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Petrochemicals surge despite possible future roadblocks

LEE NICHOLS, *Hydrocarbon Processing*

Over the past several years, investments in petrochemicals capacity additions have skyrocketed. Hundreds of billions of dollars have and will be invested in additional petrochemicals units and complexes. Most capital expenditures will be made in three primary regions—Asia, the Middle East and the U.S.

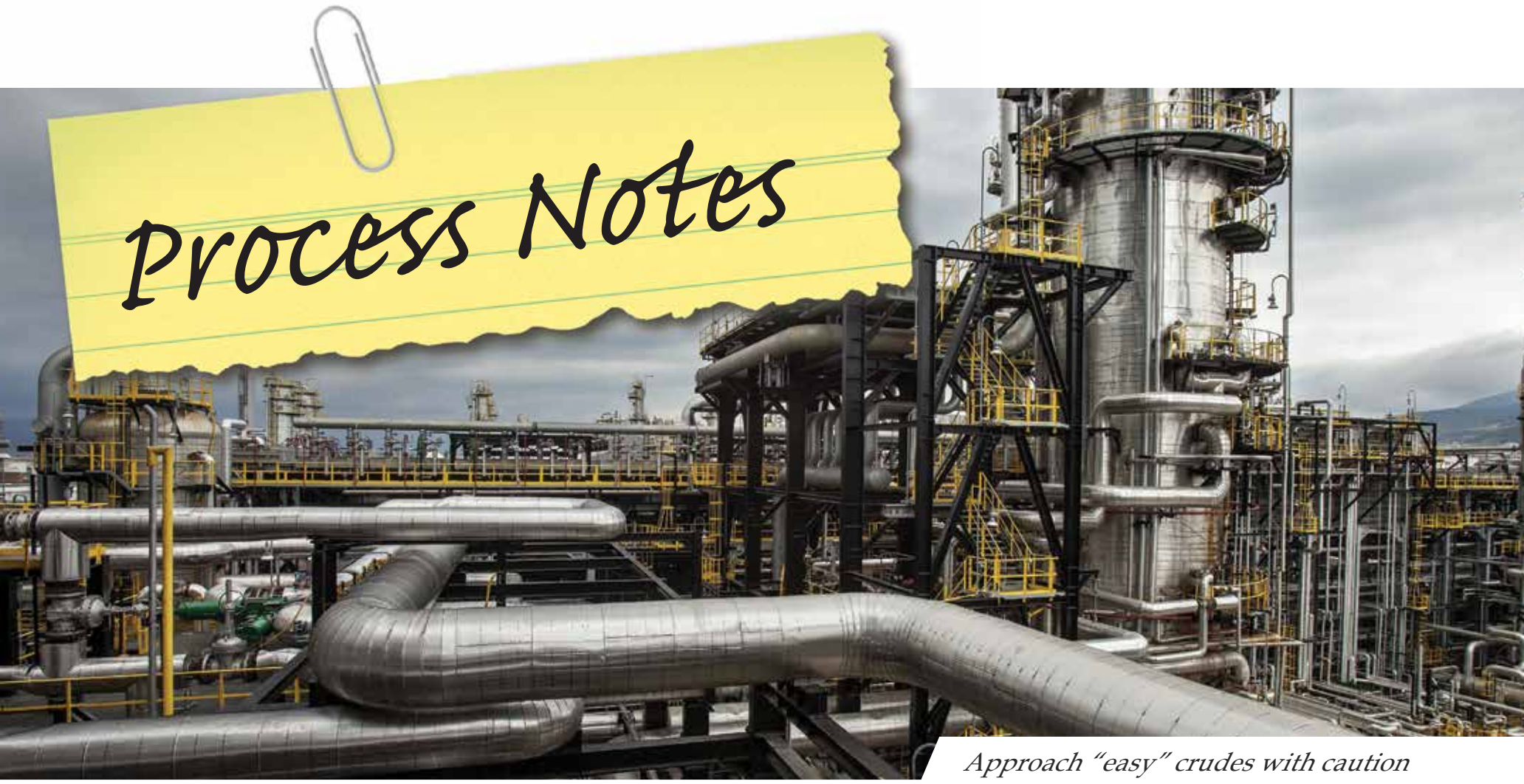
In the International Energy Agency's (IEA's) *The Future of Petrochemicals* report, the agency forecasts that approximately 25% of the increase in oil consumption to 2023 will be from demand for petrochemicals feedstocks. The report also states that the petrochemicals sector will account for one-third of oil demand growth to 2030 and increase to nearly half by 2050. This expansion in petrochemicals feedstock demand is a direct result of the massive buildout in new petrochemicals process capacity globally. In total, petrochemicals production is forecast to increase from approximately 400 MMtpy in 2020 to nearly 600 MMtpy in 2050, according to the IEA.

Roadblocks. Although demand for petrochemicals is forecast to grow significantly, several roadblocks can slow future demand for petrochemicals products. The primary trends include:

- **Slow or declining economic growth globally**—Petrochemicals product demand—especially for polyethylene (PE), which is the most widely used plastic in the world—is linked directly to GDP. A sizable decline in GDP or a global recession would significantly dent petrochemicals product demand.
- **A ban on single-use plastics**—To reduce plastics waste and pollution, many nations around the world are enacting new regulations to curb or ban single-use plastics. For example, the EU launched a circular economy initiative in 2018 that makes it mandatory for 50% of all plastics packaging to be recyclable or reusable by 2025, increasing to 100% by 2050.

  In the U.S., eight states have banned the use of single-use plastic bags, while several other nations have enacted the same ban. For example, India's Prime Minister, Narendra Modi, announced that India will ban six different types of single-use plastics starting in October 2022. The European Parliament plans to ban single-use plastics by 2021. Should more countries follow suit, global oil demand could suffer significantly. BP forecasts that such a ban globally could result in a reduction in oil demand of up to 6 MMbpd.

Although roadblocks exist, millions of tons of additional petrochemicals capacity are actively under development. According to *Hydrocarbon Processing's* Construction Boxscore Database, nearly 490 active petrochemicals projects have been announced or are in some phase of the planning, engineering or construction timeframe. These projects, located primarily in Asia, the Middle East and the U.S., account for hundreds of billions of dollars in new investments and will help satisfy future demand. •



Approach "easy" crudes with caution

Condensate is Crude

Ultra-light crudes and condensates are here to stay. These streams have flooded the market in recent years, and many of them are deeply discounted against reference crudes. Refiners have been processing increasing percentages of this light material through their Crude Distillation Units (CDUs) up against unit naphtha handling limits. On the surface, processing condensate and other ultra-light crudes with high API gravity and low sulfur should be easy. In reality, many refiners have experienced significant challenges, some of which are unique to ultra-light crudes and condensate.

Although their bulk properties signal that these crudes should be easy to process, new recovery techniques tend to leave undesirable compounds in the crudes that can adversely affect refinery CDUs or Condensate Splitters. Some of the bad actors are:

- High melt point waxes / high paraffin content
- Tramp amines from production H_2S scavengers
- Filterable solids
- Tramp phosphorous compounds

Severe crude column tray fouling

These undesirable compounds are the source of operating and reliability problems in CDUs and Condensate Splitters worldwide, and the onset and severity of certain problems can often be traced back to the introduction of new ultra-light crudes and condensates.

These supposedly "easy" crudes have been linked the following problems:

- Fouling in the cold preheat train
- Poor desalter performance
- Fouling in the warm and hot preheat trains
- Crude heater fouling and hot spots
- Accelerated overhead system corrosion
- Salting in the top of the crude column
- Plugging of kerosene section trays and exchangers
- Plugging of stripping trays

Despite the impression that new ultra-light crudes and condensates should all be easy to run, they are not. Condensates and ultra-light crudes are crudes, meaning that many of them can be difficult to process and can present unique refining challenges.

Process Consulting Services, Inc. has experience with these crudes and has addressed all of the problems above through process and equipment design features. Contact us today to maximize profitability and minimize headaches while processing these discounted crudes.

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Avoid costly startup delays with a MAC

S. MCENTEE, Rockwell Automation

A nightmare scenario for a commissioning engineer could be described as follows: Days away from the scheduled launch of a new plant or platform, the engineering team is frantically scrambling to connect original equipment manufacturer (OEM) skids and is at risk of missing the launch deadline. Sadly, almost every oil and gas company has experienced the chaos that comes with trying to finish a startup in its final days.

The good news is that this does not have to be the status quo. Steps can be taken to dramatically reduce integration challenges and keep projects on time and on budget. One such step is utilizing a main automation contractor (MAC), or changing how the company already works with its MAC.

A MAC can be beneficial to projects, but many companies offering this service lack the reach, business models and bandwidth to successfully align OEM packages. This can result in slippage and additional costs during the final days of commissioning. Embedding an OEM MAC in gas processing facility projects can help standardize equipment and reduce integration challenges.

An inherently troubled process. The last-minute scrambling that is so common in project startups happens for two main reasons. The first is the nature of how projects are typically executed. They begin with installing infrastructure, including mechanical, electrical and piping systems. Then, the distributed control system (DCS) must be started up. Finally, as the launch date draws closer, dozens of equipment packages must be integrated from a variety of vendors and OEMs with the DCS.

Another challenge is a lack of standardization. The equipment packages that arrive at a facility have a mix of protocols, operating systems, configuration tools, faceplates, and alarming and coding methodologies. Much time and resources can be spent just trying to get equipment to talk to one another. This work is often happening at the worst time—at the end of the project, when there is tremendous pressure to get the facility up and running.

This work also comes with some large costs. More personnel may be needed to integrate equipment and resolve problems. More critically, missing the launch date can be associated with more significant lost production costs. For example, consider the launch of a large gas processing facility that has been built with a significant number of modules that are then integrated onsite. The facility expects to process 400 MMsft^{3}d of wet gas to produce dry gas and NGL with combined sales of approximately $3 MM/d. The facility will lose this amount of revenue for every day the project startup is delayed.

