



## Maximizing FCC Profitability in a Changing Market

### Combining Catalyst Innovations and Improved Monitoring from Grace Davison Allowed a German Refinery to Efficiently Switch Operating Modes from Gasoline to Diesel

The 5.0 million ton per year (tpy) Holborn Europa Raffinerie GmbH in northern Germany competes in a market characterized by high motor fuels and heating oil demand. The refinery operates an Exxon Model IV pressure-balanced FCCU (Figure 1) that processed 45 m<sup>3</sup>/hr of fresh feed when it was originally put into operation in 1950 and now operates at 145 m<sup>3</sup>/hr of fresh feed capacity, an increase of 320% over its 60 year operating history. Catalyst inventory is about 45 tons at this increased capacity.

The unit has slide-valves in the U-bends between the reactor and regenerator. They are operated in wide-open (100%) position and are used for isolation only. The slide-valve in the regenerator flue gas line is kept in operation to maintain a differential pressure between reactor and regenerator to vary catalyst circulation rate (PdRC-Valve).

At the previously noted 45 ton level of catalyst inventory the catalyst addition rate amounts to about 1.0 tons per day (tpd). The catalyst exchange rate of 80% is reached after 70 to 80 days. The regenerator is designed for a coke burn capacity of 4.5 tons per hour (tph) and operates in partial burn mode to maintain the heat balance. The temperature in the unit's reactor is controlled by varying preheat temperature.

The FCCU operates at more or less constant catalyst circulation. Controlling catalyst circulation in a pressure-balanced unit is difficult, which is why fines quantity is important for catalyst circulation stability. The 0 to 40 µm fines fraction should be above 8.0 wt% in order to guarantee stable circulation. Operating modes and hardware constraints of the Holborn FCCU are shown in **Table 1**.

**Table 1.** Holborn Model IV FCCU limitations and constraints.

Constraints in the FCC	lower limit	upper limit	Eng Unit
Reactor temperature	490	505	°C
Regenerator temperature	660	705	°C
Cat circulation	7	8.5	t/min
Catalyst addition	0	1.8	t/d
Total Air	28000	34460	m <sup>3</sup> /h
Heater outlet temperature	300	425	°C
CO-Value	6	8.6	ppm
Cyclone Velocity	16	22	m/s
Reactor pressure	1.1	1.6	barg
Gasoline amount	35	70	m <sup>3</sup> /h
atm. Residue addition	0	15	m <sup>3</sup> /h
Slurry draw off	3	7	m <sup>3</sup> /h

### Operating Objective

Engineers wanted a catalyst formulation that could deliver the following benefits to the FCCU:

- Stable and safe unit conditions
- Gasoline and diesel mode flexibility
- HCO recycle
- Higher metals tolerance
- Low delta coke
- High bottoms cracking
- Cracked naphtha with high octane
- Low FCC emissions
- Flexible catalyst reformulation.

The Holborn FCCU operation can choose between maximum distillate mode or maximum gasoline mode, preferably maximum distillates. Comparison and evaluation is performed by a standard simulation model and the proprietary Flash 5.0 program. To optimize distillate production at minimum bottom yields, the following operational and catalyst features are utilized:

