<td>TK-920</td>
</tr>
<tr>
<td>Lube/VGO</td>
<td>TK-910</td>
</tr>
<tr>
<td>TK-940</td>
<td></td>
</tr>
<tr>
<td>Metal type</td>
<td>Noble metal</td>
</tr>
<tr>
<td>Base metal</td>
<td></td>
</tr>
<tr>
<td>Yield loss</td>
<td>Very low</td>
</tr>
<tr>
<td>Very low</td>
<td></td>
</tr>
<tr>
<td>H2 consumption</td>
<td>Very low</td>
</tr>
<tr>
<td>Very low</td>
<td></td>
</tr>
</tbody>
</table>

TABLE 2. Feedstock properties and operating conditions

<table>
<thead>
<tr>
<th>Distillation</th>
<th>Distillation curve, IBP</th>
</tr>
</thead>
<tbody>
<tr>
<td>221</td>
<td></td>
</tr>
<tr>
<td>392</td>
<td></td>
</tr>
<tr>
<td>466</td>
<td></td>
</tr>
<tr>
<td>529</td>
<td></td>
</tr>
<tr>
<td>591</td>
<td></td>
</tr>
<tr>
<td>663</td>
<td></td>
</tr>
<tr>
<td>752</td>
<td></td>
</tr>
<tr>
<td>1.0 wt%</td>
<td></td>
</tr>
<tr>
<td>350 wtppm</td>
<td></td>
</tr>
<tr>
<td>41 wt%</td>
<td></td>
</tr>
<tr>
<td>1,200 psig</td>
<td></td>
</tr>
<tr>
<td>LHSV</td>
<td>1.2 hr-1</td>
</tr>
</tbody>
</table>

FIG. 1. Yield loss as a function of dewaxing.
the third week of October, Pemex Salina Cruz is expected to restart by quake damaged its electric system. Cruz, was also halted after an earth-
largest refinery, the 330-Mbpd Salina
undergoing maintenance. Pemex's
the 190-Mbpd Ciudad Madero, was
for Mexico, as one of its refineries,
the fuel per day, mostly from the US
gasoline, typically buys two cargos of
Coast and Asia through September.
ens of cargos from Europe, the Mid-
East, the Caribbean, the US East
Coast refining profits.
while product refining margins
come under pressure, strong overseas
demand is expected to support Gulf
Coast refining profits.
The discount of US crude prices to
the global Brent benchmark widened
in the wake of the storm, meaning
US refiners currently enjoy higher
profit margins than those in Europe.
The sharp drop in US exports dis-
ruped many established trade routes,
forcing traders around the world to
source supplies from different mar-
kets, particularly Europe, which re-
lies heavily on diesel imports.
As a result, European diesel stocks
are expected to slide in the coming
weeks. Brazil and Mexico imported
unprecedented volumes of diesel and
gasoline from Europe and Asia in re-
cent weeks.

Shipping data shows that 10 tank-
ers carrying US diesel have also
been booked to sail to Europe this
week, following approximately three
weeks of almost no activity on the
transatlantic route.

US refineries increased crude
runs at the end of September by 1
MMbpd to 88.6% of total capacity,
the highest rate since Harvey hit on
Aug. 25, according to weekly data
from the Energy Information Ad-
ministration (EIA).

Harvey knocked out more than 4
MMbpd of US refining, nearly a
quarter of its total capacity.
While product refining margins
come under pressure, strong overseas
demand is expected to support Gulf
Coast refining profits.
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weeks. Brazil and Mexico imported
unprecedented volumes of diesel and
gasoline from Europe and Asia in re-
cent weeks.

The survey also highlighted indus-
try progress. 80% believe that regulat-
ions and technology have made the
industry safer, but there is still some
way to go. For example, 70% of com-
panies believe that there is a measur-
able change in the level of risk ex-
posure on the plant between planned
PSM hazard review periods. Addition-
ally, 74% of companies do not employ
effective solutions for monitoring and
managing the risk arising from opera-
tional activities, the impaired health
of process safety barriers and other
management system deficiencies.