A better way to integrate. It is sometimes assumed that the MAC is responsible for all automation, including the DCS and other packages. The reality, however, is that many of these companies are unable to align project OEMs to a single standard and make it stick. They simply do not have the business model or OEM relationships to achieve alignment. Traditional MACs can also benefit from the additional costs required to integrate OEM packages with disparate systems.

To reduce integration challenges, an embedded OEM MAC must play a bigger role from the onset of a project (**FIG. 1**). This starts at the front-end engineering and design (FEED) phase. Here, the OEM MAC creates a user requirement specification that the engineering, procurement and construction (EPC) company will issue to OEMs and that will be used throughout the life of the project.

By establishing this technical standard during the FEED stage, the commonality of hardware and functionality can be maximized across OEM packages. Also, variability in networks and the number of active components received can both be reduced. It is critical that the standard be developed in the FEED phase. If it is provided to OEMs at a later point, they may say that their pricing was based on a different standard during the FEED phase and then charge more to comply with the "new" standard.

The OEM MAC's role continues into the build phase. The MAC can provide embedded support to help OEMs understand and adhere to technical standards. Also, it can assist OEMs with factory acceptance testing (FAT). This assistance can involve sending commercial engineers or solution consultants to the OEM site. Increasingly, end users and EPCs are looking to speed up FATs and reduce travel costs by conducting them virtually—making it important that an OEM MAC is able to support this process. Finally, the OEM MAC can provide onsite management of the delivery, integration and acceptance testing of the OEM packages.

Smoother startups. Many of the benefits of working with an OEM MAC come during commissioning. The equipment packages that are received from several different OEMs are built to the same standard and tested. As a result, they fit into the architecture easily and integrate with the DCS using one protocol. This helps avoid common faults and reduces the risk of costly delays caused by integration challenges.

Additionally, worker training in the new facility is simplified because the human-machine interfaces (HMIs), faceplates and alarming are all the same. Valuable digital data is more easily accessible because the network and systems are harmonized.

The kind of savings that can be realized during commissioning will vary

► See **MAC,** page 18

FIG. 1. Companies can greatly reduce integration costs and challenges by changing the way they work with their MAC.

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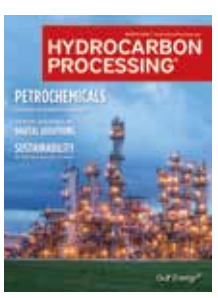

Digital reliability: 24/7 real-time machinery diagnostics

A. KOSTYUKOV, DYNAMICS Scientific Production Center USA Inc.

It is well-known that the primary costs and losses in petroleum refining come from sudden equipment failures. A distributed control system (DCS) supplies comprehensive information on the process and operation modes of the equipment. However, equipment health during operation often escapes the attention of operators who continually change process modes while controlling the process plant. For sustainable and reliable operations, it is necessary to provide operators with timely, unbiased information on how the operation mode affects the equipment's health before a failure, when early diagnostics of defects allow people to eliminate a future issue at the emergent stage.

To answer what benefits digital reliability could provide for a petroleum refinery, let's consider the difference between reliability and digital reliability; what diagnostics and early diagnostics mean; the differences between protection, condition monitoring and diagnostic system; and, finally, how 24/7 real-time diagnostics add value to every processing facility.

The conventional approach to maintain machinery reliability at a certain level has not changed over the last 70 years. It is based on three primary pillars: a safety factor, which is the ratio of a machine's structural capability to the actual applied load; the operational discipline of personnel, who are always striving to do the right things in the right ways; and failure recognition capability, or the ability to predict failure before it happens.

At the beginning of the reliability era, the primary method for extending reliable uptime of machinery was increasing the safety factor; however, significant over-increasing of structural capability to actual applied load led to rising machinery costs, which negatively impacted consumer interests. Customers required cheaper machines and agreed to substitute the excess structural capability for better operational discipline of staff.

Since the 1950s, several approaches to providing machine reliability have been developed and implemented, such as preventive maintenance, proactive maintenance and reliability-centered maintenance, among others. These approaches have two common issues: poor statistics for machinery lifespan and the human factor. To confine the influence of those factors on reliability, since the 1970s, the main focus moved to increasing a failure recognition capability. Until now, scientists, engineers and practitioners have attempted to determine the instance of a machine's failure to prevent its breakdown using different instruments and methods. We could name that era "analog reliability" because people tried to increase reliability by evolving every one of those pillars and making them stronger, clearer and more precise.

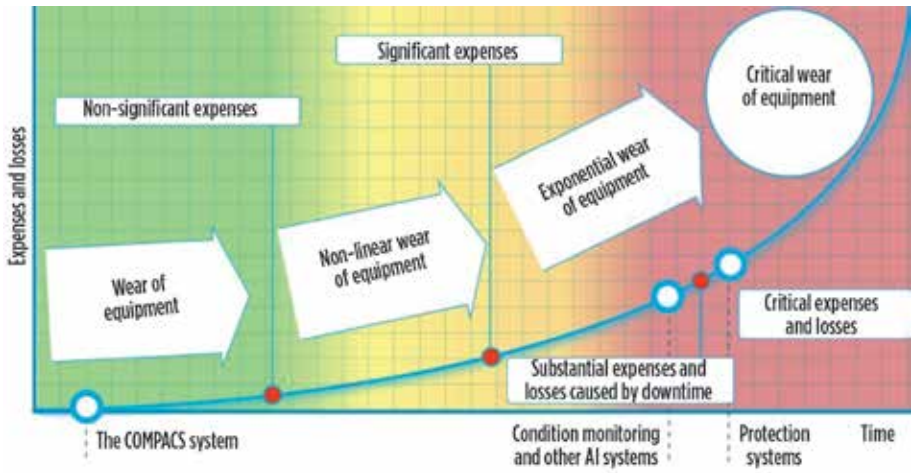

FIG. 1. The curve of dependency between the time of defect recognition and the expenses and losses caused by the failure.

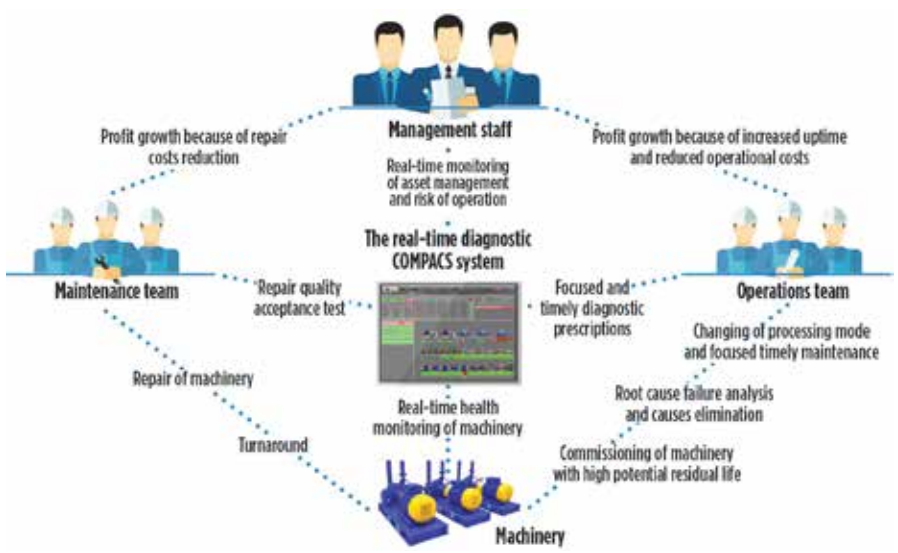

FIG. 2. The technology of safe resource-saving operation and maintenance of machinery (SROMM).

Enter digital reliability. Digital reliability emerged in the 1990s when PCs were first used for reliability tasks. Since then, computers have played a significant role in the evolution of reliability theory and practice because they compute complex functions very quickly, process large amounts of data and simultaneously deliver information to many people in different places for better decision making.

The advantages of digitalization are obvious. If everyone uses unbiased information about a particular situation, no one is forced to guess, assume, consider several scenarios, calculate probabilities and, finally, make what they hope will be the most favorable decision, which in some cases might be wrong. This simply does not make sense. Combating this faulty methodology requires creating an infrastructure for collecting useful data from relevant sources, processing data to excavate information from it, and sharing the information among the proper audience in a timely manner.

Data is only recognized as useful if it contains relevant information. Data sources must be trustworthy and directly related to the subject matter. In the analog era, we had a lack of data to be analyzed because data gathering was very expensive. Now, big data can be collected at a reasonable price. However, unless we can access the proper data and process it promptly, we still have the same lack of information because the return on investment is not expected. Moreover, even if we extract valuable information from trustworthy sources, we cannot obtain benefits unless we use it in making timely decisions. Thus, the most important advantages of digital reliability are the ability to extract preventative information from big data and share it throughout the enterprise in a timely manner.

Diagnostics. Consider the difference between machinery diagnostics and early diagnostics. Diagnostics, the process of identification of malfunction, consists of a few steps. The first and most crucial step is collecting data about machinery health that contains the choices of data type, data sources, data volume, frequency of data gathering and the tools to accomplish that. Any mistake here severely affects the diagnosis, making it either wrong or late.

The curve shown in **FIG. 1** represents the dependency of cost and losses by fault detection. Within its lifespan, equipment undergoes three stages of degradation: non-linear wear, exponential wear and critical wear. These are divided on the curve by red dots. The diagnostic process has two distinct errors: an error of static recognition and an error of dynamic recognition. The error of static recognition appears when a failure cannot be detected because either the wrong non-destructive testing (NDT) method is utilized, or the proper NDT method is used in the wrong way. The error of dynamic recognition appears when a failure cannot be detected and prevented because an interval of monitoring equates or exceeds an interval of defect evolution from emergence to failure.

