

Growing the fuel pool

Whether refiners like it or not, the drumbeat for renewable fuels grows daily. The building momentum for such fuels is boosted by government mandates and regulations. Unfortunately, the tidal wave for renewables is barely hindered by rational objections pointing out that these new fuels have low BTU content and questionable greenhouse gas (GHG) emissions savings when compared to petroleum. Still, renewable are the future and it is important for the refining industry to understand them and read the tea leaves governing where renewable fuels standards will be taking us in the future.



Dr. Jennifer Holmgren

Assisting Q&A attendees with such daunting analytics was Dr. Jennifer Holmgren, CEO of Lanzatech Ltd. Dr. Holmgren was the keynote speaker during Tuesday's general session and she helped all in attendance better understand the need for growing the fuel pool.

"By 2030, 30% of the fuel pool needs to be at zero carbon fuel," Dr. Holmgren said. "When you look at the driver for low carbon fuel, how do you get there from here?"

Several drivers for alternative fuels include energy security, the desire to mitigate GHGs and rural job creation (because it is necessary to plant, grow and harvest these fuels, jobs in rural America are created).

The Energy Independence and Security Act (EISA), signed into law in December 2007, significantly increased required volumes of renewable fuel.

"We went from 7 billion by 2012 to 36 billion gallons by 2022," she said.

The legislation separates the volume requirements into four separate categories of renewable fuel: cellulosic biofuel, biomass based diesel, advanced biofuels and total renewable fuel. Out of these categories, there are different production requirements for each. Biomass based diesel is expected to achieve 1 billion gallons by 2012 and beyond. Biodiesel is considered "renewable diesel" if not co-processed with petroleum. Meanwhile, cellulosic biofuel is looking at a required 16 billion gallons by 2022. This second edition of renewable fuel standards also mandates that 21 billion gallons must be total advanced biofuel by 2022.

The ethanol blend wall. Previous analyses were based on an assumption of 36 billion gallons of ethanol by 2022, to be used as E10 and E85 (E85 would be in very small volumes). By 2013, the EPA expects that all gasoline in the US will be E10, with 14-14.5 billion gallons of ethanol being used in E10 form. Basically, ethanol demand is maxed out at the current 10% blend rate and production has hit a ceiling. So, unless either gas demand increases or the blend rate goes up, there's just no need for any more ethanol at the pump. However, some at the USDA are advocating for increasing the blend rate and are trying to convince the EPA to up the rate to 15%.

Lifecycle of GHG emissions. Lifecycle GHG analysis is integral to the new renewable fuel standards. This analysis is used to categorize fuels, not to value them.

"The term lifecycle GHG emissions means the aggregate quantity of GHG emissions as determined by the Administration, related to the full fuel lifecycle," Dr. Holmgren said. "The mass values used to account for all

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GHGs are adjusted to account for their relative global warming potential."

The lifecycle GHG emissions classification is a big issue for plant-based renewables that require a lot of fertilizers. Under this school of thought, nitrogen is more harmful to the atmosphere than CO₂. Therefore, fuels that utilize nitrogen fertilizer to create them are weighted more heavily. The EPA is currently mulling over how best to do these analyses.

"Forests are the lungs of the planet," Dr. Holmgren said. "If you end up changing the use of the land, like by planting soybeans on what was once a forest, you are losing lots and lots of carbon reduction possibility."

Emphasizing her point, Dr. Holmgren noted that depending on the impact of global deforestation, it will take up to 40 years of biofuels to make it up ground that has already theoretically been lost. The whole forests to soybeans discussion is an example of what is called indirect land use change. But indirect land use change is a tricky concept. For instance, if one is using a soy field to make a biofuel, the classification might be okay because the field in question was always a soy field. The problem is if the soy was exported and used as food and it is now being used as fuel, food consumers are affected by indirect land change.

Production efficiencies still need to go up considerably for biofuels to be viable. One example Dr. Holmgren

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Taking advantage of leading edge solutions to automate workflows

Emerging technologies offer refiners significant opportunities to fundamentally improve their automation landscape. Randy Hoppe, Microsoft, parsed this concept in great detail during his Tuesday morning presentation to the Plant Automation plenary session. To start the discussion, Mr. Hoppe reviewed trends the hydrocarbon processing industry (HPI) is facing. These trends have helped drive evolution of how data

is handled across data infrastructure. Some of the trends affecting the HPI include a shortage of skilled resources, a complex regulatory environment, a convergence of IT and operations, shifting locations and business models, advancing user experiences and sustainability.

Architecture evolution. In most cases, architecture has evolved to address certain business needs. Now in the 2000s, highly intensive web applications that are driving our business, Mr. Hoppe said. Some examples of the evolution include how storage has changed and inputs/outputs have changed.

Mr. Hoppe believes benefits to businesses have been driven by technology. Users are now empowered with familiar tools that offer unmatched computational power and advanced analytic expressions. These tools can now be accessed on your desktop, through the web and in hand held devices. Technology has also improved organizations by providing business insights to all

employees, which leads to better, faster and more relevant decision making.

Some game changing technologies that Mr. Hoppe discussed included high performance computing, advanced collaborative technology, personal business intelligence, unified communications, complex event processing and cloud computing. These game changers can allow for the monitoring of manufacturing data from multiple sources for meaningful conditions almost instantaneously. With complex event processing, queries can be solved rapidly. Unified communications allows users to seamlessly interact with colleagues both inside and outside the organization.

Then of course there is cloud computing. A key component of Microsoft's "plus" services, cloud computing allows for immense scale and the management of immense capacity projects in a cost effective manner. It allows users to focus on running a business and not on extending the technological backbone of their company's architecture.

The idea of personal business intelligence has allowed users to use familiar tools like Excel and add ons like Power Pivot to do some pretty remarkable things. This concept is based on the idea to be able to personally pull in data and do meaningful analysis on it outside of the confines of what an organization would traditionally provide via IT services. Mr. Hoppe asked his audience to imagine pulling massive data volumes to a spreadsheet. With Excel and the Power Pivot add on, he has seen spreadsheets of 12 million rows that users can slice and dice, changing criteria within seconds.

Complex event processing. Complex event processing (CEP) is the continuous and incremental processing of event streams, from multiple sources, based on declarative query and pattern specs, with near zero latency.

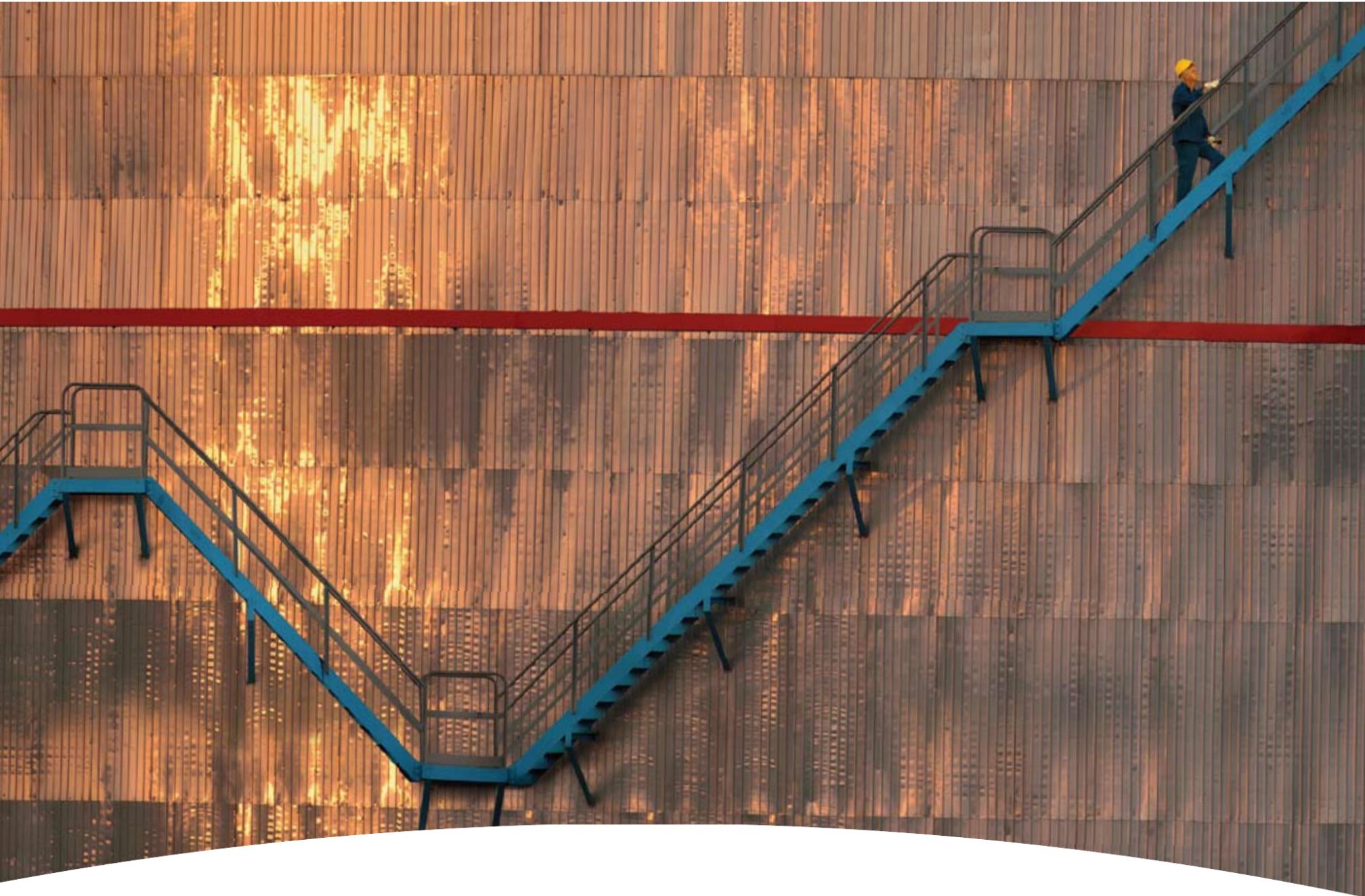
"What it means, is that CEP processes a lot of data from many sources really fast," Mr. Hoppe said.