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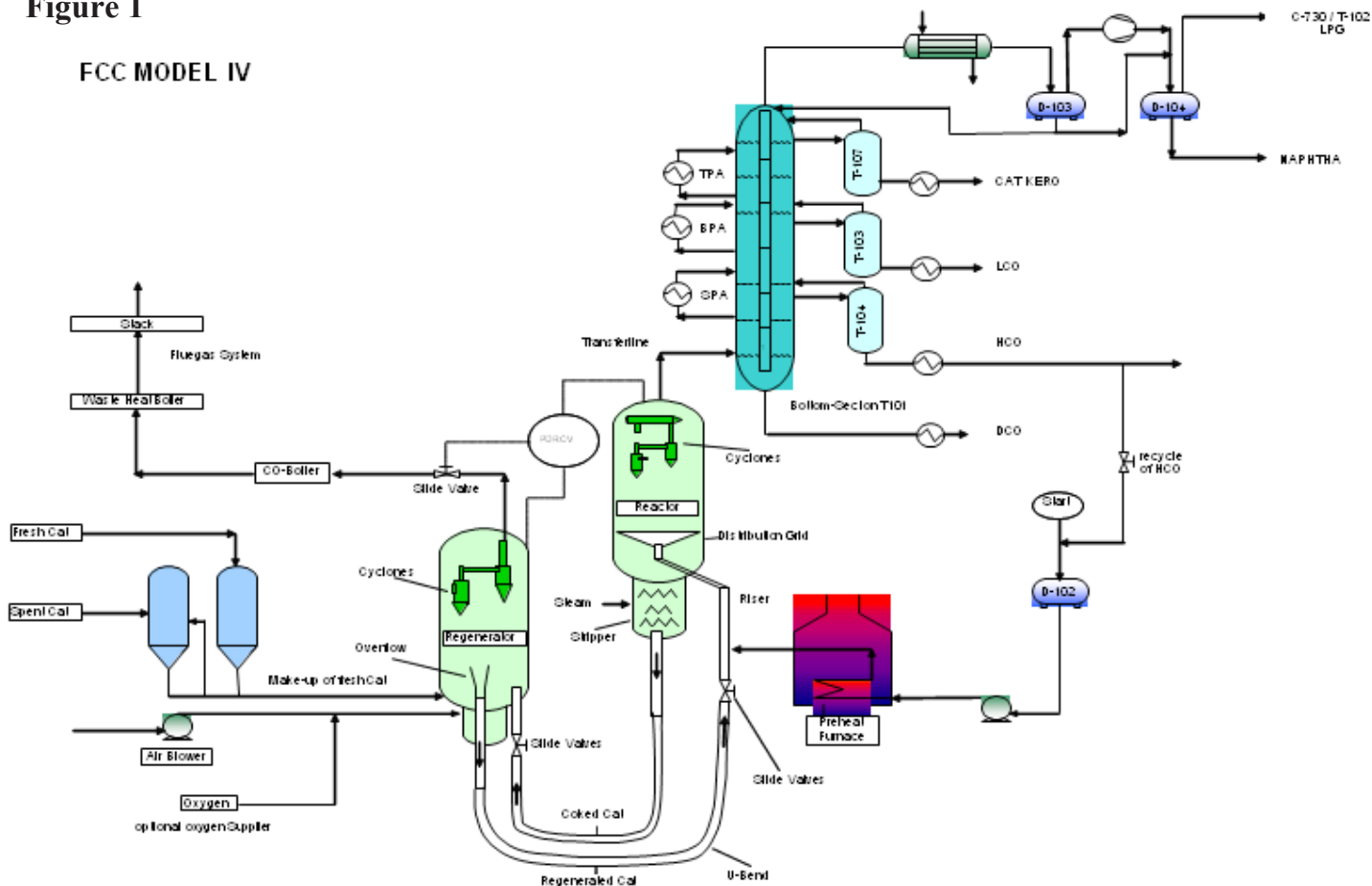
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Figure 1



- Reduction of feed temperature to decrease reactor temperature
- Optimized throughput ratio at maximum throughput (minimum cat/oil)
- Adjustment of cut points for products and unit feed
- E-cat activity reduction (i.e., lower fresh catalyst addition)
- Heavier feed (residue) processing to decrease conversion
- Use of a Grace Davison alumina-sol FCC catalyst, specifically tailored for the Holborn operation.

In order to further enhance value creation to maximize FCCU profit, the refinery operates the unit on a day-to-day basis, always bearing in mind prevailing economic and market demand. Economics can be slightly improved by careful selection of opportunistic crudes. However, refinery product prices cannot be influenced. In order to achieve the targeted profit it is of utmost importance that the FCC processes are run at optimum conditions. This involves:

- Monitoring mass, energy and heat balance
- Continuous calibration of orifices
- Daily considerations for optimum settings to push the unit to its limits
- Tailored FCC catalyst.

According to engineers at the Holborn refinery, the difference between their facility and their competitors is that their competitors have modified FCCU hardware whereas Holborn engineers have optimized the process. Pipes, pumps, compressors, control valves and feed nozzles were adjusted according to optimized process requirements. Major FCC sections, such as the reactor, regenerator and U-bend were left unchanged. There has been a continuous technology development of the FCCU, with only slight changes to the original design.