The later a defect is identified, the greater the consequences and expenses are. Therefore, it is critical to identify a defect the instant it begins, as this is the best opportunity to in-

► See DIGITAL, page 7

How human intelligence and AI are driving project planning in the oil and gas industry

D. PATTERSON, InEight

The science of project planning has something of a tenuous reputation. How often do large oil and gas capital expenditure (CAPEX) projects really come in according to plan? Almost never. Indeed, 30% of respondents to a 2018 PwC survey said they had experienced cost overruns of 10%–50% on their Middle East capital projects.[1]

Even during this era of digital transformation, project schedule and cost overruns are still the normal course of business, not the exception. Arguably, the reason for this is less about poor execution and more about how the industry still struggles to accurately forecast how long these complex CAPEX projects will actually take to complete.

According to a 2017 McKinsey report, the Middle East has one of the most significant project pipelines anywhere in the world, with a total of $396 B of future projects planned across the region. In the U.S., the electricity and power sector accounted for $423 B in CAPEX projects—the largest of all sectors.[2]

New approaches using digital planning and risk assessment tools are poised to change oil and gas project economics, bringing with them the potential to deliver successful and on-time CAPEX projects, while unlocking significant value. Digital project planning solutions can combine artificial intelligence (AI) and human intelligence to create true risk intelligence. This is achieved by combining historical project data and human expertise. This path allows planners and project teams the ability to produce more accurate and fully risk-adjusted schedules for their projects (**FIG. 1**).

If oil and gas companies in the Middle East can use these tools to adapt their scheduling practices to meet the needs of their unique regional environment, the productivity improvements could deliver up to 30% in cost savings—nearly $250 B.

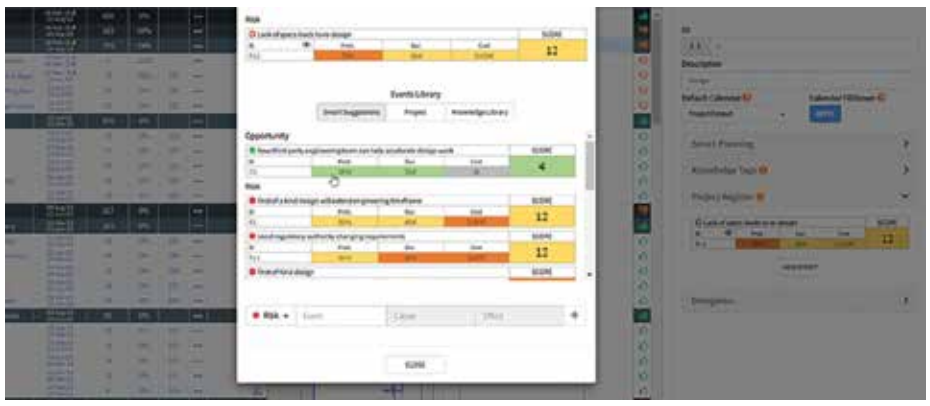

FIG. 1. Planners can now produce more accurate and fully-adjusted schedules.

Although a wide variety of factors can contribute to project delays and CAPEX mismanagement, the root cause has less to do with the likes of planning techniques not being fit for purpose and more to do with inaccurate data being fed into those plans.

The tide is finally turning toward more accurate project forecasting with the advent of AI and the simple realization that it takes the expertise of a specialized team to build a plan.

To help address the challenge of developing a meaningful risk model, a more team-centric and collaborative means of capturing both risk and uncertainty, along with more easily consumable and actionable risk reports, has been developed.

Enter the human intelligence element, where a team's collective expertise is pooled together on a single platform.

Let the software compile the uncertainty ranges. Rather than force team members into the "describe the range of outcomes as a distribution" approach, why not capture such expert opinion through a simple scorecard? Simply ask team members to either buy in or push back on the proposed durations. This approach carries the massive benefit of making the expert opinion and knowledge capture process fast and easy for contributors, while still retaining the underlying modeling methodology. This approach also ensures that the total consensus of the team is accounted for in the risk model rather than it being "the voice of one."

Relating back to the challenge of owner/engineering, procurement and construction (EPC) contractor alignment, this concept of consensus-based planning helps drive that necessary synergy tremendously, which, in turn, drives buy-in and, ultimately, the project's chances of on-time completion.

Applied in practice. Petra Nova, the world's largest commercial-sized post-combustion carbon capture system, was one such infrastructure project that benefited from this change in approach. The facility's project engineer's use of an integrated platform prompted a total rethink on how to do daily work plans, quantity claiming and time collection. It also allowed users at every level of the job to access and maximize data from every aspect of the project.

The ability to clearly communicate work and project scope, provide daily work plans and ensure operational efficiency and compliance not only contributed to the project's on-time and on-budget completion, but also increased productivity by 20%. The job required nearly 1.4 MM work-hours, but by pooling the team's collective experience, it achieved a craft-to-staff ratio of 4.2/1—a 50% improvement on the average achieved by peer projects.

Use AI to help establish your risk register. In addition to more efficiently capturing duration ranges through this approach, the second step in the risk model building process is to capture and quantify risk events.

Traditionally, risk events have been tracked in a project risk register. The modeling challenge arises when linking those identified risks from the risk register into the schedule risk model. This process causes huge challenges in project risk workshops.

Instead of identifying risks in isolation of the schedule and then trying to embed them back in, why not provide an environment where risks are identified *and* scored directly in context of the schedule itself?

By leveraging AI, team members can also take advantage of the computer making suggestions as to common risks and their historical impact on similar scopes of work. Rather than team members having to brainstorm from a blank sheet of paper, they can take into account previously realized risks and opportunities from similar historical projects. As new risks are identified, they can be automatically added to the enterprise risk register, ready for subsequent consumption. This self-perpetuating risk management loop is an entirely new and more effective way for an oil and gas company to adopt a more mature outlook on risk.

Risk-adjusted forecasting is applicable to all project stakeholders. Historically, project risk analysis has been available to larger project organizations and, typically, embraced more by business owners than EPC contractors. The advent of next-generation, risk-adjusted forecasting software is opening up the benefits of risk insight to the broader market. By combining the data mining power of AI and pooled human intelligence, risk modeling is making huge strides forward.

Contractor organizations can benefit from determining applicable contingencies, along with appropriate margins, when developing their commercial bids. In short, contractors can ensure they are more competitive by following this risk-adjusted forecasting approach. Likewise, owners get more insight into the realism and achievability of contractor schedules and can react and remediate faster.

In all instances, the benefit of providing an easier means of capturing inputs, applying them to a proven approach, and then gaining deeper and more meaningful insight through next-generation risk reporting is hard to argue against.

The long-overdue collaboration between human intelligence and AI is finally becoming a reality. By enabling on-time project completion, this culmination of proven practices becomes a perfect union and has the potential to unlock value across a project's lifecycle. The end result is that more projects will see the light of day. ●

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DAN PATTERSON founded BASIS, a company that developed an AI planning software tool that was acquired by InEight in 2018. Following the acquisition, Mr. Patterson became a member of InEight's executive leadership team. He now focuses on expanding upon his vision of creating next-generation planning and scheduling software solutions for the construction industry.

BASF INTRODUCES FOURTUNE™ FCC CATALYST TO DELIVER MORE BUTYLENE FOR REFINERS

BASF has launched Fourtune™, a new fluid catalytic cracking (FCC) catalyst product for gasoil feedstock. Fourtune is the latest product based on BASF's Multiple Framework Topology (MFT) technology. It has been optimized to deliver superior butylene over propylene selectivity while maintaining catalyst activity and performance.

Fourtune commercial trials have confirmed its ability to deliver better economic performance through butylene selectivity, high conversion and maintains coke selective bottoms upgrading and high distillate yields that increase refiners' profitability.

BASF's MFT technology enhances performance through the use of more than one framework topology that work together to tailor the catalyst selectivity profile. Successful evaluations have demonstrated Fourtune's ability to help maximize margins and provide operating flexibility to make more butylene to feed the alkylation unit. The technology provides an answer to the increased demand for octane since today's tighter sulfur regulations often require post treatment on the gasoline stream.

Detlef Ruff, Senior Vice President Process Catalysts at BASF, said, "We are confident that the benefits of this new product will bring our customers improvements in butylene selectivity and the overall potential to make the refineries more profitable." ●

DIGITAL, continued from page 4

tervene and prevent a serious accident and possibly a shutdown due to equipment failure. While diagnostics itself is a process of defect detection, early diagnostics is a process of defect prevention.

Existing solutions, such as protection or condition monitoring systems, are focused on confining consequences, not preventing breakdowns. DCS merely shows the failure, at best correctly starting the emergency shutdown to minimize the consequences of that failure—it does not identify the fault at an early stage of degradation and take urgent actions to eliminate it. If the protection system alarms, the breakdown happens. Even new AI software solutions work at the end of the exponential wear stage because the AI analyzes the same parameters that protection, condition monitoring or control systems measure.

Expert interpretation. Additionally, almost all condition monitoring systems require an expert to interpret. Without that interpretation, the operator cannot understand what should be done to prevent an impending failure. This is the main reason why most breakdowns and accidents happen on the night or weekend shift: the expert is not on duty at the facility. To prevent failures as well as repairs and maintenance, we must identify the emergence of issues in the non-linear wear stage, when destructive forces are just beginning to degrade the equipment. Operators should play a crucial role in the reliability of the facility, and they need precise, proven and timely information about what should be done to recover equipment health.

With the stationary equipment monitoring system COMPACS® diagnosing the health of every piece of equipment in real time and delivering precise, timely prescriptions to operators 24/7, an operator need not be an expert in vibration analysis to know how and when to react. If operators identify and eliminate these destructive forces at this stage, safe and reliable operation will become a reality. It is essential that only real-time diagnostic systems—which have low errors of static and dynamic recognition of defects and are able to identify destructive forces influencing the emergence of defects—can shift operation reliability and maintenance efficacy tremendously toward paramount safety and uptime. This disrupts the existing mechanism of conventional relationships among operators, the maintenance team and management.