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Randy Hoppe, Microsoft

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Schedule of sessions and special events

Wednesday, October 13, 2010

7:30–8 am	Early Bird Coffee and Rolls
7:30–10 am	Registration
8–11 am	FCC Principles and Practices
8–9:30 am	Plant Automation: Emerging Technologies Session (Part I) <ul style="list-style-type: none"> • Managing Environmental Emissions in the Hydrocarbon Industries, <i>David Ruger</i>, Honeywell • Virtualization for Operations Management, <i>Asa Queen</i>, Valero Energy, and <i>Nena Fremin</i>, Aspen Technology • Distillation Column Flooding Predictor, <i>George Dzyacky</i>, 2ndpoint, LLC
9:30–9:45 am	Coffee Break
9:45–11 am	Plant Automation: Emerging Technologies Session (Part II) <ul style="list-style-type: none"> • Application of Semantic Data Management for Process and Asset Integrity Excellence, <i>Andrew Nelson</i>, Matrikon • Procedural Automation: Improving Consistency and Production, <i>Tom Williams</i>, Honeywell • Closing Comments

Q&A and Technology Forum Conference news

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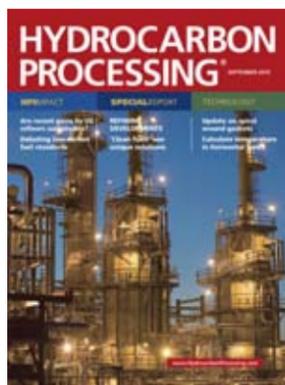
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First industrial-scale MOF synthesis

Natural gas-powered vehicles may soon be able to travel double the distance on a single tank—due to metal organic frameworks (MOFs). BASF research scientists have developed an innovative method for solvent-free industrial-scale manufacture of those materials for better gas storage. MOFs produced by the new method are being trialed for natural gas storage in heavy duty vehicles.

With their special structure and large surface area, MOFs open up new opportunities for alternative propulsion systems, in catalysis, as nanoreactors, and in drug delivery, making them hugely interesting both for industry and university research.

BASF has been working toward industrial-scale synthesis of metal-organic frameworks for the past 10 years. MOFs are highly crystalline structures with nanometer-sized pores that allow them to store hydrogen and other high-energy gases. The larger specific surface area and high porosity on the nanometer scale enable MOFs to hold relatively large amounts of these gases. The pores are adjustable in terms of size and polarity and so can be fine-tuned for specific applications.

Used as storage materials in the natural gas tanks of municipal utility vehicles MOFs offer a docking area for gas molecules, which can be stored in higher densities as a result. The larger gas quantity in the tank increases the vehicle's range. ■

News in brief

Foster Creek receives approval to expand oil sands production

Cenovus Energy Inc. is moving forward with the expansion plans for its Foster Creek oil sands operation after receiving regulatory approval from the Alberta Energy Resources Conservation Board (ERCB). The approval covers three phases of expansion (F, G and H), which are expected to increase Foster Creek's production capacity to 210,000 bpd from the current 120,000 bpd.

"The regulatory approval of these expansions at Foster Creek is another milestone reached in Cenovus's efforts to expand production and increase net asset value," said Brian Ferguson, CEO of Cenovus. "With these approvals, we believe there is a step change in the value of this project as there's increased certainty around the schedule and timing of the expansion."

Each of the three phases that have been approved by the ERCB is designed to add an additional 30,000 bpd of oil production capacity to the Foster Creek facility. The next step for the expansion project is to receive endorsement from the Foster Creek/Christina Lake partnership with ConocoPhillips.

Engineering on phase F is already underway and preliminary ground work is expected to start soon. Additions to plant infrastructure will happen first, followed by pipelines and well pads. Cenovus

expects to employ about 1,000 people to complete phase F. First production from this phase is anticipated in 2014 and the other two phases in 2016–2017.

"In addition to expanding our current operations, our teams are working hard to prepare for regulatory reviews of several new, additional projects," Ferguson said. "We anticipate our combined expansions to result in a five-fold increase in our oil sands production by the end of 2019."

Willbros granted an EPC contract with Diamond Shamrock

Willbros Group, Inc. has been selected by Diamond Shamrock Refining Co. to provide engineering, procurement and construction (EPC) of the new flare gas recovery facilities at the Valero McKee refinery located in Sunray, Texas. The project is valued at approximately \$14 million.

"We are pleased with this award and look forward to executing this critical project for the Valero McKee refinery," said Jim Gibson, president of Willbros Downstream Oil & Gas. "Through our InServ and Wink Engineering business units, we have the ability to provide integrated project management, engineering, procurement and construction solutions that add value for our customers. We view this assignment as an indication that our service offering is aligned with our customer needs." ■



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Production optimization of energy use in distillation operation

According to the Department of Energy (DOE), there are over 40,000 distillation/ fractionation columns in North America consuming about 40% of the energy usage in the refining and bulk chemical industries and 19% of the total energy is used in manufacturing plants in the US. Using energy properly in distillation columns is important.

During Monday afternoon's plant automation session, Doug White, Emerson Process Management, discussed some general approaches to sav-

ing energy in fractionation/ distillation through improved control. He also presented techniques for economic analysis that recognize the non-linear character of distillation operation and the effects of product blending.

Normally, a company starts with a product variation, reduce the variation and improve the profit by changing the control, moving closer to the limit – but, when is this valid and when is it not?

Dr. White started with some statistics, looking at the product composition vs.

time (represented in a histogram). The frequency of occurrence vs. composition, assuming statistical distribution, was plotted on a Gaussian distribution graph (Fig. 1).

When there's better control when does it result in an economic improvement?

The distribution is mapped over the expected function and is at the peak of the Gaussian distribution and it gives an expected value for the production (Fig. 2.) Now, a better job of control is done, distribution is tightened, but the graph shows that the product value did not change. If you have a linear objective doing a better job in control does not change the economic value. It only changes the value when you move the average closer to the limit of the curve (moving in the direction of improved economics).

It was found that for nonlinear relationship, the expected value of the energy cost is NOT at the value equivalent to the median of the composition. Its value depends on the standard deviation of the composition.

Some of the cases that Dr. White worked on included tiered product price-

ing which proved that optimum composition target may not be at the maximum impurity limit; optimum energy usage depends on energy pricing and may shift from constrained to unconstrained; even with product blending there is an incentive for better control performance; minimizing pressure continues to have value for many separations; and high purity columns often have non-symmetric compositional distributions requiring special statistical analysis beyond Gaussian distribution assumptions.

The effects on non-linearities in distillation, both in the response of typical columns to changes in operating conditions and in common economic valuation functions can have significant impacts on the economic optimum energy usage in the column. If the economic valuation is non-linear, then the optimum setpoint that maximizes profitability depends on the control variance achieved. A reduction in the standard deviation of control can have a positive impact on the expected operating margin of the column, in contrast to the case of a linear objective function.

If the energy price is high, the optimum reflux is the minimum that just allows the column to maintain both products in specification. However, if the price is lower the optimum is actually unconstrained. It may be more profitable to operate the column at impurity levels less than the actual limit. Reducing pressure can have a significant impact on overall energy costs at constant separation. The impact should be checked via simulation initially and then pressure reduction control strategies implemented. ■

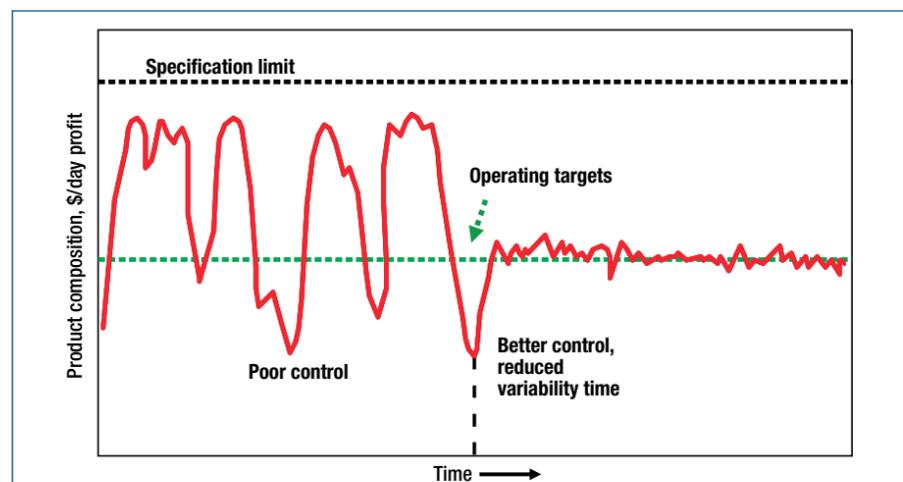


Fig. 1. Traditional control benefit analysis.

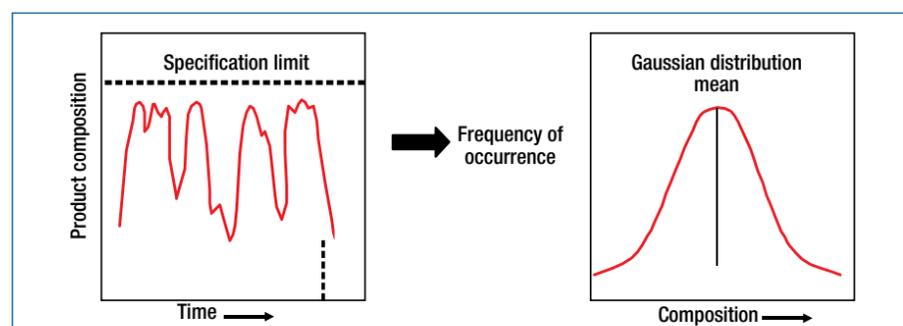


Fig. 2. Representation of variability.



Doug White, Emerson

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offered was that one acre of land produces 80 gallons a year of soybean-based diesel. Ethanol numbers are a little higher, but still, you are talking about 600 gallons per acre and when you adjust for the BTU content you could end up about the same. So, the productivities are not huge.

"You'll end up having to plant entire continents to meet the mandate," she said.