### Life Cycle Monitoring

In December 2009, to further maximize gasoline and/or LCO, within the FCCU limitations and constraints, Holborn switched to the state-of-the art

DieselizeR technology from Grace Davison. With increasing change out from NOMUS-DMAX to DieselizeR, the unit operation was closely monitored and Grace Davison's specific life cycle testing program was set up. This testing program comprised the following actions/use of tools:

- Regular calls and meetings to discuss the situation in the FCCU with the primary contacts at the Holborn Europa refinery
- Regular and intensive e-cat characterization based on weekly sent e-cat samples
- E-cat data (measured by Grace's European R&D lab) as well as weekly test run data from the Holborn FCCU were used to calibrate the simulation model for data evaluation
- The calibrated data were then plotted and interpreted for the purpose of monitoring unit performance, and subsequently these trends were discussed with unit and monitoring personnel.

In addition, the resulting calibrated cases (e.g., reactor product streams, corrected yields, etc.) are used for data prediction in order to closely monitor the actual unit operation but also to further optimize the FCCU unit performance based on the resulting predictions received. A more intense testing via Grace Davison's standard laboratory testing protocols was conducted, with the aim to follow the increase in change-out from NOMUS-DMAX to DieseliseR in the unit. The results were also discussed regularly with Holborn's operation & strategic team.

The Grace Davison Advanced Catalyst Evaluation (ACE) pilot plant testing protocol with actual refinery feed was carried out with e-cat samples from Holborn that represented the unit's typical deactivation pattern as summarized in **Table 2**.

The ACE pilot plant testing shows that DieseliseR further improved unit performance compared with NOMUS-DMAX by providing:

- Higher conversion (the lower delta coke enabled a higher cat/oil)
- Increased gasoline and LCO yield
- Significantly lower bottoms yield
- Higher gasoline octane.

The gasoline mode is set by operating the FCCU at high cat/oil ratio (lower throughput) and targeting a high e-cat activity. Holborn used the flexibility (no air constraint) to either maximize HCO recycle or process atmospheric residue with the FCCU feed. Using DieseliseR, a higher cat/oil could be achieved than with the previous NOMUS-DMAX catalyst, which resulted in a higher conversion. Typical results for the gasoline mode comparing DieseliseR and NOMUS-DMAX are shown in **Table 3**.

To summarise, DieseliseR provided the following benefits in the gasoline mode:

- A significantly higher conversion, which is predominantly due to the higher cat/oil achieved.
- Higher gasoline yields
- Enhanced lower slurry yields.
- Higher LCO-to-slurry ratio.

**Table 2.** ACE pilot plant test results: NOMUS-DMAX vs DieseliseR

	NOMUS-DMAX 227	DieseliseR, 80% change
Cat to Oil [-]	5.33	6.21
Standard Conversion [wt.% ff]	74.7	75.3
Hydrogen [wt.% ff]	0.34	0.31
Total C1 + C2 [wt.% ff]	2.53	2.60
Total C3 + C4 (LPG) [wt.% ff]	19.5	19.5
Gasoline [wt.% ff]	48.3	48.8
Light Cycle Oil [wt.% ff]	14.9	15.2
Heavy Cycle Oil 337°C [wt.% ff]	10.4	9.5
Coke on Catalyst [wt.% ff]	0.77	0.66
<b>Coke [wt.% ff]</b>	<b>4.10</b>	<b>4.10</b>
Motor Octane Number	82.3	82.8
Research Octane Number	93.5	94.0

**Table 3.** FCC yields and operating data in gasoline operation mode.\*

Catalyst	NOMUS-DMAX		DieseliseR	
	Dec 09	April to August 2010	Deltas	
Date				
Throughput ratio	1.08	1.08	0.00	
V ppm	2191	3692	1501	
Cat/Oil Ratio	3.6	4.2	0.7	
Standard Fresh Feed Conversion < 221 °C, wt%	63.6	65.6	2.0	
Standard Total Naphtha, < 221°C	49.3	50.0	0.7	
Standard Light Cycle Oil, 221 - 343°C	22.1	21.6	-0.5	
Standard Clarified Oil, > 343°C	14.3	12.8	-1.5	
LCO over Slurry, Ratio	1.55	1.70	0.15	
Delta Coke	0.93	0.84	-0.09	

\* Note: For an appropriate comparison, in the following the yields for gasoline, LCO and bottoms were corrected as follows:

Gasoline cut, < 221°C  
 LCO cut, 221 °C – 343°C  
 Bottoms cut, > 343°C

### Diesel Mode

The diesel mode is generally characterized by a lower cat/oil ratio, while processing maximum available fresh VGO in combination with a low throughput ratio and a lower e-cat activity. This results in a lower severity but still enough gasoline is produced at maximum LCO yield. **Table 4** shows typical data comparing DieseliseR with the previous NOMUS-DMAX catalyst in diesel mode. To summarize, DieseliseR provided the following benefits in the diesel mode compared to NOMUS-DMAX:

- Lower conversion in the distillate mode than for the gasoline mode (due to lower cat/oil, lower e-cat activity)
- Higher cat/oil in the distillate mode (due to lower delta coke)
- Better bottoms upgrading into gasoline and/or LCO in the distillate mode (ratio depends on the conversion)
- Higher LCO-to-slurry ratio in the distillate mode (even though conversion is lower overall).