Value delivered. The real value delivered to a petroleum refinery by the real-time diagnostic COMPACS system comes from several sources. First, it prevents accidents and shutdowns. According to several analyses, in 2017, an average amount of annual refinery losses due to unscheduled shutdowns was approximately $150 MM. By transforming sudden defects in machinery into gradual ones, refiners can avoid most of the incidents and corresponding losses and save an estimated $100 MM/yr.

Another source of value is extended uptime. By decreasing a turnaround's outage and extending average uptime from 91% to 99%, an average refinery can attain roughly $100 MM/yr of additional profit. Finally, an average U.S. refinery spends more than $9 MM/yr on maintenance, which could be reduced significantly. The combined additional profit from the COMPACS system implementation at an average U.S. refinery could reach $200 MM/yr.

However, reaching a sustainable value from 24/7 real-time machinery diagnostics requires a paradigm shift of reliability management. In **FIG. 2,** three information loops are provided by the real-time diagnostics COMPACS system. The system identifies malfunctions of every piece of equipment in the facility every three minutes and sends precise and timely information to operators, the personnel who can prevent degradation in the emergent stage.

This is why we promote the operator-driven reliability approach. When prescriptions are received, operators must take urgent action to improve equipment health and reliability. The second information loop is for the maintenance team, which uses unbiased information from the COMPACS system and is prepared to perform a complex repair in a short period of time, or to schedule repairs according to the condition of the equipment. The third loop is for management staff. They receive unbiased information about machinery health, the operator's involvement in reliability, and the quality of maintenance performed; this provides transparency and makes the benefits mentioned above achievable.

Takeaway. To reach the desirable outcomes in safety and uptime, digital reliability requires proper infrastructure for collecting useful data from trustful sources using the SCADA structure, the physics-based AI that operates by invariants to extract information on time, and a plant diagnostic network for simultaneous information delivery to all levels of decision making, from operators and engineers to managers. The COMPACS system is the only one that meets those requirements and assists refiners to make the reliability paradigm shift to implementing the technology of safe, resource-saving operation and maintenance of machinery (SROMM). It brings timely and objective information about machinery health, an operator's involvement in reliability, and maintenance quality. Moreover, it provides financial benefits that exceed investments in the solution by at least ten times, provides confident safety of process operations, and generates prosperity for all who are involved. •

Remember vital backup generation systems

C. M. MARTINEZ, Fluor Corporation

Backup generation systems are commonplace in many industrial facilities, both onshore and offshore. Typically, they are relatively small in capacity when compared to a main power plant or main substation. This may be why they are sometimes given a lower priority in the execution of a project—it can be said that they are sometimes underestimated or even forgotten, albeit not necessarily on purpose. Underestimating their complexity can result in many long, stressful days of engineering and design.

Granted, not all backup systems have the same purpose and their relative importance varies. For example, emergency, essential and standby systems carry different regulatory requirements. Ironically, an emergency system designed to be "simple" can be underestimated because it appears simple, despite its high importance. Likewise, a complex standby system can be given a lower priority because it is not called an emergency system. Additionally, backup generation must be coordinated with "instantaneous" backup systems, such as uninterruptible power supplies.

Because Fluor begins working on projects at different stages of their development, we have had the opportunity to not only develop standby systems from scratch, but to finalize development and design of systems that have been started by others. This experience provides a perspective of the implications when these backup systems are not developed in a timely manner and are not properly designed.

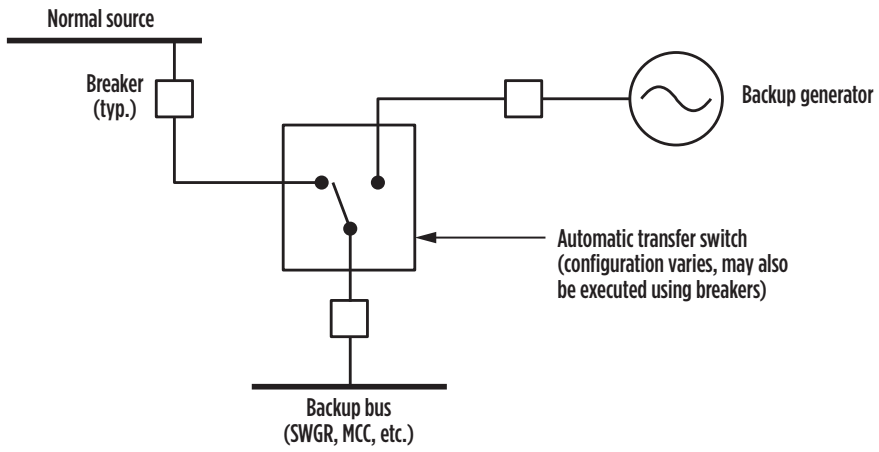

FIG. 1. Simple backup system.

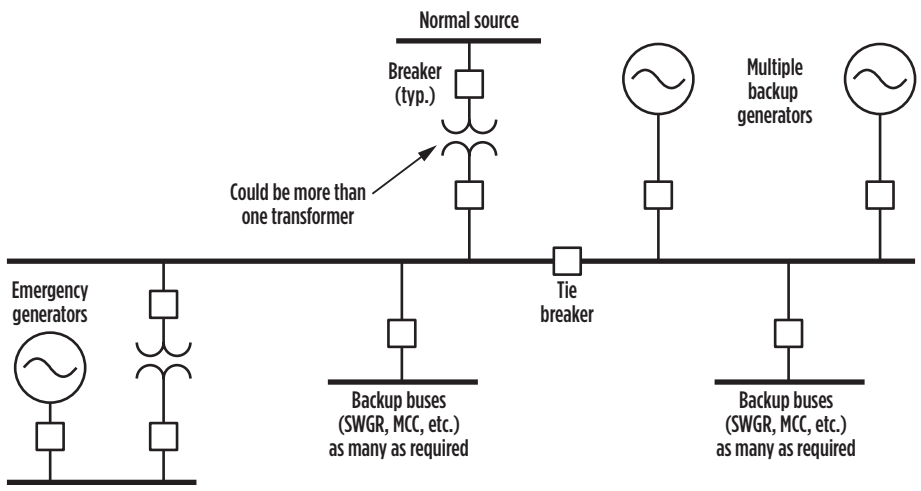

FIG. 2. A not-so-simple backup system.

Successful execution. What about these relatively small power systems can make their execution so difficult? A full answer cannot be provided here, but some examples can illustrate key points.

In a simple system, such as the one shown in **FIG. 1,** a backup generator (typically, but not necessarily, a reciprocating diesel engine) starts after a transfer switch operates, changing over from normal to backup generation. This generator will supply a simple radial system. Once the generator is connected and the electrical backup system is energized, normal operation can be expected. However, it may not be that simple.

Differences between the normal and standby systems' behavior can result in undesirable conditions, including:

- Short-circuit capability is reduced
  - o Relay coordination may not work as well, or at all
  - o Incident energy levels (arc flash) differ from normal power levels
  - o Inability to start motors
- System may be less stable to adverse events
- Voltage regulation can be affected depending on generator capabilities.

These issues apply (to some extent) to practically any backup generation system.

More complex backup systems require other considerations. **FIG. 2** shows a more complicated, multi-generator standby system. In this case, the generators can run in parallel and with the normal power system.

For this example, energizing the electrical system from the backup generators requires the orchestration of the correct breakers in the appropriate sequence. This is also true for returning to normal operation. Some additional items to consider include:

- Short-circuit capability is noticeably variable according to the number of generators in service
  - o Relay coordination used for normal service may not work as well, or not at all, and the coordination must consider generation possibilities
  - o Incident energy levels (arc flash) differ from normal power levels according to the number of generators operating
  - o Inability to start motors varies
  - o Ground fault levels may be variable depending on the system grounding method
- System may be less stable to adverse events, and this stability will vary depending on the number of generators interconnected
- Load sharing and voltage regulation control systems will require additional attention
- Configuration of the electrical system to allow backup generation to come online
- Synchronization schemes during backup operation to return to normal and for testing purposes
- Return to normal breaker operation sequencing and generator control.

Different configurations and implications. Other configurations include backup systems where standby and emergency generators can run in parallel, and others that share their power supply with firewater systems. These have additional implications, not only from an electrical and regulatory complexity standpoint but also from the perspective that the emergency or firewater systems must not be impeded by these interconnections.

Handling these possible issues can be as unique as the backup systems involved. However, some aspects should be considered, in any case:

- Include development of the backup generation system as a line item in the project tasks; it is important to keep these systems in mind and to work through the issues in a timely manner.
- Develop the requirements of the system and basic configuration early in the project; this configuration should be sufficient to determine regulatory impacts, provide a clear philosophy and to determine electrical system impacts and requirements.
- Determine regulatory requirements early on the project, preferably during early front-end engineering.
- Determine limitations and capabilities of the backup system, including those mentioned above (short circuit, motor starting, etc.); this determination typically results in a range of equipment and operating envelope—it is not deterministic early in the project.
  - o Minimum backup generation required
  - o Maximum generation the backup system can handle
  - o Range of short circuit (required/capable)
  - o Basis for relay coordination and protection
  - o Compliance with incident energy limits
- Define load sharing and voltage control systems requirements
- Identify interactions between the normal and backup systems (synchronization, parallel operation, short circuit effects, etc.)
- Set up a plan to finalize the backup generation system design.

If there is one thing to take from this narrative, remember to give these backup generation systems their due priority, and to not delay their development. It may not be easy to bring such typically small systems to the forefront of early project execution. ●

NO WORD YET FROM TRUMP ADMINISTRATION ON REFINERY BIOFUEL WAIVERS

U.S. Senators Chuck Grassley and Joni Ernst of Iowa have asked the Trump administration not to appeal a court ruling that would slash the use of small refinery biofuel waivers but have not heard back yet on its decision (as of 3/24), Senator Grassley said.