Technology solutions. From near term (ethanol, biodiesel) to long term (synthesis gas, algae), technology will be playing the defining role in the success or failure

of biofuels. Dr. Holmgren thinks pyrolysis oil stabilization has a lot of potential.

"If you are going to move biomass far it is hard to do because you are moving 40% water as opposed to a dense concentrated liquid like petroleum crude," she said. "Can you make cellulosic waste look more like oil? The possible solution is pyrolysis."

Dr. Holmgren also advocated for gasification, because you can start with a variety of feedstocks, get them into a syngas form and then all of processing is the same at that point. She also pointed out that the

reason it so difficult to convert biomass is because Mother Nature spent a long time figuring out how to put it together.

Summary. Global legislation is driving the inclusion of alternative fuels in to the transport pool. Dr. Holmgren said it is important to promote technology neutral and performance based standards and directives to avoid standardization on old technology. She thinks that global partnerships between industry, academia and government are required to create a successful outcome. ■

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CEP is a computation that deals with simple or complex events by calculating totals, averages or other aggregative functions, allowing users to predict events and trends. CEP often used to increase situational awareness and for high frequency data collection. CEP can integrate high speed data values and be used for continuous time windows. It is also valuable within data cleansing, with diagnostic information analyzed to call out suspect data. Plus, technologies associated with CEP allow for a quick determination of situational awareness of a given operating environment.

Collaboration. Over 75% of respondents to a recent Microsoft survey

reported that they spend 1–2 hours a day collaborating with colleagues. Barriers to successful collaboration include finding the right resources within organization, knowing availability of the right resources to help solve the problem and access to the right resources due to geographical constraints.

"There is a driving need to collaborate in increasingly efficient ways," Mr. Hoppe said. "Today's collaborative technologies can often overload users through the sheer number of devices and applications. But some technology can help reduce complexity and simplify the collaboration process."

To this in, Mr. Hoppe noted that through unified communication, users

can have one ID and login for all devices (phone, cell, Internet, computer, etc). Rather than invest in expensive and redundant infrastructures, unified communication allows for the use of software for more effectively. It transcends geographic boundaries so users can stay in touch no matter where they are in the world. It allows people and systems to communicate across the spectrum.

Cloud computing. Xbox Live is a cloud service. So is Hotmail. Cloud computing is not a particular new concept, in fact, it has been around over last decade. Within that time period, computer infrastructure has moved from centralized to highly decentralized. In the

past, computing infrastructure was optimized for efficiency. Then it was for agility. And now it is optimized for both.

In the computing world, things are moving from high up-front costs to more of a pay-as-you-go model.

Some business impacts delivered through cloud computing include improved economics and reduced management by letting others handle the chores of patching, maintaining and deploying systems. Cloud computing also moves upgrade cycles from 3–4 years to one of continual upgrades. For at least the next decade it is envisioned that organizations will implement cloud solutions in a hybrid manner to satisfy different business requirements. ■

When the right reaction matters ...

The petroleum refining landscape is constantly evolving through changing crude slates, shifts in refined product demands, and the necessity to produce more from existing assets. In the face of these challenges, BASF offers innovative solutions. If you are looking for a catalyst supplier whose technologies and services will enable you to make more of the products you want with enhanced operating flexibility, look no further than BASF. Trust BASF FCC Catalyst Technologies and Services to deliver innovation, value, and performance to your refinery.

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Advances in scheduling are helping to reduce costs

S. ROGERS, M3 Technology

In recent years there have been substantial improvements in scheduling technology. These advances are being implemented by oil and gas companies around the World to respond to the challenging global economy by reducing costs and improving their agility and customer service.

The first attempts to solve the refinery scheduling problem in oil refineries had very limited success because they were too complicated, difficult to use, slow and hard to maintain. This was because of the limitations in information technology and computers of the time and because of the approach taken. In general the industry tried to extend linear programming optimization technology, which had been extremely successful in planning, to the scheduling problem. However the scheduling problem proved intractable to optimization solvers. And the resulting applications were effectively a black box which made it difficult for the users to interpret the results and to try alternative schedules.

As engineers became powerful users of spreadsheets they used them to help schedule a wide range of assets such as

refineries, gas plants and petrochemical sites. These Excel applications had the advantage of being extremely transparent to the users (i.e. a white box). They were interactive allowing them to leverage the knowledge and intelligence of the schedulers to find a number of feasible solutions and to select the best one. Many companies still use Excel based applications to solve a wide range of scheduling problems. However they require a high level of knowledge to use and maintain. They do not easily support collaboration or integration with other applications. And they have a limited user interface and poor modelling and reporting capability.

The first wide spread, successful implementations of dedicated scheduling applications in oil refineries were in the 1990's. The success was due to advances in personal computing and a change in approach. The refinery scheduling problem was broken down into smaller problems and an interactive (white box) approach was taken to use the knowledge of the scheduler to find a feasible rather than an optimum schedule. This mimicked the spreadsheet applications that

were being widely used. Although these applications were more successful they were still slow, difficult to integrate and had no optimization capability. Separate applications were developed for product blend optimization which required integration with the operations scheduling applications and a separate user interface.

The latest generation of scheduling technology has addressed many of the weaknesses of the previous generations. It uses the latest service oriented, three tier architecture with an enterprise scale relational database and Web Services to provide an easy to use, maintain and integrate solution. It provides a comprehensive solution covering crude receipt and blending to product blending and shipment. It incorporates a mixed integer programming solver for feed and product blend optimization. It has an intuitive graphical user interface and model builder making it much easier to use than previous scheduling solutions. It incorporates powerful logic to automate the scheduling of vessels to docks and to assign tanks to activities. It is capable of scheduling pipelines and

other forms of transportation and it can aggregate schedules of multiple refineries and terminals enabling it to be applied to the entire supply chain.

As a result of these technology advances SIMTO Scheduling has been widely applied in the refining and LNG industries. And there is growing interest in improving scheduling around the World with SIMTO projects awarded this year for refineries in North America, China, India and The Middle East. This has led to M3 Technology being named in the prestigious 2010 Inc. 5000, a list of America's fastest-growing companies. There is also increasing interest in applying the technology to the oil and gas supply chain. ■



Simon Rogers came to M3 with more than 20 years of experience in the application of information technology to the refining and petrochemical industries. M3 (www.m3tch.com) is a leading provider of supply chain scheduling solutions focused on enterprise planning, advanced asset scheduling and blending optimization software for the oil and gas industry. M3's SIMTO Scheduling and M-Blend software is being used worldwide. Simon leads M3's global sales and marketing team and M3's European operation in London.

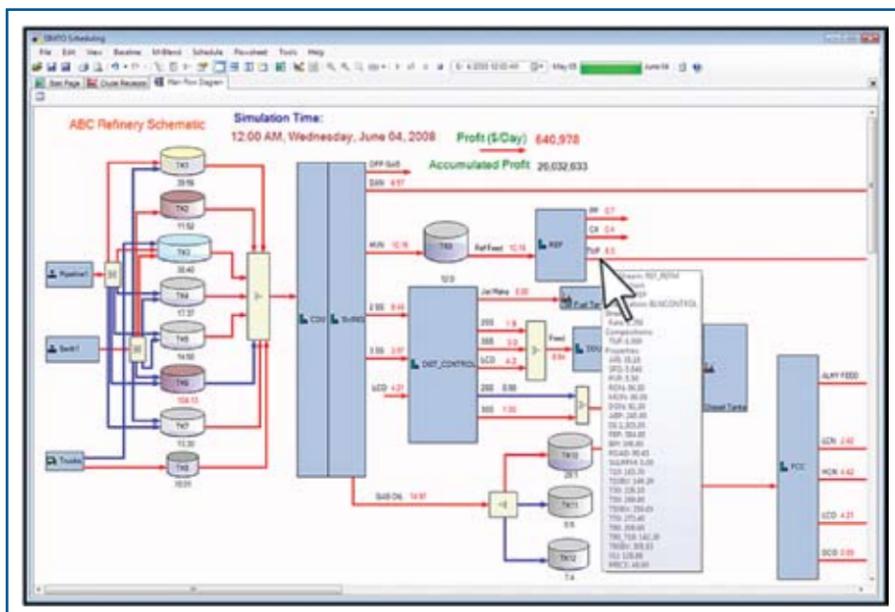


FIG. 1. A schematic of the interactive SIMTO Dynamic process flow.

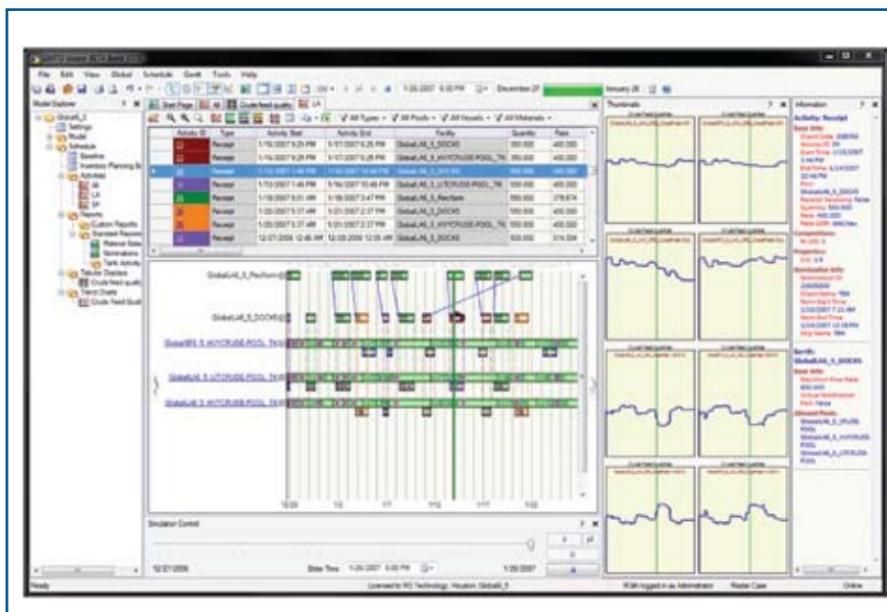


FIG. 2. SIMTO's multi-site scheduling with tabular and trend charts.