Holborn use a tailored DieseliseR catalyst from Grace Davison that displays:



- Excellent bottoms upgrading via enhanced matrix functions
- Low delta coke
- Enhanced metals resistance.

This provided the refinery with the flexibility to process either HCO or atmospheric residue with the fresh VGO feed, in order to achieve the maximum unit profitability. ■

**Editor's Note:** This article was prepared from a paper presented at the ERTC in Istanbul by the Grace Davison experts based in the Worms, Germany offices. For more information on DieseliseR and its capabilities contact Colin Baillie in the Worms office (+49 6241 40300, colin.baillie@grace.com).

**Table 4.** FCC yields and operating data in the diesel operating mode.\*

Catalyst	NOMUS-DMAX		DieseliseR
	Dec 09 to Jan 2010	Apr-10	Deltas
Throughput ratio	1.04	1.04	0.00
V ppm	1903	3128	1225
Cat/Oil Ratio	3.8	4.0	0.2
Standard Fresh Feed Conversion < 221 °C, wt%	62.2	62.0	-0.2
Coke, wt. %	3.2	2.8	-0.4
Standard Total Naphtha, < 221°C	46.9	48.0	1.1
Standard Light Cycle Oil, 221 - 343°C	23.2	23.6	0.4
Standard Clarified Oil, > 343°C	14.3	12.8	-1.5
LCO over Slurry, Ratio	1.59	1.64	0.05

\* For an appropriate comparison, in the following the yields for gasoline, LCO and bottoms were corrected as follows:

- Gasoline cut, < 221°C
- LCO cut, 221 °C – 343°C
- Bottoms cut, > 343°C



## PROCESS OPERATIONS

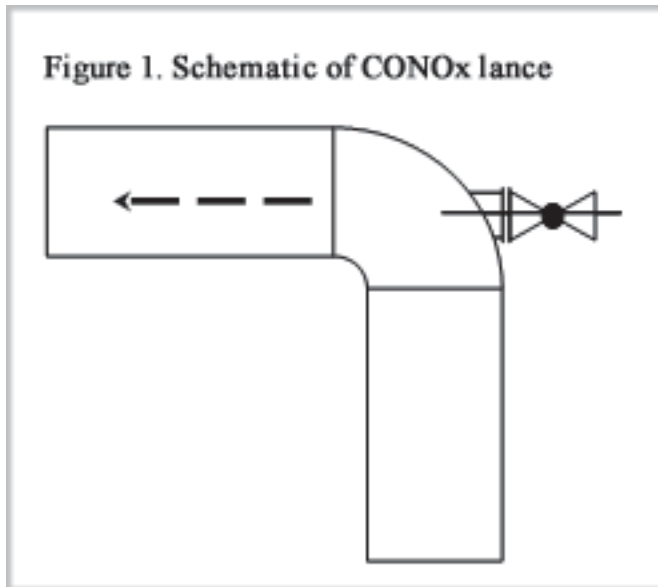
# Shell Global Solutions and Praxair Update on CONOx Technology

The CONOx FCC regenerator NOx emissions reduction technology introduced by Shell Global Solutions (US) Inc. and Praxair, Inc. is designed to be effective in both full-combustion (full-burn) and partial combustion (partial-burn) regenerators, with as much as a 60% reduction in NOx emissions. This level of emissions reduction allows more regenerator operating flexibility so that regenerator temperature, air blower capacity and velocity limitations can all be addressed.

The CONOx system is a high-velocity, highly reactive oxygen jet with superior mixing capabilities enabling rapid reactions of carbon monoxide (CO) and NOx precursors at typical flue gas temperatures. According to information available from Praxair, the CONOx technology alone can increase FCCU capacity by allowing for operation at much lower excess O<sub>2</sub>,

thereby utilizing more capacity through the air blower, in addition to its anticipated ability to reduce CO, NOx, and NOx precursors (ammonia/HCN) in FCC regenerator off gas.