"We haven't been told one way or another officially," he told reporters on a conference call.

The U.S. Renewable Fuel Standard (RFS) requires oil refiners to blend billions of gallons of biofuels like ethanol into the nation's fuel pool.

However, the Environmental Protection Agency (EPA) that administers the program grants waivers to small refineries that can prove compliance would cause them financial strain. The Trump administration has roughly quadrupled the number of waivers the EPA has granted, infuriating the biofuel industry and its representatives who say they hurt demand.

A court in January ruled that the EPA had been overusing the waivers in a decision that could gut the program. A group of Texas lawmakers has been urging the Trump administration to appeal the decision, arguing it could cost countless blue-collar jobs in the refining industry. ●

Sustainability: Initiatives, innovation and solutions to crucial challenges

J. BECKER, Chevron Phillips Chemical

JIM BECKER is Vice President, Polymers & Sustainability, overseeing the polyethylene and resin businesses for Chevron Phillips Chemical, as well as the company's sustainability strategy. Previously, he served as Vice President, Specialties, managing the specialties businesses, including normal alpha olefins, polyalpha olefins, drilling specialties and a wide range of specialty chemicals. Mr. Becker is also on the board of directors for Americas Styrenics, a JV equally owned by Trinseo and Chevron Phillips Chemical.

Hydrocarbon Processing's Editor-in-Chief/Associate Publisher, Lee Nichols, was pleased to speak with Jim Becker (JB), Vice President, Polymers and Sustainability for Chevron Phillips Chemical (CP Chem). The following Q&A provides insights on CP Chem's sustainability initiatives, plastic waste bans around the world, advances in chemical recycling technologies and solutions to help mitigate plastic waste around the world.

HP: Can you detail CP Chem's sustainability initiatives?

JB: The first thing we want to acknowledge is that plastics and polymers do a lot of good things in the world. They save energy, reduce weight, preserve food and are used in several medical applications, among others. However, unmanaged plastic waste does not belong in the environment.

Our company is trying to eliminate unmanaged plastic waste with several initiatives. We are a founding member of the Alliance to End Plastic Waste (AEPW). This organization—comprised of more than 40 companies across the entire supply chain—has a simple mission: To end plastic waste in the environment. The organization is actively being built now, so the world will start to see a lot of new initiatives coming out of this alliance to address and mitigate plastic waste—approximately $1.5 B has been committed to this issue by the AEPW.

One interesting initiative CP Chem is a member of is Operation Clean Sweep Blue. The enhanced version is a set of processes and programs—everything from engineering design to processes and systems—to ensure that plastic pellets do not leave our manufacturing sites.

Another initiative is helping our customers develop sustainability solutions. For example, if we have a customer who wants to figure out how to increase the percentage of post-consumer resin in their products, CP Chem's talented polymer chemists can help with that. We are also developing products that will enable manufacturers to thin-gauge products and use less polyethylene.

Finally, we are actively engaged in sustainability advocacy through industry organizations, such as the AEPW, Plastics Europe and the American Chemistry Council, among others.

HP: Why do you think that plastics are a sustainable solution?

JB: A key to this whole puzzle is chemical recycling. If you want to keep plastics out of the environment and landfills, which is the ultimate goal, you can mechanically or chemically recycle it. Mechanical recycling—although it has been very successful—has limits. If you mechanically recycle resin enough times, it deteriorates to a point where you cannot harness the properties to recycle it any more.

We think chemical recycling is an important key to this. Our company is investing resources in developing chemical recycling technologies. This means recycling the material back down to feedstock components, which can then be processed into a virgin resin. This process takes that piece of plastic out of a landfill or the environment, creating a circular approach. Unmanaged plastic waste then becomes a resource. We think that if you do all of these processes right, plastics *are* a sustainable solution.

HP: Many governments are imposing bans of plastic products. Is this the right strategy?

► See SUSTAINABILITY, page 13

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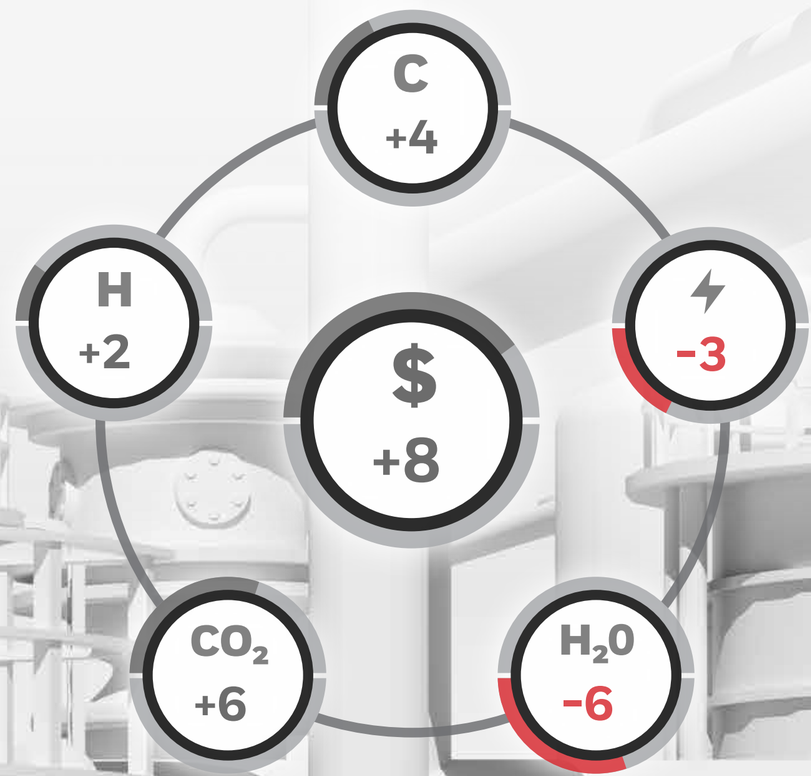

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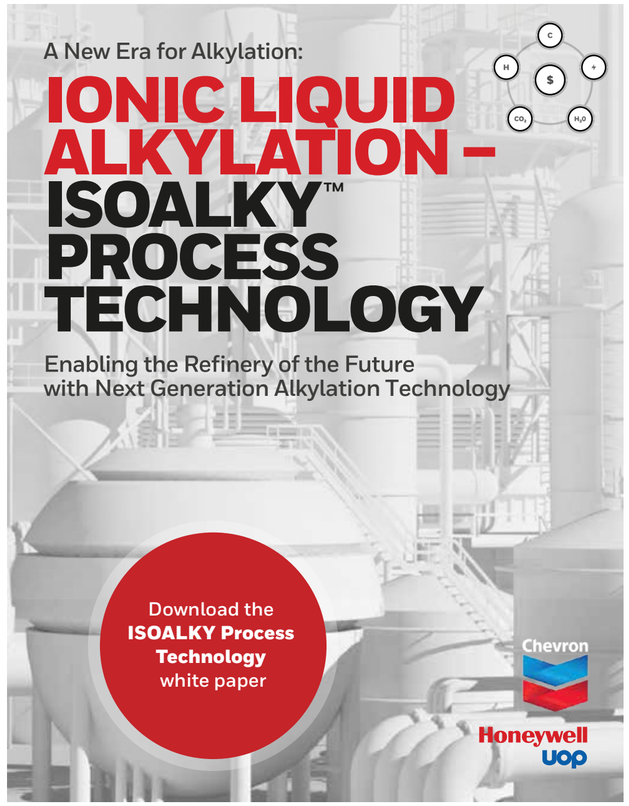

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C +4

1. Are you selling any products at a discount?
2. What streams do you want to create more of or avoid?

H +2

3. How constrained is your steam methane reformer?
4. Do you ever need to shift your operations based on hydrogen availability?

-3

5. What are your fuel gas, power, and steam costs/drivers?
6. Do you have infrastructure constraints that impact any of these?

CO_2 +6

7. What is your carbon tax rate?
8. How are you performing against existing emission permits?

H_2O -6

9. Because water is a scarce resource, are you concerned about water availability?
10. What is your cost for water?

$ +8

11. What is your Hurdle Rate (required minimum rate of return) ?
12. What are your financing constraints?

Let's talk about the efficiency of your investments.

The future of FCC on the evolution of the refining industry

C. VACCESE and **V. SCALCO,** General Atomics Electromagnetic Systems, USA

Increasing profits and maintaining a positive bottom line are critical for complex refineries. By 2020, the refining sector will be comprised of approximately 735 petroleum refineries worldwide. More than half of these refineries will utilize severe catalytic cracking technology to increase profits and take advantage of existing crack spreads. More than 18 MMbpd of crude oil are processed through a fluidized catalytic cracking (FCC) system, along with 75% of the worldwide gasoline demand. FCC systems have become the most versatile operating units in a refinery to improve the bottom line. With the increase in crude prices due to the pending IMO 2020 regulation enforcement, the spread between lighter, less severe crudes and heavier, opportunistic crudes will become a bigger part of the refining sector's economics.

Heavier, opportunistic crudes are pushing the limits of catalytic cracking. Refiners are increasingly considering the utilization of more complex technologies for deeper conversion of challenging feedstock arising from the processing of opportunistic crudes. Licensors like Axens, Technip, and Kellogg Brown and Root (KBR) have a suite of technologies designed for residual conversion and opportunistic feedstock upgrading. These technologies are tailored for processing heavier crudes and producing high-quality final products, including Axens High-Severity Fluid Catalytic Cracking (HS-FCC™); deep catalytic cracking (DCC); resid to propylene (R2P); KBR Veba Combi Cracking (VCC™); KBR Maxofin™; UOP Petro FCC™; and LCO Unicracking™.