Mobile workforce management makes money for refiners

Most major US refineries are planning to implement or have already implemented mobile workforce solutions. Typically these involve a handheld computer or PDA running software that processes and transmits device-specific information to data historians, operators or enterprise decision-support systems. These help operators, field engineers and supervisors create inspection and regulatory procedures, assign, schedule and execute rounds, and report critical findings, improving equipment availability and efficiency.

"In typical downstream environments, estimated savings are in the \$2 to \$3 million range per 100,000 bpd, primarily due to better operating efficiencies gained from improved mechanical availability to reduce unplanned downtime, combined with main-

tenance cost reductions including reductions in secondary failures and lower expenses of primary failures," says Charles D. Mohrmann, product marketing and strategy director at Invensys Operations Management.

For example, at the 2009 Microsoft Global Energy Forum, BP's business information manager said they regained millions of dollars by improving refining reliability, using their mobile workforce and decision-support system to accelerate and sustain operator-driven reliability initiatives. The project improved work processes and facilitated best practices in the field, delivering a 40% internal return rate and yielding more than \$10 million in hard benefits.

Other companies have reported similarly dramatic

results. At a recent ERTC conference, the rotating equipment reliability manager of Valero reported typical one to two percent reductions in total maintenance budget costs and \$2 to \$3 million in annual cost reductions. And at a SAP Centric EAM Conference, another reliability manager for that same company reported that mean time between repairs (MTBR) nearly doubled while 12-month repair costs were halved.

"Mobile solutions improve work flow and enhance a company's ability to make better, faster decisions in real time. Empowering the mobile field workforce with a multi-tasking and intelligent mobile solution enables them to execute best practices and continually improve performance," said Mr. Mohrmann. ■

BASF introduces Multi-Stage Reaction Catalyst platform for FCC catalysts

BASF introduces its latest FCC catalyst manufacturing innovation, the Multi-Stage Reaction Catalyst (MSRC) platform. This breakthrough manufacturing development takes advantage of staged reactions with different catalytic attributes much the way that staged hydrotreating loading permitted different reaction zones in a single reactor vessel. The commercial concept of staged reactions is not new to the refining industry, but its application to a moving bed catalytic system is a true step forward in manufacturing technology.

The MSRC platform uses existing catalyst technologies like Distributed Matrix Structures (DMS) and Proximal Stable Matrix and Zeolite (Prox-SMZ), but through its novel manufacturing process combines two or more existing FCC catalyst functionalities within a single catalyst particle. The location of the various stages can be specifically engineered to achieve maximum value for the customer. This staging approach can be applied to processing of heavier feedstocks, or to maximize specific product yields in the FCC unit.

The manufacturing process for this multi-stage reaction catalyst is based on BASF's unique *in situ* manufacturing technology and involves several key manufacturing steps in which the active components for each reaction stage are added at the desired quantities giving each catalyst manufactured under the

MSRC concept different characteristics. One of the key success factors to the development of the MSRC is the binding properties given by the *in situ* manufacturing process which allows zeolite to grow across the catalyst stages and interface acting as a binder and giving the catalyst particle its attrition resistance properties.

The first product from this new platform is designed for resid applications, where contaminant feed metal passivation is crucial. In particular, traces of nickel in the resid feed have a detrimental effect on the catalyst performance. In state-of-the-art resid FCC catalysts, specialty alumina is integrated in the catalyst formulation to trap the nickel and render it innocuous. By examining spent FCC catalysts from refineries BASF researchers observed that nickel mainly deposits and accumulates on the outer surface of the catalyst. It would thus be advantageous to concentrate the nickel trapping alumina at the outer layer of the catalysts to make it more effective. This component staging was realized by using the novel MSRC manufacturing technology. The inner stage has the DMS structure to allow enhanced diffusion of heavy molecules, maximizing gasoline yields. The outer stage is also based on DMS technology, but is enriched with specialty alumina to trap the nickel directly where it deposits on the catalyst.

The MSRC manufacturing process is based on BASF's unique *in situ* manufacturing technology and was demonstrated at plant scale production in first quarter 2010. Commercial trials of this new resid catalyst are scheduled for the third quarter of 2010.

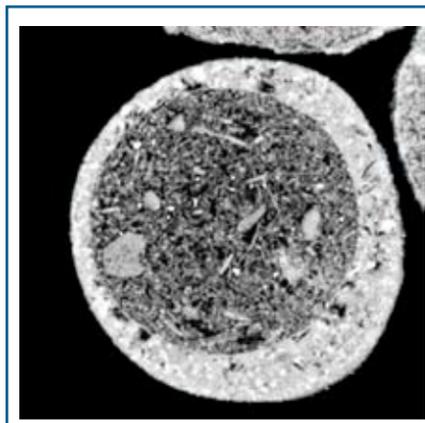


FIG. 1. Cross-sectional SEM picture of commercially produced MSRC catalyst showing dual reaction stages in a single particle.

BASF is very enthusiastic about this breakthrough manufacturing technology and the doors it will open to a wave of new, innovative multi-stage reaction FCC catalysts. ■

DMS
An award-winning technology platform with over 125 commercial applications and growing; Distributed Matrix Structures (DMS) delivers increased gasoline yield with a high degree of coke selectivity for optimum unit operation. 2000
Prox-SMZ
New Proximal Stable Matrix and Zeolite (Prox-SMZ) platform combines attributes from both high zeolite and high matrix activity for maximum distillate yields from FCC unit. 2008
MSRC
The Multi-Stage Reaction Catalyst (MSRC) platform is based on an unique manufacturing process resulting in a catalyst composition of heterogeneously distributed reaction stages for enhanced performance. 2010

FIG. 3. BASF platforms at a glance.

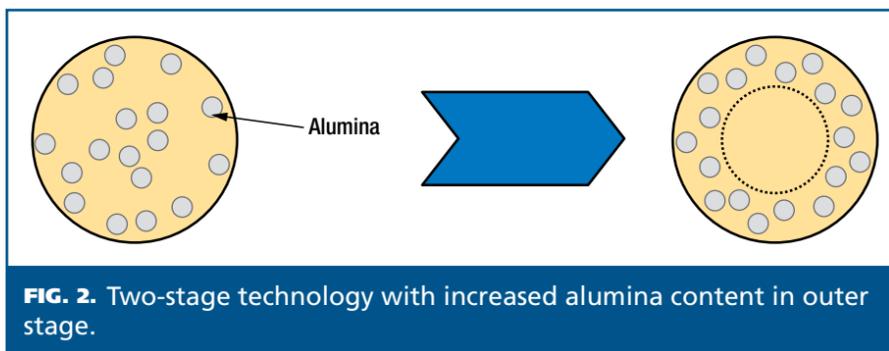


FIG. 2. Two-stage technology with increased alumina content in outer stage.

Downstream innovations

New technology analyzes difficult water samples

New technology from GE will make it easier for the water process industry to analyze difficult industrial water samples. Expanding GE's capabilities for process, environmental and wastewater analysis, the Sievers InnovOx online total organic carbon (TOC) analyzer will allow users to analyze challenging water samples on a routine basis without requiring excessive preventive maintenance. Monitoring the levels of TOC in the water is an important step for industrial users to control processes that are critical to their operations and to comply with regulations.

The Sievers InnovOx offers increased uptime and instrument reliability, two important features when it comes to analyzing difficult industrial samples. It has been designed by GE Power & Water's analytical instruments unit, petroleum, pulp and paper, and food and beverage markets, as well as environmental organizations and municipalities.

The InnovOx online, like its InnovOx laboratory model predecessor, uses an innovative supercritical water oxidation (SCWO) technique that offers enhanced reliability, greater ease of use and lower maintenance than other TOC analyzers. By utilizing SCWO, the InnovOx is the TOC instrument most capable of cost-effectively analyzing difficult industrial process, environmental and wastewater samples on a routine basis. SCWO has historically been used to treat large volumes of aqueous-waste streams, sludges and contaminated soils. GE is the first company to use this technique in a commercially available TOC analyzer.

The first commercial application for the new InnovOx online TOC analyzer is monitoring seawater

in Taiwan. The seawater, which contains about 3% sodium chloride, is used as industrial-process water, and both incoming and outgoing water streams need to be monitored for environmental protection. A main source of contamination can be hydrocarbons coming from a petrochemical refining process. The InnovOx's robust handling of the brine sample was a significant factor in the analyzer's selection.

"The TOC market demanded technology with greater reliability and uptime, two critical needs that were not being met," said Stephen Poirier, vice president of business development for the analytical instruments unit of GE Power & Water.

Advanced technology converts CH₄ and CO₂ into gasoline

Carbon Sciences, Inc., the developer of a breakthrough technology to transform greenhouse gases into gasoline and other portable fuels, announced the filing of the first of a series of patent applications for its highly scalable clean-tech CO₂-based gas-to-liquids (GTL) fuel technology for transforming a combination of natural gas and CO₂ directly into gasoline.

This first patent application discloses the design and manufacturing of a novel chemical catalyst that converts methane gas and CO₂ directly into gasoline. These greenhouse gases can be sourced from natural gas fields or human-made coal-fired power plants, landfill gas, municipal waste and even algae.

"This heralds a new era for Carbon Sciences and it means that our plan for delivering a market-ready technology could be delivered as soon as next year," said Byron Elton, CEO of Carbon Sciences. "The ongoing tragic events involving BP's unchecked flow of oil into

the Gulf of Mexico further underscores the urgent need to reduce and eliminate our addiction to petroleum, foreign and domestic. Carbon Sciences' breakthrough technology takes us closer to a world without petroleum by essentially transforming pollution into energy."

The announcement is related to the most important module of the company's previously announced end-to-end CO₂-to-fuel system that recycles raw CO₂ flue emissions from carbon emitters like coal-fired power plants directly into gasoline and other portable fuels. The new module under development is designed to be a stand-alone system to substantially shorten the timeline to commercialization, and reduce the overall systems and operating costs and produce a fuel that can be used in the existing infrastructure, supply chain and vehicles.

Dr. Naveed Aslam, the company's chief technology officer, commented, "We are very excited about the stand-alone commercialization of our CO₂-GTL gasoline module. This system will provide a sizable part of the energy industry with an immediate clean-tech solution for the energy and climate challenges we face. Unlike other technologies, such as those for algae biofuels, that may require decades for commercial deployment, our plan for delivering a market-ready technology may be available as soon as early next year. Within a short period of time, we believe that the world can stop drilling for oil and start converting natural gas and greenhouse gases to gasoline."