CONOx can also be combined with other control technologies, such as additives or regenerator design, to achieve even higher NOx emissions reductions. CONOx enables FCCU operation at higher CO while maintaining low NOx emission in partial combustion. The NOx precursors are destroyed in the reducing environment of the flue gas duct. NOx leaving the CO boiler stack is



reduced while CO boiler firing is also reduced due to heat input from CONOx burning some of the CO.

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In full combustion, CONOx enables FCCU operation at low excess O<sub>2</sub> to achieve low NOx while maintaining low CO emissions (between 50-100 ppm). The technology can also be used as an “insurance policy” to handle CO excursions. In one known test case, a refiner demonstrated he was able to reduce NOx emissions from 100 ppm (at >2% excess O<sub>2</sub>) to less than 30 ppm (at <1% excess O<sub>2</sub>). However, this mode was not sustainable due to CO levels increasing beyond allowed limits. The use of a CONOx system in this case would have achieved the desired NOx target without exceeding the CO constraint.

“The CONOx system creates a high-temperature, highly reactive, oxygen-rich stream that can be easily integrated into flue gas ductwork with minimal modifications,” said Pankaj H. Desai, Licensing Manager, Shell Global Solutions (US) Inc. “CONOx is the latest offering to help our refinery customers improve environmental performance and operational efficiency while lowering their costs,” said David

Burns, refinery business development director, Praxair, Inc.

Shell Global Solutions will be involved in marketing CONOx to refiners through its worldwide sales force. Shell Global Solutions will work with Praxair to leverage their expertise to continuously update and improve the technology. Praxair will carry out process design engineering in concert with the refiner, provide the CONOx lance (**Figure 1 on page 4**) and gas flow control equipment as well as participate in safety reviews, start-up and optimization. The CONOx Hexmesh refractory coated lance is designed for continuous operation with minimal maintenance. In larger units a 6-inch OD retractable lance inserts through an 8-inch gate valve at the optimum location for mixing in the flue gas overhead line as determined by CFD analysis. Smaller FCCU’s would use a 2-inch or 4-inch lance. ■



## INDUSTRY Q&A

### FCC Q&A Part II



#### Catalyst Slide Valve Reliability

*To improve unit reliability and safety, do you see the need for further improvements to catalyst slide valves, and if so what should be the focus (mechanical design, control system, maintenance practices, etc.)?*

**Eric Hennings, Tech Services Manager, Shaw Energy and Chemicals Group, [eric.hennings@shawgrp.com](mailto:eric.hennings@shawgrp.com):** A mentor once told me, “It’s very easy to shut down a cracker. The important part is to avoid the nuisance shutdown.” **Instruments** which direct the catalyst slide valves to close have come a long way in increasing the reliability of the safety system. These include redundant

transmitters with voting logic as well as other primary devices. Instrument purges are from the same source and must be clean and dependable. If a low signal selector is used to throttle the slide valve as the delta P decreases, pay particular attention to the tuning factors, which are usually too slow to close the slide valve during an upset.

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Mechanical improvements include a cold-wall design to minimize stresses. Enhanced reservoir for high pressure hydraulic fluid and “fail-safe” slide valve closure are now part of normal design.

Maintenance is enhanced by eliminating flanges and using “lip seals” where appropriate. Avoid wet steam in purges and consider spring-loaded “dead-man” valves for blast connections. Pay particular attention to stem

packing quality, especially for plug valves. As part of energy isolation during maintenance, isolate the hydraulic oil pumps and completely depressure the reservoir.

## FCCU Turbomachinery Efficiency

*Energy consumed by turbomachinery is a major cost in refinery operations, particularly in the FCCU. How is operation at reduced throughput affecting the way refiners mitigate WGC and MAB energy “inefficiency”?*

**Eric Hennings: Energy Efficiency:** At lower throughput, the reactor pressure will decrease. This allows lower pressure on the regenerator and blower horsepower. As an aside, the surface condenser may produce greater vacuum. Turndown of the air distributor is extended at the lower density air, reducing

steam requirements even further. Often, the feed preheat can be reduced at reduced coke, which not only improves conversion, but may allow shutdown of the fired heater. Anti-surge controls on the blower and wet gas compressor (WGS) can be challenged, which may reduce spillback and horsepower. In

some cases, the operating control line is well away from the surge line. This extra safety factor may not be apparent at full rate. Another consideration is use of “extra” WGC capacity to reduce supplemental steam to the riser, required for proper velocity during turndown operation.