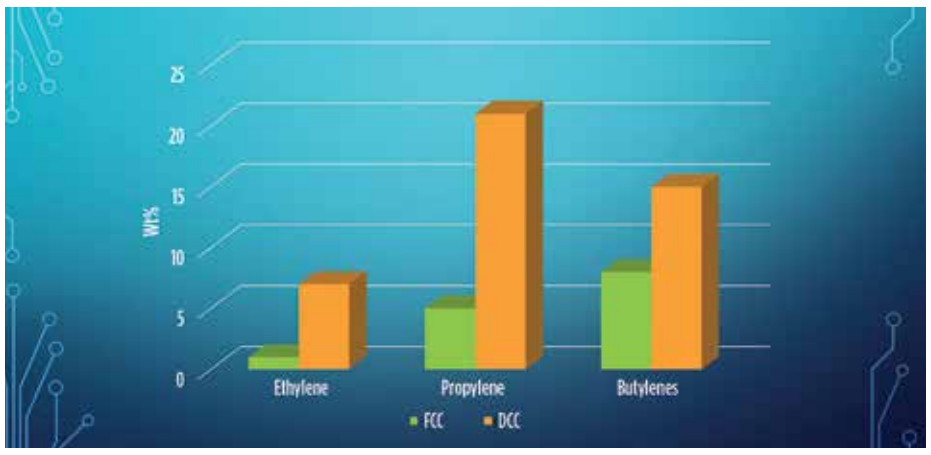

FIG. 1. Comparison of light olefins yield between DCC and FCC, wt%.

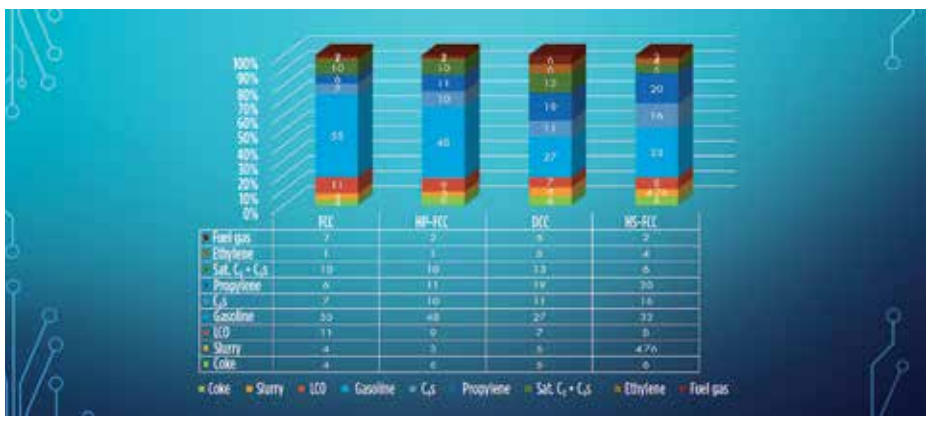

FIG. 2. Yield comparison, wt%.

Challenges. Severe catalytic cracking activities (**FIG. 1**) come with the challenge of higher concentration of sediments and filterable solids within the slurry oil stream. This challenge can be efficiently addressed by adopting the right separation technology. Sediments are composed of large particles greater than 20 µm, while filterable solids are composed of smaller particles typically in the range of 20 µm to submicron level. The sources of the solids are iron sulfide, silica, clays, scales, ash, coke and catalyst fines. Contamination starts upstream after the desalter and reaches downstream of the catalytic cracking unit. New catalysts, co-catalyst and additives, while benefitting the process, are at the same time adding more sediments, solids and poisoning metals to the bottom of the barrel, creating more challenges to removing these contaminants.

The FCC system is one of the most productive and profitable technologies among refining processes. Upgrading catalytic cracking technology must be simultaneous with increasing efficiency, reducing maintenance costs and improving the catalyst equilibrium cycle. Removing solids and ultimately increasing the lifespan of the FCC system is directly related to incrementing the bottom line in refining.

Case study. S-Oil Refinery in Ulsan, Korea, recently performed the inauguration of its first phase of a new residue-upgrading complex (RUCP) and olefin downstream complex in support of its integrated refining and petrochemical operations. The state-of-the-art facility features the first commercial 76,000-bpd, high-severity fluidized catalytic cracking (HS-FCC) unit, developed by Axens. S-Oil's petrochemical portion has been increased from 8% to 13%, including production of propylene (300,000 tpy), polypropylene (405,000 tpy) and gasoline (907,000 tpy).

HS-FCC operates at critical conditions and concentrations. This makes the process more challenging, especially at the bottom of the barrel where high concentrations of solids, contaminants and catalysts are undermining the possibility of upgrading the slurry oil stream.

Three main factors differentiate HS-FCC from its competitors. The first is a high temperature up to 650°C (1,202°F), whereas normal FCC operation is ~500°C (~932°F). High temperatures bring the advantage of high conversion and olefins selectivity, along with the challenge of increased thermal cracking activity and potential product degradation. The second is short contact time of the feed/catalyst (< 0.5 sec.). The advantage of short contact time is a reduction in secondary reactions and in thermal cracking. There is a disadvantage, however, of efficiently achieving conversion having to deal with rapid mixing and separation. The third and most influential factor is high catalyst/oil ratio (C/O). The challenges posed by the first two factors lead to a solution using high ratio of catalyst/oil (C/O) to increase the catalytic cracking activity. Although the new HS-FCC technology presents many advantages, a resulting disadvantage exists. The HS-FCC slurry stream is highly concentrated with asphaltenes, increased ash, heavy metals, coke and unfilterable solids for normal mechanical methods.

The success of the HS-FCC production relies on providing clarified slurry oil at < 50ppm. Several different filtration and separation technologies, claiming to be the most efficient and reliable in the market, were reviewed by Axens to find the most suitable solution capable of upgrading this challenging slurry oil stream. With heavy asphaltene and coke content, mechanical filtration was ruled out due to the inherent plugging characteristics. The only technology available to work in the concentrated slurry was the electrostatic separator. The electrostatic separator for slurry oil operates continuously without plugging or blockage from asphaltene with an average efficiency at the outlet of < 30ppm catalyst fines. Proven robust technologies like the electrostatic separator are needed to successfully handle the challenges accompanying high-severity processing and the need to increase profits from the bottom of the barrel.

The evolution of the refining industry is racing toward more severe catalytic cracking technologies capable of processing heavier opportunistic crudes. Refining and petrochemical integrations are leading the way for refineries to increase profits from every barrel (**FIG. 2**). The move toward implementing more severe catalytic technologies is an important step to improve refinery flexibility and profitability. ●

JET FUEL REFINING MARGINS TURN NEGATIVE AS AIRLINES GROUND FLEETS

Asian jet fuel refining margins have turned negative for the first time in more than a decade as airlines continue to ground flights on international and domestic routes amid stringent travel restrictions to contain the coronavirus pandemic.

"Global air traffic is down by about 40%–45%, according to flight tracking sources, with further deterioration expected over the coming weeks as more flight restrictions and airline capacity reductions take effect," said Richard Gorry, Managing Director at JBC Energy Asia. "We expect global jet/kero demand to fall by 4.3 MMbpd quarter-on-quarter in 2Q 2020 to just 2.5 MMbpd, representing a year-on-year decline of 5.6 MMbpd (–70%) as air passenger travel activity is reduced to a minimum."

Refining margins for jet fuel plunged to –$0.07/bbl over Dubai crude on Monday, a level not seen in the last 11 years, according to Refinitiv Eikon data.

Also known as cracks, refining margins are the difference in value between the raw material, crude oil and the products churned out by refineries. A negative jet fuel refinery margin means refiners would lose money by producing the aviation fuel at current prices, indicating they will either reduce jet fuel output or lower overall refinery throughput.

"I think the cracks haven't gone to their worst yet. Unless some vaccines come out soon, it looks like it will really take some time to recover," a Singapore-based trader said.

Australian fuel supplier Viva Energy said on Tuesday it expects jet fuel demand to plunge by up to 90%, while its peer Caltex Australia forecast a similar demand drop during the period of flight cancellations. ●

JB: First, the major trend in plastics demand is growing middle classes around the world, particularly in China and India. A huge economic momentum shift within these countries is leading to this new middle class wanting access to more products comprised of plastics. With the growth in demand, our industry must do a good job with sustainability. We must address the concerns that people rightfully have about unmanaged plastic waste.

However, you must be careful and understand the science behind a strategy on banning plastic products because the substitutes also have an environmental impact. In many cases, as was detailed in a 2016 industry report, some substitutes have a higher environmental impact than plastic.[1] We encourage people to make those kinds of decisions based on science and with all the information regarding both plastics and substitutes.

HP: How did CP Chem institutionalize sustainability within your organization?

JB: One of the simple but powerful things we did was work sustainability directly into our company's strategy. We do it in two places. First, we have a new tagline: *Performance by design, caring by choice.* Combined with the company's tagline is a direct corporate strategy of proactively helping the world find solutions to sustainability.

Secondly, we have created resources to address sustainability, along with raising the profile of sustainability to the Vice President level, with elevated sustainability positions in Asia, Europe and the U.S., as well as a sustainability technical manager and a sustainability policy and program manager, among others. This program is not housed only in the sustainability group. The leadership team at CP Chem has a clear interest in this issue, as well as operations teams at all of our company's process plants.

Sustainability has drawn lots of interest from our employees, as well. They are excited about it and have had many questions on the issue, such as: What is the company doing about sustainability? To educate our personnel, the company's communications and sustainability teams developed an information package called Plastics and You.

HP: What will it take to solve the problem of plastic waste in our lifetime?