Mr. Elton added, "The clear and short path to commercialization with this new CO₂-based gas-to-liquids technology makes it our singular focus for the next 12 to 18 months. The company's Website has been updated to reflect this strategy and focus." ■

Applying statistical tools may solve today's refinery problems

During Monday afternoon's plant automation session, Jose Bird, Valero Energy, and Jack Davis, Resources-2Energy, used statistics to illustrate their point. The session focused on the presenters' experiences with statis-



Jose Bird, Valero, discusses how statistical tools can be applied to solve refinery problems.

tical analysis and why refinery personnel should use a statistical approach to address refinery problems and how it can improve efficiency. Mr. Bird also provided an overview on statistical methods and indicated the importance of using the available statistical tools. He worked on a number of different "real-life" refinery problems using statistics to develop solutions using the refinery data available. When the program was implemented, they had a cost savings of over \$150 million/year.

There are many possible applications of statistical approach when solving refinery issues and these include operating performance analysis (yield analysis); cost reduction (energy consumption reduction); reliability (predict failures); emissions control (defining variables

impacting emissions) and accurate reporting (key performance indicators).

The statistical approach addresses exploratory data analysis (EDA) and selecting statistical methods. Several tools in the EDA step may be frequency histograms, scatter plots and trend charts. General statistics such as the mean and standard deviation can be used to get a feel for the typical value of a given process variable and the degree of variability of this variable. Another useful tool is the correlation matrix.

Several statistical methods are available to conduct statistical analysis in support of refinery operations. The complexity of the analysis techniques vs. the value added needs to be considered in selecting a tool. Some prevalent statistical methods used in engineering applica-

tions include multiple linear regression analysis (MLR) and univariate statistical process control. Multiple linear regression analysis is used to build predictive models in which the response variable can be expressed as a linear combination of explanatory variables.

More advanced statistical methods available include response surface methodology (RSM), the multivariate T^2 statistic, classification and regression trees (CART), random forest, neural networks and support vector machines (SVM). These techniques can handle both continuous variable problems as well as categorical or discrete variable problems.

Mr. Bird indicated that few of these tools are used extensively by refinery staff due to a lack of training in statistics and/or the time required to review, select, install, and learn how to use any of the statistical packages available. To illustrate the application of statistical methods, two cases were discussed and demonstrate the breadth and value of employing a statistical approach to solve typical refinery problems.

Case 1: Operations monitoring.

A one month spike in fuel gas usage was observed for the ultra-low sulfur diesel unit, so what drove this increase in fuel consumption? The approach used in this case was MLR to predict energy consumption and identify process variables that significantly impact energy consumption. Result: a model was developed that found the deethanizer reflux ratio as the most significant variable impacting energy consumption.

Case 2: Yields analysis.

Problem: during the last 12 month period, economics have required FCC operations to frequently shift. It is therefore important to identify the most influential process variables impacting gasoline and diesel yields. To perform this analysis, each observation was classified as either gasoline or diesel mode of operation and the response variable modeled as a 0/1 categorical (discrete) variable. The CART and random forest methods were then used to predict the diesel or gasoline mode of operation using other process variables. Result: the method showed that the fractionator overhead temperature is the most significant driver to shift from gasoline to diesel operating mode. Secondary drivers identified by the random forest technique include light cycle oil (LCO) draw temperature which was found to be highly correlated with the fractionator overhead temperature and riser differential pressure.

Mr. Bird concluded that statistics provide an available tool set to process engineers to meet the demands of operations and suggested investing in some statistical training to build up in-house expertise, chose a champion for the application of statistical approaches and have that champion develop the expertise required to support the needs of the rest of the group. The case studies showed that the investment quickly payoffs in terms of operating improvements. ■

“... benefits on the order of \$1-5 million per year are being realized in each refinery...”

Technology in Action, BP

“Quickest startup in our plant history.”,
Engineer, Borealis Polymers

“... we are able to save over \$1 million per year in energy consumption.”,
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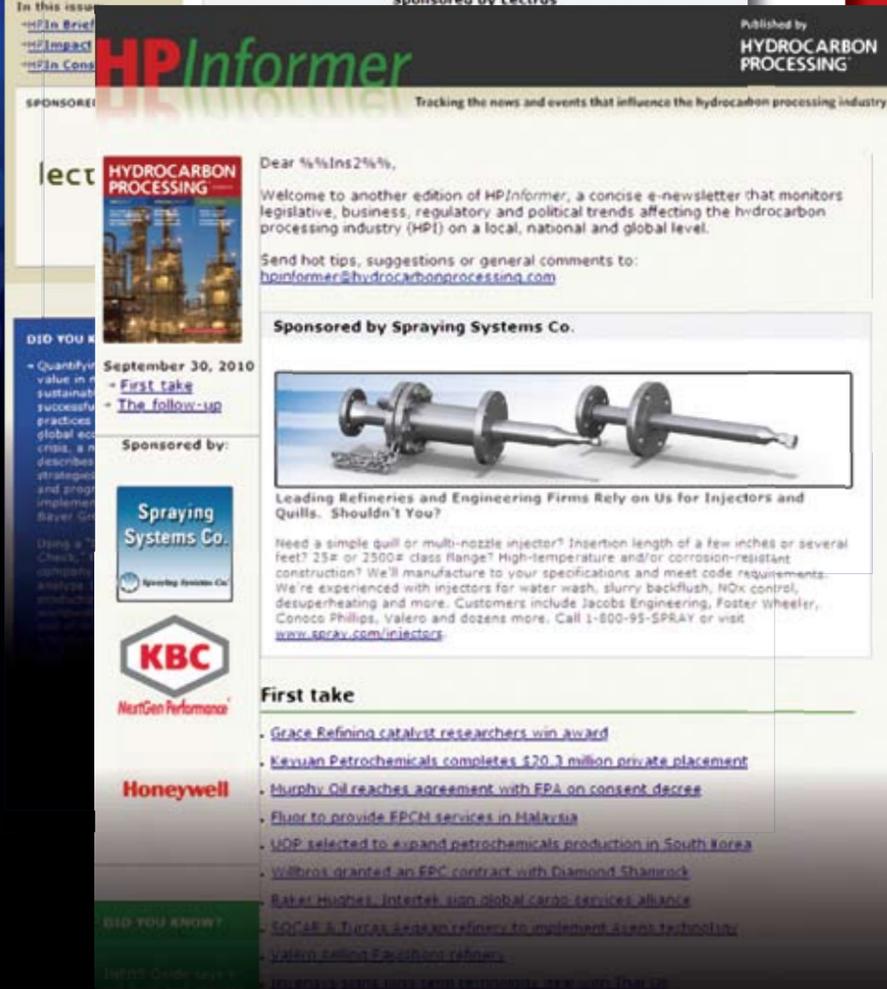
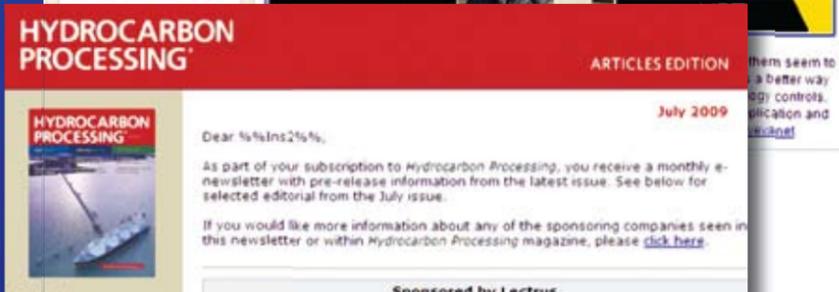
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Reduction of hydrogen sulfide in asphalt with chemical programs

J. DRAPER and J. STARK, Baker Hughes Incorporated

Hydrogen sulfide (H_2S) is a safety and environmental concern for the petroleum industry. For those refiners that produce asphalt from “bottom of the barrel” products, such as vacuum tower bottoms (VTBs), the concern is H_2S exposure to workers and to the community. Asphalt-blend stocks often contain high levels of H_2S and can pose significant danger to individuals involved in its production and handling. Many producers have H_2S specifications at railcar and tank truck loading racks. Moreover, the American Conference of Governmental Industrial Hygienists (ACGIH) recently lowered the recommended threshold limit value (TLV) for hydrogen sulfide from 10 to 1 ppm. Finally, state air quality boards limit the amount of H_2S allowed in ambient air at the refinery fence line in order to improve local air quality.

The use of chemical hydrogen sulfide scavengers can reduce the H_2S content of asphalt-blend stocks and keep the H_2S level low during extended storage at elevated temperatures. Scavengers reduce tank emissions and the associated nuisance odors as well as decrease the safety risk to those individuals involved in the transfer, transportation, and use of these products.



FIG. 1. Hydrogen sulfide scavenger reduces the dangerous effects of H_2S in asphalt.

Hydrogen sulfide in asphalt poses greater dangers.

While H_2S can potentially be a concern for all fuels coming from refinery processes, VTBs are particularly hazardous because they do not receive additional processing to remove H_2S . Moreover, VTBs are among the heaviest of the products coming out of the refinery and typically the product in which sulfur compounds concentrate. Because of the viscosity of asphalt, it is stored at high temperatures (300–400°F or 140–204°C). These temperatures are high enough to promote further thermal cracking of sulfur-containing compounds and the formation of additional H_2S . Furthermore, asphalt has a high (400:1) vapor:liquid partition coefficient, meaning that proportionally more H_2S will collect in the vapor phase relative to other hydrocarbon products. For all these reasons, asphalt contains extremely high levels of H_2S , often exceeding 2% (20,000 ppm).

Chemical additive selection.