## Analyzing Hot Spots

*Considering the age of many older FCCUs, there is growing concern that specific hot spots in the unit’s piping and refractory lined systems will push the unit past ASME safety limits. How can refiners cost-effectively analyze hot spots for stress and strain before they become a problem?*

**Eric Hennings: Hot Spots:** As hot spots arise, it is essential to keep the hot spots cool. This is normally accomplished with steam for a small area. As the area increases, a steam manifold and spray distributor is used. As the hot spots become more challenging, a water mist

(or even a water spray) can be used for enhanced cooling.

Refiners will enhance monitoring, using IR camera and other thermal devices. They will also monitor for “bulging” or other indications of deformation and stress. A plan for emergency

repairs is also formulated. Refer to Ken Fewel’s presentation (“Analyzing Hot Spots for Stress and Strain Using Finite Element Analysis,” Shaw Energy and Chemicals Group, CAT-10-103) during the 2010 NPRA Cat Cracker Seminar.

## Avoiding Shutdowns due to Catalyst Losses

*In troubleshooting catalyst losses, can you describe any cases where a unit shutdown was imminent (e.g., severe cyclone failure) if the losses could not be stopped quickly? What is your recommendation for avoiding shutdowns due to excessive catalyst losses?*

**Jeff Koebel, Senior Technical Service Manager, Grace Davison Refining Technologies, [jeff.koebel@grace.com](mailto:jeff.koebel@grace.com):** In cases where catalyst losses are ongoing and getting worse, it can take weeks or even months before the losses get to the point of requiring a shutdown of the unit. Sometimes the losses never get bad enough and the unit can run until the next planned turnaround. Thus, it is not typical for an ongoing catalyst loss situation to get to the point where a quick decision needs to be made about shutting down the FCC. More often, these cases involve considerable planning in advance of the shutdown and the timing of the shutdown is more dependent on when all the necessary resources can be pulled together.

Cases where the catalyst losses start suddenly are more likely to require this type of decision. A common situation is that there are severe catalyst losses following a restart after a shutdown. The shutdown could have been for a planned turnaround or for just a quick issue in the unit. Whatever the reason, something happens during the shutdown that compromises the catalyst containment system and the catalyst losses during the restart attempt are unsustainable. Either the losses are stopped quickly or it becomes necessary to abort the startup attempt and try again. If multiple restart attempts result in the same trouble, a full inspection of the cyclones is generally necessary. Common causes of such trouble are blocked diplegs that result from coke spalling, refractory loss, stuck dipleg valves, or defluidized catalyst.

**Ray Fletcher, Senior Technologist, Intercat Inc., [rletcher@intercatinc.com](mailto:rletcher@intercatinc.com):** Catalyst losses resulting from a cyclone or plenum hole have a tendency to begin slowly with catalyst loss rates increasing dramatically as the size of the hole increases. As the cyclone hole increases in size the catalyst losses will first be observed by losses of the smaller (PSD) particle size distribution (0-40  $\mu$ ). As the 0-40  $\mu$  fraction drops many units will begin to experience erratic fluidization. Exxon Model IV units, units equipped with hybrid angled standpipes and units equipped with long standpipes and few aeration taps will be more sensitive to the loss of fines. In severe cases, poor fluidization may result in an unplanned shutdown even if the opacity &/or

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particulate emissions levels are within emissions constraints.

One temporary solution, albeit non-optimal, is to initiate an attrition source in the unit to intentionally produce fines to improve fluidization. The most commonly used attrition source is via the dispersion steam. Intentionally initiating an attrition source will result in increased opacity and particulate emissions. Furthermore, most of the fines being extremely small will be lost from the regenerator almost immediately. It is recommended that this option be exercised as a last resort.

An alternative solution occasionally attempted but with poor results is to recycle electrostatic precipitator bin #1 fines into the FCC unit. This is accomplished through either the fresh catalyst loader or through an additive loader. This material being extremely fine many times will not flow well resulting in substantial difficulties for the

FCC operators. Additionally, this very fine material will be lost from the FCC unit almost immediately upon injection.