JB: That is a big question—one that does not come with a quick answer. I can tell you some of the things that have to be done. Those include:

1. We need to clean up the waste that is there now. This is one area where the AEPW is focusing its efforts.
2. Infrastructure. Different parts of the world are at very different stages in dealing with plastic waste. Many places around the world—primarily in Africa and Asia—do not have the infrastructure to deal with plastic waste. For example, it is not an issue of somebody not wanting to place their waste in a trash bin—they may not have trash bins. If they have trash bins, they may not have anywhere to take them or a system in place to manage waste removal. We must further develop infrastructure in countries that do not have it. In developed regions such as Europe and the U.S., the infrastructure could be more robust in terms of collection and sorting.
3. Innovation. As previously mentioned, chemical recycling is fairly new in the world of sustainability. Chemical recycling plants are very small and very entrepreneurial. Our industry needs to find a way to scale up these production plants. How do you make this on a much larger industrial scale? How do you make it more efficient and reliable? All of those things will need to happen to grow the chemical recycling industry. A lot of innovation is being fostered. Take product design. How do you make products that are more recyclable? Many consumer product companies and converters are working hard on this challenge and trying to find a solution that will retain the properties, while making it more recyclable. It is a crucial engineering challenge. Another area needing innovation is sorting material for mechanical recycling. An efficient mechanism needs to be put in place. New techniques are happening, but more innovation is needed.
4. Consumer education. This solution is not only about educating the consumer on recycling but also how to recycle and the products that are recyclable. Many nations around the world will need significant education on recycling. Ultimately, education will make the consumer part of the solution.

It will be a long process, but it is a problem that is solvable. We are an industry of problem solvers. The issue of sustainability is squarely on the radar screen for companies and people around the world. We have, and will continue to see, significant progress in this area. It is a problem that our industry, along with others, can solve, which will change the world for future generations. ●

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Coarse filtration: The "first line of defense" for oil and gas processes

D. WILLIAMS, R.P. Adams

For the oil and gas industry, coarse filtration of various fluids is critical to ensure reliable production, extend the life of a wide variety of upstream and downstream equipment, and increase the intervals between backwashing or necessary maintenance.

Upstream, production wells often use coarse filtration (from 30 microns–100 microns) to remove sand, solids or debris during secondary phase waterflooding, where clean filtered water is introduced into a rock layer through injection wells to push residual oil to operating wells.

Deepwater rigs may prefilter seawater to remove solids before further filtration for uses ranging from enhanced oil recovery to heat exchangers, to producing potable water.

Upstream, when oil is produced, liquid separation is used to separate produced water from the oil. Coarse filtration may be needed during the produced water treatment.

In downstream applications, coarse filtration may be 125 microns–3,200 microns. Refineries often prefilter raw water from lakes, rivers and aquifers to remove organic, aquatic and other solids, which allows fresh water to be used as process and cooling water. In cooling towers, filtration can improve cooling efficiency while reducing fouling and plugging. In process equipment, the removal of suspended scale and debris from heat exchangers and cooling systems can prevent the clogging of equipment and nozzles.

Without adequate coarse filtering of process fluids, oil and gas systems can be susceptible to expensive damage from large particulates. Raw or produced water that is inadequately pre-filtered can cause excessive fouling, leading to decreased production as well as costly, premature replacement and unscheduled production downtime.

Fortunately, a growing number of oil and gas industry professionals are ensuring more reliable production with superior water or process fluid quality by using low maintenance, multi-element, automatic self-cleaning strainers. This approach provides a more effective first line of defense against equipment damage and downtime.

Optimizing process reliability and production. Historically, the oil and gas industry has utilized certain types of sand or media filters, centrifugal separators and basket type strainers for coarse filtration. However, in many cases these have a number of shortcomings, including susceptibility to fouling and damage, which can require frequent cleaning, maintenance and early replacement.

Whether for upstream or downstream processes, the industry wants to keep production going 24/7. The goal is to avoid equipment damage, process interruption and having to pay maintenance technicians to open up filters for cleaning when they get dirty.

In response, many oil/gas industry professionals now rely on multi-element, automatic self-cleaning strainers like those from R. P. Adams (**FIG. 1**). The company first introduced and patented the technology in the 1960s and has more than 10,000 installations worldwide today.

This design provides an alternative to sand and media filters, centrifugal separators and basket type strainers. Unlike those designs, the multi-element, automatic, self-cleaning strainers can provide continuous removal of suspended solids. When utilized as the "first line of defense" for oil/gas water or fluid filtration, the strainers can reliably filter out sand, silt and other suspended solids as small as 30 microns–100 microns in size.

Design features. A significant feature of the multi-element design is in the engineering of the backwash mechanism, which enhances reliability. With many traditional strainers, the backwash mechanism comes into direct contact with the straining media. This can be problematic, as large, suspended solids often encountered with raw or produced water can become lodged between the straining media and the backwash assembly. The result is straining media damage and/or rupture that can compromise filtration and even other downstream equipment, hindering production. Instead, the multi-element design utilizes a tube sheet to separate the straining media from the backwash mechanism. This prevents the backwash mechanism from coming into contact with the media and damaging the elements.

Oil/gas industry operators often also need to consider how to best reduce membrane fouling and required maintenance. However, traditional strainers, due to limitations in straining area, can become clogged quickly. When that occurs, cleaning, media replacement or backwashing is necessary, adversely

affecting productivity as well as maintenance costs. In this regard, the multi-element design provides three to four times the surface area of traditional strainers and pre-filters. This translates directly into less frequent backwashing so less water goes to waste, less power is consumed and less maintenance is required.

While traditional media found in large basket designs can lead to collapse and failure under differential pressures as low as 35 psid, the smaller diameter of the media used in the multi-tube strainers also enables the strainer to safely handle differential pressures in excess of 150 psig. This protects production even under higher differential pressures in the field, which could otherwise result in significant downtime.

As an additional protective measure, the strainers also include a shear key, which sacrifices itself in the presence of excessively large debris. So, if large debris were to cause mechanical problems within the strainer, the shear key breaks, protecting the unit's rotating assembly, motor and gearbox by halting the drive shaft rotation. Filtration continues, but operators notice an increase in differential pressure as the backwash cycle is interrupted and can act to clear the obstruction and replace the shear key.

For oil/gas environments exposed to highly corrosive elements like seawater or salt spray, upgrade options to materials such as super duplex and duplex stainless steels, titanium, Monel, Inconel and Hastelloy can also provide further resistance to corrosion and corrosion-related damage.

When considering technology for oil/gas course filtration systems, automatic multi-element, self-cleaning filters are an increasingly popular choice and a reliable, cost-effective solution. ●

DEL WILLIAMS is a technical writer for R.P. Adams, a Buffalo, New York-based manufacturer of durable, low-maintenance industrial filtration equipment and engineering solution with more than 80 years of experience.

FIG. 1. Multi-element, automatic, self-cleaning strainers like those from R. P. Adams can help oil and gas industry professionals ensure more reliable production with superior water or process fluid quality.

CHEVRON LEADS ANOTHER WAVE OF MASSIVE OIL INDUSTRY SPENDING CUTS

Chevron Corp. has cut its capital spending budget by $4 B, leading a wave of cost-cutting announcements across the reeling oil-and-gas industry as the coronavirus pandemic has slashed demand and triggered a dramatic slide in oil prices.

Crude oil prices have crashed by 60% since January as Saudi Arabia and Russia pump full bore to grab share in a dwindling market, and gasoline and jet fuel use has slumped. Demand worldwide is expected to fall by more than 12 MMbpd, more than 10% of daily demand.

The reset is being felt across the industry, as Chevron was joined on Tuesday in reducing expenses by Schlumberger, the world's largest oilfield services company, independent refiner Phillips 66, and Canada's Suncor.

"This is as unprecedented an oil price environment as I can recall seeing," Chief Executive Michael Wirth said.

Chevron will spend $16 B this year, down from a planned $20 B, halving its spending in the Permian Basin, the top U.S. shale field. It is the lowest spending level for the company since 2005. Chevron now expects to pump about 125,000 fewer bpd oil and gas in the Permian Basin by the end of this year, down 20% from its 600,000-bpd target.

This is the first indication from an oil major of how sharply it would pull back in the Permian, which has made the U.S. the world's largest oil producer.

Chevron will cut $2 B from its Permian spending, from an expected pace of about $4 B/year. ExxonMobil, the largest U.S. oil company, has also vowed to make significant cuts this year. ●

The skeptic's guide to ORM digital twin

S. LEHMANN, Sphera

Unless you've been sleeping under a rock for the past couple of years, you couldn't help but hear about "digital twins." Lately, there has also been more talk about more specialized digital twins, known as operational risk management (ORM) digital twins.

Digital twins are the future, and the future is now. Their promise and potential are possibly unrivaled by anything except artificial intelligence (but that's for another piece). With every hyped article, vendor marketing piece and technology prediction we read, there are seemingly endless reasons to jump on the bandwagon. Otherwise, as we're told, our company is going to be "disrupted," and we might even become the next Nokia or Blockbuster if we don't. Hey, there's still a Blockbuster doing business in Australia, right?

Maybe we should be looking at this from the opposite and a somewhat-more-skeptical perspective that strips away all the hype and asks a few basic questions:

- What is an ORM digital twin?
- Why should you care?
- How can it help your organization?

These questions should be addressed one at a time to better understand how an ORM digital twin can practically and tangibly improve operations.

FIG. 1. An ORM digital twin provides a single, shared view of the operational reality and enables personnel to make better operational decisions to proactively manage risk and activity.

What is an ORM digital twin? An ORM digital twin is like all digital twins in that it is a virtual, digital counterpart of a real object, which enables other software, systems and operators to interact with it directly while bypassing the real object.

A digital twin must include:

- A unique model of the physical asset
- Data generated by the asset from multiple sources
- The ability to monitor the asset in real time
- Dynamic visualizations
- The ability to simulate "what ifs," "trade-offs" and/or "simulations" without affecting the live plant.

An ORM digital twin specifically provides a single, shared view of the operational reality (**FIG. 1**) to know what's happening, where it's happening, when it's happening and what's driving the risk so you can understand the trade-offs and make better operational decisions to proactively manage risk and activity.