The viscous nature of asphalt, its necessarily high storage temperatures, and the propensity to continue to produce H_2S are obstacles to the efficient scavenging of H_2S from asphalt-blend components. Because of the elevated temperatures typical of asphalt applications, water-soluble scavengers are generally not suitable; rather, oil soluble carriers for scavengers are preferred. Reducing the hydrogen sulfide content of asphalt requires a scavenger that can function under severe conditions. An asphalt H_2S scavenger must demonstrate these additional qualities:

- Large H_2S uptake capacity; the scavenger must be very reactive towards H_2S in order to minimize the required additive volume
- Rapid reaction with H_2S ; often

very little residence time is available, so the scavenger must be able to reduce H_2S quickly

- Non-reversible, thermally stable reaction products; the reaction product between the scavenger and H_2S must be thermally stable, even under the high-temperature conditions of asphalt

- No detrimental effect to the asphalt; asphalt has specific quality requirements, therefore the additive cannot change its physical attributes

- Selective for H_2S ; application economics are improved when the scavenger targets hydrogen sulfide only and is not consumed by other species.

Application expertise.

The reduction of H_2S in asphalt is an important consideration because asphalt shipped by railcar and tank truck poses a risk to personnel and consumers. Tank emissions and nuisance odors to surrounding communities are also a consideration. Removing H_2S from asphalt can be accomplished through the proper application of a chemical scavenger. An additive program that uses best-in-class application technology and test methods can optimize additive dosage, improve scavenger response, and allow refiners to meet their H_2S specifications economically.

A thorough understanding of the asphalt blending configuration, tank residence times, available mixing equipment, and injection points is critical to designing a program that produces the desired results without costly giveaway. Difficulties measuring H_2S content in asphalt safely and reproducibly can also be an issue. With the proper additive, equipment and monitoring, H_2S scavengers allow refineries to increase employee safety, comply with environmental regulations, and

minimize capital expenditures. Baker Petrolite has over 20 years experience reducing the H_2S content of asphalt and offers a full line of SULFIX® additives and applications technologies with proven performance.

Case history. A refinery requested that Baker Petrolite design a H_2S abatement program for their asphalt storage tanks and loading racks. The goal was to maintain flexibility in shipping schedules by reducing H_2S in the storage tanks to levels acceptable at the loading rack and continue to maintain them after an extended storage period. To complicate matters, the storage tanks keep the asphalt at elevated temperatures (>390°F or 199°C) and it could be hours or days before the asphalt would be transferred to the loading rack. The elevated temperatures meant that additional H_2S was being generated, and the levels of H_2S could increase by 40% potentially exposing workers and the environment.

Using Baker Petrolite's proprietary test methods for accurate and reproducible determination of H_2S levels, an additive treatment program was developed that would allow this refiner to meet safety guidelines and still remain flexible in their shipping schedule. Field trials validated this approach, and this program has been in commercial use for over two years. The ability to ship asphalt on demand without concern about H_2S safety has resulted in increased flexibility and the additional economic benefit of reducing costs associated with idle trucks and railcars. The program has also resulted in fewer environmental incidents and greater peace of mind for the refiner, workers, and transportation companies. ■

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H2scan receives multi-analyzer order from BP

The BP refinery in Cherry Point, Washington, has selected multiple H2scan hydrogen process analyzers integrated with the NeSSI platform system for their analyzer upgrades. H2scan's analyzers, based on palladium-nickel alloys and proprietary molecular coatings, have been operating successfully at the BP facility in the first stage recycle compressor in the hydrocracker unit and have shown good performance in a high percentage, harsh contaminant and multi-component process gas mixtures in comparison with traditional process analyzers.

Integrated with modular Intra-flow NeSSITM sample substrates provided to H2scan by Parker Hannifin, H2scan analyzers will provide real-time measurement without the need of valve switching, frequent calibrations and is designed to save considerable retail space in BP's analyzer shelters. ■

Use of dynamic simulation for control analysis in hydro-desulfurization units

J.M. FERRER ALMAZAN and M. MANZULLI, AspenTech; F. ARCONADA, A. LOPEZ-RODRIGUEZ, A. DE MANUELES and M. YUGO, Repsol

In 2009 the European Union introduced new environmental fuel specifications and regulations such as the obligation to make sulfur-free fuels. This new European specification has required not only a revamp of several hydro-desulfurization units (HDS) but also the review of the control philosophy.

Project objective. To achieve the ultra-low-sulfur specifications, Repsol and AspenTech jointly explored ways in which dynamic process models may help to:

1. Evaluate different process control strategies
2. Achieve a more accurate control strategy for the future 10 ppm operation

A project was initiated with the objective to develop a dynamic HDS simulation model integrated with the multi-variable predictive controller (MPC). The model would represent a “virtual” unit (corresponding to the HDS unit in Repsol’s Puertollano refinery) for conducting control studies without disturbing the real operating unit.

Model development. The project involved different phases from the initial steady state simulation to the final dynamic model linked with the Puertollano HDS unit advanced process control. To represent the reactor thermodynamic and kinetic mechanisms accurately, one of the most critical steps was to implement the Repsol proprietary reactor model as a standard unit operation in the Aspen HYSYS environment, both in steady state and dynamic modes. The HDS reactor model thus developed can be used by Repsol as a standard unit operation within the flowsheet simulation platform.

Before integrating the MPC controller, the basic PID loops in the dynamic model had to reproduce the same control behaviour specified by the control parameters in the Distributed Control System (DCS). All such parameters were input into the PID controller objects of the simulation platform as per the requirements of the algorithm used in each PID loop.

The final dynamic simulation was an integrated model of all the different sections involved (feed, reaction, fractionation) and with the same control configuration as in the real plant.

DMC controller integration in dynamic simulation. Dynamic matrix control (DMC) is one of the most popular methods of model predictive control. It is based on an empirical matrix model that predicts the behaviour of the dependent process variables (CVs—typically product qualities, process constraints, etc.) with respect to changes in the independent variables (MVs—typically set points or valve positions). Each cell of the matrix contains the step response curve of each pair of independent-dependent variables.

To identify the dynamic matrix for the unit modeled, a virtual step-testing was performed: selected manipulated variables (MVs) and disturbance variables (DVs or FFs) were automatically moved in a specified sequence to perturb the process model and examine the effects on the control variables (CVs). Once the movements were done, a .clc file was generated with all the CV responses to the MV and FF changes.

With the .clc file obtained by step-testing the virtual (model) plant (or the real plant), the dynamic matrix model can be developed and connected to the simulation model. It can then be tested in controlling the virtual unit (Fig. 1).

Fig. 2 compares the DMC models obtained by simulation vs. the real plant, as part of the validation to check how well the dynamic simulation represents the real plant. As a guideline: existing unit DMC at 200 ppm (blue line); DMC from Plant Tests at 50 ppm (pink line); and DMC from rigorous model (red line).

The DMC models generated with the dynamic simulation at 10 ppm (red colour) show a good match in terms of gain and response time when compared with the existing unit DMC models at 50 ppm (pink colour) and also at 200 ppm (blue colour). These comparisons prove that the simulation model was accurate enough for control analysis studies. Thus a simulation object directly linked to the APC controller software was added in the simulation model.

Control studies. Due to the tighter sulfur levels required in the final gasoil, the margin for correcting out of specification products by blending is reduced. It is therefore critical to increase the capability to respond faster to plant distur-

bances, such as changes in the feed sulfur content, and to avoid quality giveaways.

In the real HDS unit, a sulfur analyzer was located in the gasoil product line, but its response had a large dead-time and a slow process response to perform accurate control. So, as part of the process to choose the most profitable control strategy for the 10 ppm operation, the dynamic simulation was used as a tool to understand the HDS dynamics and explore different control alternatives.

In this context, a key question was whether to install a feed sulfur analyzer, with an investment requirement, or to implement a product sulfur inferential as a new variable in the DMC model in order to assess and drive the control response.

By using the HDS dynamic simulation, a “virtual” feed analyzer was added as a new variable in the MPC controller. Tests confirmed that a significant improvement in the control response of the Gasoil product sulfur was achieved, both in terms of stabilization time and standard deviation.

Later, during the APC revamp project for the 10 ppm operation in the Puertollano HDS unit, a “fast model” (online inferential) was developed and tested to predict product sulfur. This inferential, based on weight average bed temperature (WABT), feed flow and other parameters, was calibrated with coefficients derived from step-testing and from the rigorous simulation model. It would also be updated periodically with analyzer data.

After the inferential implementation, sulfur control is much improved, allowing the plant operation under less severe conditions (2°C WABT reduction), closer to the 10 ppm sulfur target and with associated savings in energy, hydrogen consumption and catalyst life cycle (Fig. 3).

Conclusions. The integration in a single rigorous simulation of a complete HDS unit model provides a powerful tool to understand the plant dynamic behaviour. It can be used for generating/updating inferentials, what-if studies, evaluating the impact of operational or feed quality changes, thereby reducing operational, safety and product quality risks.

This project has been very ambitious with high technical development goals, required an advanced level of simultaneous expertise in diverse areas to develop the simulation tools, and a conscious effort to enhance knowledge-sharing between all the groups involved.

As a result of this work dynamic simulation has demonstrated a great potential in control analysis. Repsol’s current objective is to also apply this approach to improve control strategies of distillation columns, and to use the HDS model in other units for inferential development. ■

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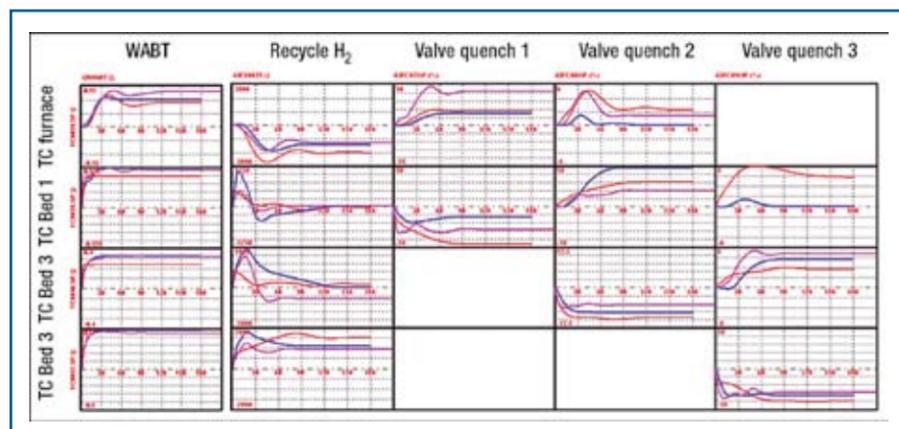


FIG. 2. DMC models comparison.