Ninety percent believe risk aware-
ness and safety would be improved if
the workforce and management had
access to real-time process safety risk
indicators on the plant—a significant
increase from 73% in 2016.

“Process safety, operational risk
and asset integrity professionals un-
derstand the complex nature of the
challenges they face. The goal now
is to deploy systems that enable or-
ganizations to bring PSM into the
fold of operational excellence,” Mr.
Jones said.

The Petrotechnics PSM survey
was conducted online between June
14 and July 27, 2017. More than 200
individuals took part, and two thirds
of respondents have management re-
sponsibilities at the corporate level,
with the remaining third having sin-
gle-site or regional responsibilities.

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gle-site or regional responsibilities.
At the popular Principles & Practices: Emerging Leaders Town Hall, industry veterans and younger, up-and-coming professionals discussed the future of the industry.

The stakes were high at the casino-themed Athlon Solutions hospitality suite, and it was a good thing that the money wasn’t real.

Michael Volk from the University of Tulsa sits patiently while a digital artist creates his portrait during a visit to the Criterion Catalysts & Technologies team.

During a Tuesday morning OPCAT session, Steve Bitar from ExxonMobil Research and Engineering presented, “Open Process Automation: A Standards-Based, Interoperable and Secure Control System Architecture.”

Shine ‘em up! Johnson Matthey welcomed its visitors with a complimentary shoe shine.

Golf Skills with Reactor Resources was a popular suite, as a steady stream of golf enthusiasts practiced their swing.

It’s all in the follow through. Chris Stoves (left) and James Norton from Norton Engineering (bottom) face off during Haldor Topsoe’s carnival-themed hospitality suite Monday night. Next to them, Raj Singh from TechnipFMC impressed the crowd by improving his score with each round, no small feat considering that this was the first time he had ever played Skeeball.

The crowded exhibition hall provided a perfect venue for companies to showcase their latest technologies.
POWERING AHEAD IN 2018

AFPM 2018 Meetings

Annual Meeting
March 11 – 13
New Orleans Hilton
New Orleans, LA

International Petrochemical Conference
March 25 – 27
Grand Hyatt
San Antonio, TX

International Base Oils and Waxes Conference
March 25 – 27
Grand Hyatt
San Antonio, TX

Security Conference
April 23 – 25
Omni Royal Orleans
New Orleans, LA

Labor Relations/Human Resources Conference
April 26, 27
Omni Royal Orleans
New Orleans, LA

National Occupational & Process Safety Conference
May 15, 16
Grand Hyatt
San Antonio, TX

Reliability & Maintenance Conference
May 22 – 25
Henry B. Gonzalez Convention Center
San Antonio, TX

Cat Cracker Seminar
August 21, 22
Royal Sonesta
Houston, TX

Operations & Process Technology Summit
October 1 – 3
Atlanta Marriott Marquis
Atlanta, GA

Environmental Conference
October 14 – 16
Marriott Rivercenter
San Antonio, TX

www.afpm.org/conferences
Tighter fuel specifications and the processing of heavier crudes continue to increase the demand for hydrogen around the world adding more pressure than ever on refiners.

Globally over 14 billion SCFs of hydrogen are produced daily across Johnson Matthey KATALCO hydrogen production catalysts. Every day hydrogen is sold to refinery operations from Industrial Gas companies around the world and over 5 billion SCFD of this hydrogen are made over Johnson Matthey KATALCO hydrogen production catalysts. Our KATALCO range of products and services have been proven to be the industry solution for hydrogen production using a range of feedstocks, from natural gas and refinery off-gas, to LPG and naphthas providing reliable, efficient hydrogen to put refiners at ease in meeting new fuel specifications and processing of heavier crudes.

How is your hydrogen being produced?