Why should you care? If you think about it, the operational risk landscape of our assets changes as fast as the operational reality, which likely happens on a daily basis. Since the day the asset became operational or the last process hazard analysis (PHA) or periodic safety review was completed, its process safety risk exposure began to change. The real world of operations is neither simple nor static. When our well-designed and well-specified processes and equipment enter service, things begin to change. Our assets age; we intervene to maintain them; and changes happen.

These changes can include impairments to equipment running outside their normal operating parameters; operations activities such as equipment startups and shutdowns; or even the hazards we introduce into the plant as a result of maintenance and/or permitted activity, such as doing hot work, breaking containment, isolating a piece of equipment, or even deferring safety critical maintenance and inspections.

These and other potentially daily occurrences affect the process safety risk of our assets. Unavoidably, these risks are often managed in different parts of the organization. With siloed information, the dots are not con-

nected and often decisions are made without the full context.

Not getting it right can have real consequences, including systemic operational inefficiencies related to extended idle time for crew and contractors, safety incidents and regulatory fines, and unplanned downtime.

How can an ORM digital twin help your organization? An ORM digital twin can provide the right insight, to the right people, at the right time to facilitate the right decisions. Commonalities to most organizations in hazardous industries are discussed here.

Proactive risk mitigation and management. If operators and their supervisors can better understand how the state of the plant might affect the job they're about to do and how it might affect the state of the plant, they can make better operational decisions that proactively mitigate risk. Imagine a required external vessel inspection in a specific area of a plant where plant conditions are outside normal operating parameters.

An ORM digital twin can provide an operator and/or a supervisor with dynamic visualizations of how the planned activity and equipment impairments come together to affect risk in an area of the plant. They can see a potential risk pathway developing, which means that the likelihood of a fire or explosion hazard is potentially increasing. As a result, they can make better, more-informed decisions about how to proactively mitigate and manage the risk impact of live activity in a live process plant, or even defer the work.

Ensure the schedule is executable. Typically, the schedule that operations receives from the maintenance management system isn't executable "as is" because it needs to be balanced against all other activities, the safety dependencies needed to do the job, plant conditions, location hazards and risk on the live plant. An ORM digital twin can provide the operations supervisor with dynamic visualization of all the live and planned activities, as well as the equipment impairments in time and space and with regard to cumulative risk to better balance risk against productivity. This allows the operator to get more of the right things done safely and efficiently. That can be accomplished by:

- Accounting for all safety dependencies required to execute the activity [e.g., permit to work, isolations and lockout/tagout (LOTO), certificates, other tasks]
- Understanding and dynamically managing simultaneous operations (SIMOPS) and conflicting activities
- Ensuring work is done in the "correct order or sequence"
- Managing the dynamic of the day better when things don't go according to plan.

Improve maintenance prioritization. An ORM digital twin can help improve maintenance prioritization and effectiveness and, ultimately, asset uptime (**FIG. 2**). By providing better context around the major hazard risk impact of the maintenance backlog and how it may be forcing operations to expend extra effort to "work around" the consequences, organizations can move beyond "who shouts the loudest" and what the "the shiny stuff" priorities are and ensure that risk becomes a key factor in decision-making.

An ORM digital twin makes major accident hazard risk exposure visible, prominent and available in real time. You can practically and tangibly connect process safety management to operations. The operator, with a wrench in hand about to open a vessel, can now understand how the state of the plant could affect the job about to be completed and how that job could affect the state of the plant. Ultimately, an ORM digital twin is more than just cool technology; it's a decision support tool that allows workers to better understand the trade-offs we can make to ensure that proactive risk mitigation is an integral part of safe and effective operations. ●

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FIG. 2. Maintenance prioritization and effectiveness and, ultimately, asset uptime, are improved with the utilization of an ORM digital twin.

Making sense of ESG: A focus on downstream applicability

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In his annual letter to CEOs for 2020, Blackrock CEO Larry Fink declared, "The investment risks presented by climate change are set to accelerate a significant allocation of capital." BlackRock, one of the largest institutional investment banks in the world, is making sustainability front and center for how it manages risk, constructs portfolios and engages with customers. According to a survey conducted by *The Harvard Business Review,* 70 senior executives from 43 global institutional investment funds, including BlackRock, Vanguard and State Street, said that environmental, social and governance (ESG) issues were top of mind. This should be a wake-up call to the downstream energy sector for more companies to focus efforts on sustainability.

The growing importance of sustainability. The external pressure to act is gaining momentum. Not only are external investment firms focused on ESG, but shareholders are also expressing concern about the importance of sustainability. For instance, a Morningstar analysis revealed that, over the last 16 years, the level of shareholder support of sustainability measures has increased from 10% to 29%. Proxy voting has trended towards shareholders expressing their views for greater inclusion of management that share sustainability goals and objectives. The study indicates that, given the difficulty in getting new resolutions on the ballots for voting, the fact that roughly one-third of shares were voted in support of ESG is significant. Companies must pay attention and heed these concerns.

However, does sustainability mean that investors can no longer include downstream companies in their portfolio? The answer is a resounding, "No." The simple evidence here is that BlackRock still includes ExxonMobil in its iShares ESG MSCI USA ETF fund. The reality is that investment funds are an indication of balancing risk and reward. Therefore, if a company does well in two of the main categories of ESG, it still may be included and have a high sustainability rating. Portfolio managers must continue to strike a balance with investing in a diverse portfolio of companies.

Diverse framework. How does this translate to the downstream energy sector? The conclusion to be drawn is to adopt a focus on sustainability and ESG strategies within the company. A downstream company doesn't have to drop their use of fossil fuels and suddenly shift to 100% renewables to be sustainable. Rather, the company must adopt a framework to report on the wide diversity of its ESG initiatives across the company. The reality is that, today more than ever, investors and shareholders are scrutinizing businesses and their practices. Therefore, the more transparent a company can be to emphasize what it is doing to contribute to the larger sustainability goals, the better it will compare against its peers.

The guidance on voluntary sustainability reporting provided by the American Petroleum Institute (API) in 2015 still rings true today. Companies should use the sustainability guidance report to engage with stakeholders over issues that are material and mutually critical to both the company's value chain and the stakeholders where they operate: environmental, health and safety issues, and social and economic issues. Shareholders want to see action and work toward sustainable goals.

However, adopting a transparency model focused on reporting ESG characteristics within a company is easier said than done. Take a lead from "first movers" within the energy sector that have already compiled annual sustainability reports and developed internal processes around them. Also, look to the coalition of CEOs that formed the Oil and Gas Climate Initiative. This initiative focuses on three main areas: reducing the energy value chain footprint, accelerating low-carbon solutions and enabling a circular carbon model. This initiative is tackling large energy issues and focusing its efforts on what it views as three critical areas where the coalition can make an impact on sustainability in the long term.

Moving forward. Reflect on your business operations, your strategy, where you operate and your overall value chain. Next, examine stakeholder groups and communities in those areas. Identify material concerns, using the lens of ESG that would overlap between the company, its operations and the communities where it operates. Establish a governance process internally that allows for stakeholders to bear witness of the efforts underway and targets directed towards sustainability.

Is a 1% cut enough? Should it be 5%–10%? How close is this to the Paris Climate Agreement? What do regulators think? How will investors view the company with this increased transparency?

There are no easy answers here. Companies must establish a baseline based on data by which they can consistently, efficiently and, with proper processes, report on efforts to attain sustainability goals. No one answer for one downstream company will be the same answer for a similar company operating in a completely different location. Know your stakeholders and use the reporting to open communication with a diverse group: activists, community leaders, politicians, regulators, investors, shareholders and employees, to name a few.

Avoidance and non-action are not effective strategies. The trend is that sustainability concerns, investor concerns and outside pressures are here to stay. The pressure to act will only increase, especially for those that don't yet have a constructive dialogue with their investors, communities where they operate, internal employees and shareholders. ●

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based on the size of a gas processing facility and the number of OEM packages needed for integration. However, even in a small, 15-package facility, the slippage risk could be reduced from 40 d to 10 d, while realizing hundreds of thousands of dollars in cost savings. Most importantly, by reducing the potential for integration delays, the likelihood of multimillion-dollar production delays can also be reduced.

The benefits of an OEM MAC extend far beyond startup. Worker training can be simplified, and spare parts can be greatly reduced, as equipment is standardized. Instead of technicians using multiple work stations and multiple technologies to resolve issues, they can use one station and work with the same technology every day.

OEM MACs at work. Gas processors are taking advantage of OEM MACs to keep project startups on time and on budget. In one case, a leading energy producer turned to an OEM MAC to support the launch of three gas processing plants to provide 1 Bft^3d of capacity. The OEC MAC was hired to engineer, procure and manage the control systems, safety instrumented systems and interfaces to the OEM skids in each facility. The company was also involved throughout the project, from the FEED to the FATs to plant commissioning and startups.

In the end, the OEM MAC helped the company deploy all three plants at 10% under budget and 5%–10% ahead of schedule, depending on the plant. More than merely supplying control technology, the OEM MAC provided key benefits like cleaner technology integration and an accelerated project schedule.

In another project, the same OEM MAC was hired to provide a robust SCADA system for an LNG terminal upgrade. The role included project planning, execution of a phased delivery approach and development of strategies to minimize integration issues with third-party equipment.

The OEM MAC provided the SCADA system and the overall project's system design, including network design, cybersecurity policy implementation and server virtualization. It also managed the cabinet build and conducted a full, integrated FAT.

A paradigm shift. Integration challenges that are common today in project startups do not have to be the norm. System and equipment integration for a new gas processing facility can be a far more seamless and painless process when working with an OEM MAC—specifically, a MAC that has the right people, infrastructure and technical and industry know-how.

This change in strategy can save valuable time and money—and it can help commissioning engineers sleep better at night. ●