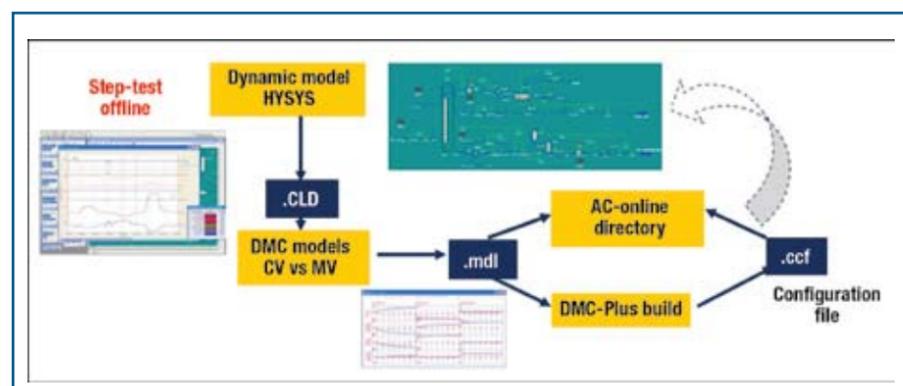


FIG. 1. Aspen DMCplus controller development in the Aspen HYSYS environment.

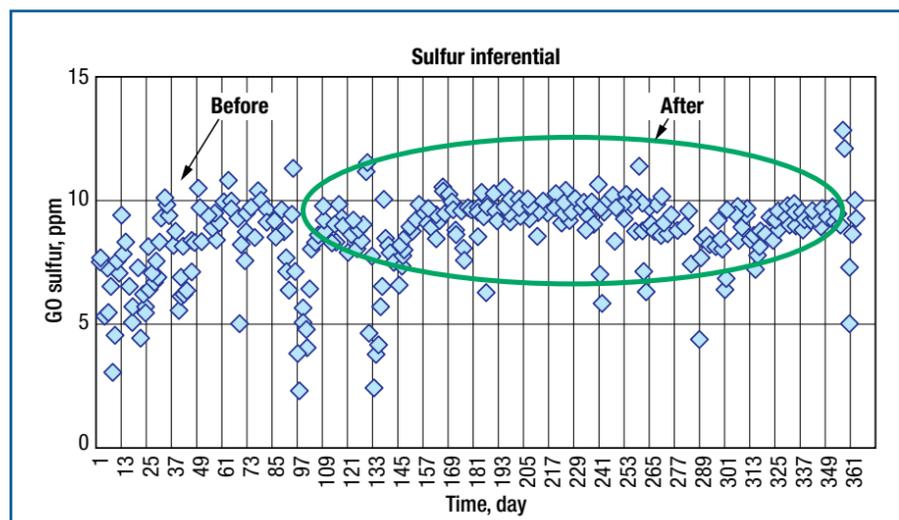


FIG. 3. Gasoil product sulfur content before and after inferential implementation.

Identifying regen cat standpipe aeration problems

D. FERGUSON, Tracerco, Pasadena, Texas

Techniques employing gamma radiation to investigate process problems have been available for many years.

Gamma scanning identifies changes in the density of material passing between a source and detector that is monitored by measuring detector count rates over time. In processes where density control is essential, such as solids handling, stationary monitoring offers a way to monitor for any fluctuating density. This information can help identify the causes of circulation problems and aid in optimizing corrective actions.

Case history. A US refinery had been through a revamp and there was a desire to better understand how the FCCU was operating. A series of tests was designed to gather information about flow patterns, distribution, residence time and aeration densities of

the catalyst and vapors in various parts of the FCC.

One part of this project was to investigate the performance of the aeration steam in the regen cat standpipe. Operations had indicated that the flow of regenerated catalyst was unstable.

Tracerco performed a TRU-SCAN* of the standpipe to determine the average density of the catalyst and steam mixture flowing down the standpipe. The source and detector were aligned at the top of the standpipe and synchronously lowered. Fig. 1 shows the results of this scan. The amount of radiation passing through the standpipe is inversely proportional to the density of the mixture. Therefore, the more radiation counts, the lower the density of the mixture. The vertical scale shows the distance from the top of the exposed standpipe.

The TRU-SCAN indicated that density across the regen cat standpipe was fluctuating as evidenced by

the spikes of high radiation counts (low density). This scan is not only a scan in elevation but in time as well, each measurement consisting of a 3 second accumulation of data at each elevation. The TRU-SCAN results indicated that stationary monitoring was needed to obtain a better understanding of the fluctuations in density over time.

Fig. 2 shows the results of stationary monitoring at four elevations on the first day; first at the two extreme positions, then two additional positions to pinpoint the location of concern. The results (blue line), seven feet above nozzle 1, were very spiky, indicating rapid fluctuations in density. The next elevation, at the nozzle 4 elevation, showed a very consistent density (red line). The results (green line) at the third elevation nozzle 2, indicated the density was fluctuating, but less severely than above nozzle 1. The last position was at the nozzle 1 elevation. These results (black line) showed more intense spikes than at nozzle 2, but not as intense as above nozzle 1.

Taken together, the results indicated that some of the steam entering at nozzle 1 was being drawn down with the downward flowing catalyst, as expected, but that the steam was disengaging from the catalyst and forming bubbles that rose counter current to the catalyst flow.

A couple of days later, adjustments had been made to the steam flows. The FCC was operating much better. Initially, stationary monitoring was performed at the top of the standpipe, seven feet above nozzle 1. Fig. 3 shows that the density was reasonably high and very consistent. Secondly, stationary monitoring was performed at nozzle 1. The density was virtually the same as above and was very consistent. Thirdly, stationary monitoring was performed at nozzle 2. The results showed that the density was much lower (higher radiation readings) and the density was reasonably consistent.

Finally, a TRU-SCAN was performed. The results seen in Fig. 4 showed that the density was relatively high at and above nozzle 1, but just below the nozzle, the density dropped rapidly and then achieved a reasonably consistent value. The steam injection rate was now properly adjusted to match the regenerated catalyst flow rate, providing good aeration without the formation of bubbles rising counter current to the catalyst flow.

Conclusion. The use of gamma radiation technology provided the customer with a clear understanding of the cause of their unstable flow. This information allowed the customer to better understand the steps needed to correct the problem. ■

*TRU-SCAN is a registered trademark of Tracerco.

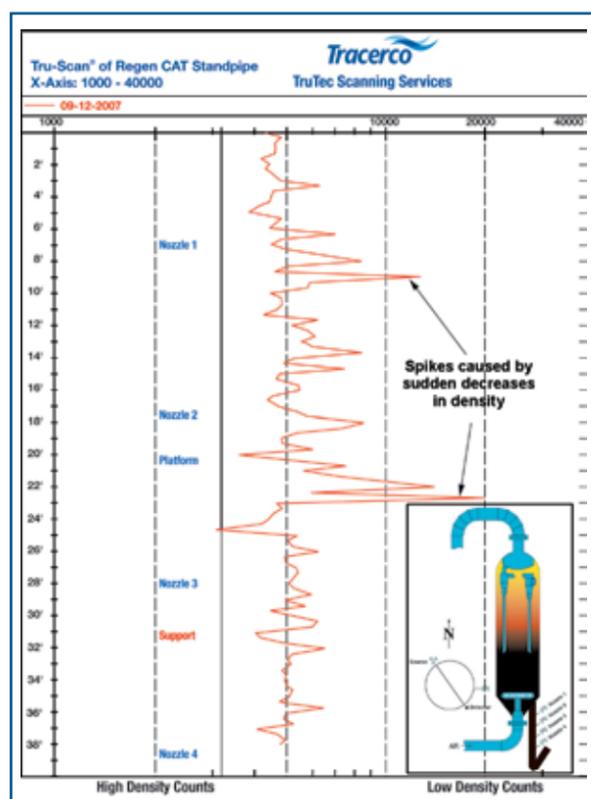


FIG. 1. Scans of the regen cat standpipe were performed to determine the average density of the catalyst and steam mixture flowing down the Standpipe.

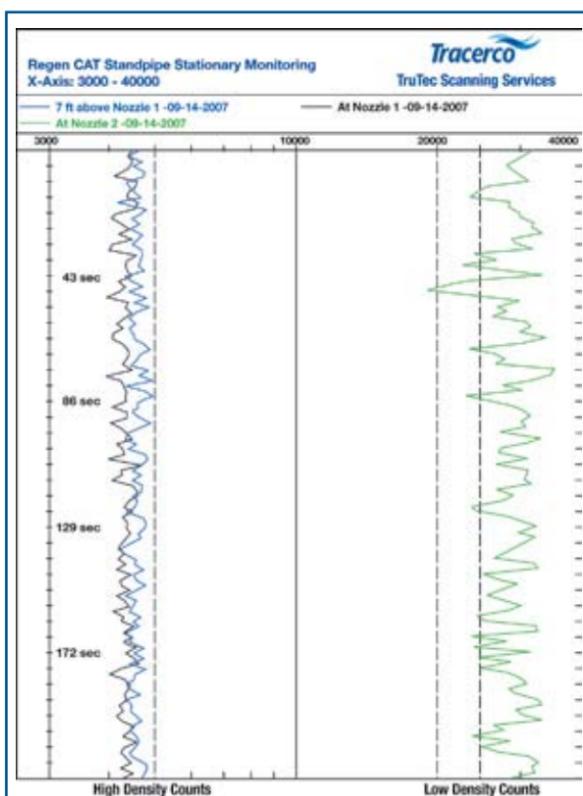


FIG. 3. After adjustments to the steam flows, the density below nozzle 1 was reasonably low and very consistent.

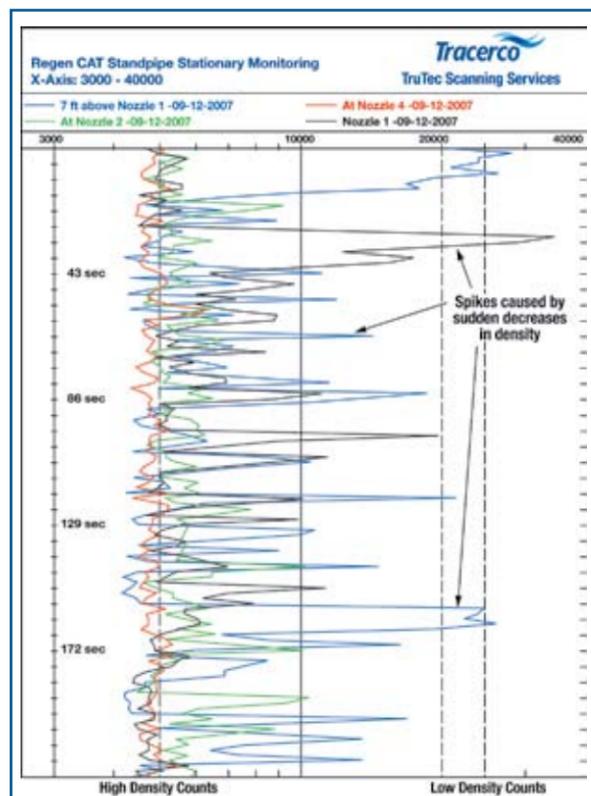


FIG. 2. Scan results indicated that some of the steam entering at nozzle 1 was being drawn down with the downward flowing catalyst, as expected, but the steam was disengaging from the catalyst and forming bubbles that rose counter current to the catalyst flow.

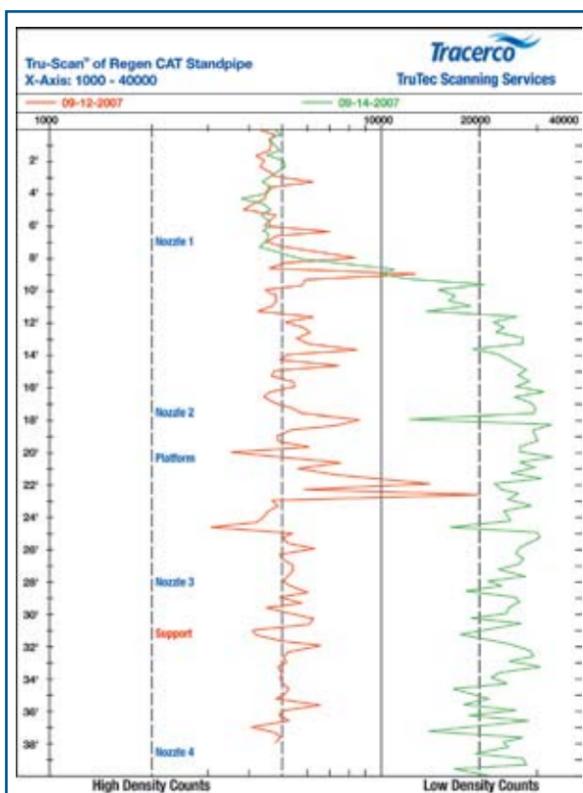


FIG. 4. TRU-SCAN results showed that the density was relatively high at and above nozzle 1, but just below the nozzle, the density dropped rapidly and then achieved a reasonably consistent value.

Did you know?

Murphy Oil reaches agreement with EPA on consent decree

Murphy Oil USA, Inc. has reached an agreement on a consent decree with the US Environmental Protection Agency (EPA) that will cover Murphy's two US refineries in Meraux, Louisiana, and Superior, Wisconsin.

"After several years of negotiation with the EPA and the states of Louisiana and Wisconsin, we are pleased to reach an agreement on a consent decree. The terms of the agreement are similar in nature to those of Consent Decrees that currently cover 90% of US refining capacity," said Tom McKinlay, Sr., vice president, Murphy Oil USA. ■

Much can be learned over breakfast

During a breakfast Tuesday morning, the team from Air Products and Goar, Allison & Associates welcomed Q&A attendees and offered descriptions of some of the services they offer.

Sulfur plant services. Air Product is a provider of open-art and proprietary sulfur plant technology, including COPE, an oxygen-enrichment technology for increasing existing sulfur recovery unit (SRU) capacity by 20% to 100+%. Large capital savings can be achieved by eliminating the need for expensive new SRUs at existing facilities or by reducing the number or size of SRUs for grassroot plants. Key features include:

- Improved conversion and reduced emissions
- Improved flexibility and reliability
- Satisfaction of consent decree requirements for redundancy
- Quick implementation
- Proven safety.

Another sulfur plant service they offer is D'GAASS, a sulfur degassing technology for reducing the concentration of dangerous H₂S in liquid sulfur to less than 10 ppmw, making it safer for storage and transport. Key features include:

- Low capital investment
- Low operating cost; reliable operation with no catalyst use
- Pressurized operation can provide zero SO₂ emissions
- Very well suited for retrofit installations; small footprint.

Air Products express (APEX) services. Air Products provides fast, flexible industrial nitrogen and hydrogen services for temporary requirements. The company's nitrogen services can be used for:

- Planned or unplanned turnarounds
- Plant start-ups
- Maintenance activities
- Pipeline applications
- Blanketing, inerting, and purging.

Air Products hydrogen services are useful for:

- Supplemental supply to boost production
- Backup/emergency supply
- Plant start-up procedures
- Catalyst regeneration.

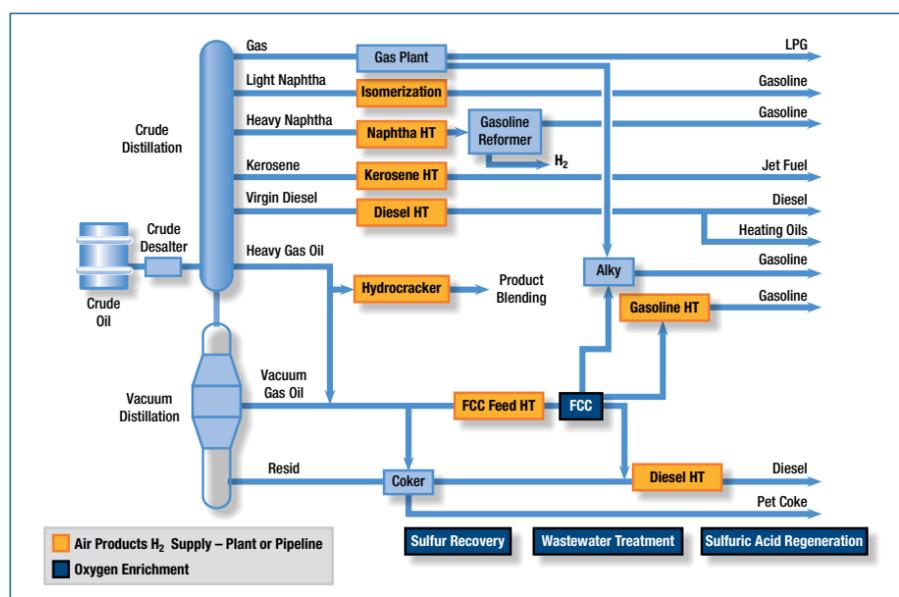
These services are beneficial to Air Products customers because they offer:

- Custom-engineered service to specifications

- Quick commitment through a dedicated hotline, 1-800-APEX GAS
- Rapid response—deployment of equipment within 24 hours
- Safe operation—built-in safety features.

Another interesting thing discussed at the breakfast was the Air Products and Technip H₂ alliance. This alliance provides refiners with competitive technology and a reliable hydrogen supply. The pairing of Air Products and Technip for hydrogen purposes is a good fit because of:

- Air Products' experience with petroleum industry
 - Greater than 30 hydrogen supply contracts
 - Over 40 facilities worldwide with approximately 1,000 collective operating years
- More than 30 projects completed together since 1992
- Operating experience fed back into design of each new facility
- Proven track record of reduced capital costs through:
 - Schedule reduction
 - Standardization in design
 - Leveraged buying
 - Reduction in field construction/start-up risks. ■



Air Products has a suite of products that can add value throughout a refinery.

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Scenes from the Forum



Ann Marie Dolan, Travis Weirich and Timothy Lebrecht, Air Products, John Raeside, Technip, and Ronald Jordan, Air Products, find that NPRA's topics are always enlightening.



Gasoline Processes Q&A panel: John Clower, Chevron; Greg Harbison, Marathon Petroleum; Alec Klinghoffer, Coffeyville Resources; Randy Peterson, STRATCO; and Wayne Woodard, Valero Energy.



Patrick Conroy, Ken Sulik, Harold Eggert, Rick Markle and Mark Wagoner of Champion Technologies believe in the best people, best technology and the best service.



John Sigmon of TriStar and Susan Moore of United Laboratories are here to represent Zyme Flow, the leading technology for chemical decontamination.



Jerry Wilson, Crystaphase, is looking for change he can believe in, along with Chuck Cherry, John Novak and Alan Sweezey, BASF, and Michael Schmidt, Axens.



George Buckbee and Jack Pasquill of ExperTune and PlantTriage are at NPRA to meet clients' needs.



Gordon Wollam, Nancy Wollam, Carlos Valdez and Michael Bourgeois and Mary Bourgeois, Gulf Chemical, believe value comes from conservation and recovery.



FCC Q&A panel: Pat Dennler, Shell; Emerson Domingo, Sunoco; Conrad Jensen, Holly.



Nicholas Hernjak discussed how to overcome the challenges in sustaining advanced process control value.



Jim Robinson and Randy Alexander of Eurecat and Anthony Ferrell of Axens enjoy the hospitality suites.



As the sun sets on another successful Q&A, we wish you safe travels and a renewed sense of purpose.

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National Safety Conference and Exhibition

May 10–11
Omni Fort Worth
Fort Worth, TX

Labor Relations/Human Resources Conference

May 25–26
Convention Center
Denver, CO

Reliability & Maintenance Conference and Exhibition

May 24–27
Convention Center
Denver, CO

Environmental Conference

October 24–25
Venue TBD
New Orleans, LA

Q&A and Technology Forum

October 9–12
JW Marriott Hill Country Resort & Spa
San Antonio, TX

International Lubricants and Waxes Meeting

November 10–11
Venue TBD
Houston, TX

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