A better solution is to inject a low average particle size catalyst additive directly into the circulating inventory to improve fluidization characteristics. Such materials are usually available for immediate shipment by additive suppliers such as Intercat. The average particle size of this material is approximately 50  $\mu$  with less than 5% 0-20  $\mu$  material. These fines may be injected via an additive loader. The FCC process engineer will be able to precisely control injections into the unit to stabilize fluidization. Additionally, the "F-Prop" calculation can be used to estimate the amount of fines necessary on a daily basis. This will assist the refinery in acquiring sufficient material for use until a shut down for repair is possible.

The controlled injection of such material will enable the refiner to pull

down feed tanks when necessary and to schedule a shut down for cyclone repairs at a time that is most convenient for the refiner.

**Eric Hennings: Catalyst Losses:** Rapid loss of catalyst can occur when the operation of one or more of the cyclones is compromised. Immediate increase in e-cat loading may allow time to re-establish proper operating conditions. E-cat can be supplemented with ESP fines or outside emergency purchases. Some refiners have been successful in resealing a stuck dipleg by rapidly bouncing the regenerator pressure. Since this involves backflow of catalyst, it is only used as a last resort.

Coke can also build in the reactor cyclones, partially blocking catalyst discharge. Use of specialty "settling chemicals" in the slurry product tank can allow continued FCC operation.

## Re-Optimization of Underutilized FCCUs

*What defines FCC under-utilization and where do you look for profit improvement in situations?*

**Ann Benoit, Technical Service Representative, Grace Davison Refining Technologies, ann.benoit@grace.com:** An FCCU can be considered under-utilized when the unit is no longer limited by processing constraints. This is a good question considering some refiners are cutting crude rate for economics, which sometimes limits the charge rate on the FCCU. The lower charge rate will typically alleviate multiple unit limitations. Some typical limitations are air blower, wet gas compressor, catalyst circulation, and regenerator bed temperature.

Several options can be considered when the FCCU is no longer fully utilized. For example, if the unit has available air blower capacity, it might be profitable to process other streams to fill up additional capacity and utilize the additional air. Purchased feed or internal refinery streams such as resid may be an option if economics are positive and logistics allow. Consider recycling heavy cycle oil or slurry as an option to utilize excess air blower capacity. If additional conversion is desired, reactor temperature and/or feedstock temperature can be adjusted to use remaining air blower capacity. Things to consider when increasing

reactor temperature are metallurgy, refinery fuel gas balance, wet gas compressor, and regenerator bed temperature limitations. Lower feedstock temperature will provide additional conversion by increasing catalyst circulation and will consume available air blower capacity.

If the unit is no longer wet gas compressor limited, ZSM-5 might be an option. ZSM-5 is a catalyst additive that produces additional propylene, butylenes, and gasoline octane and can be used to fill up downstream units such as the Alkylation unit or increase product sales.

It is also a good idea to re-evaluate the current catalyst strategy since conditions have changed and the unit is no longer limited by processing constraints. Changing your catalyst strategy can be as simple as taking a look at fresh catalyst additions per barrel of feed to determine what the optimum point is for the new situation. Models can also be utilized to determine the optimum activity. Catalyst reformulation may also be considered due to the change in unit conditions. Catalyst type, zeolite surface area, matrix surface area, and unit cell size can be re-optimized to the new conditions. As discussed with catalyst, it may make sense to re-optimize additive usage as well.

It is important to look at different optimization options to improve the profitability of the FCC during times of under-utilization. Overall refinery economics, configuration, and limitations need to be considered to help determine which options are the most profitable.

### **Eric Hennings:**

The FCC is traditionally designed to produce gasoline. As a general strategy during unfavorable gasoline economics, diesel is optimized by extracting this material from the cat cracker feed. This has a very positive effect on cetane, if diesel hydrotreating is not limited. Note that LCO is very low cetane and contains some of the more onerous sulfur species for deep hydrotreating.

Often, additional resid can be added to the feed recipe, since additional coke can be tolerated. This may require catalytic changes to accommodate the higher metals or increased diesel. Other candidate feeds are non-aromatic naphthas, which can be cracked to propylene-rich LPG.

Refer to Steve Gim's presentation ("FCC Opportunities at Lower Throughputs," Shaw Energy and Chemicals, paper AM-10-174) during the 2010 NPRA Annual Meeting. ■

## EDITORIALLY SPEAKING

# Newest Technologies Provide Low Cost Alternatives to Operational Challenges

There is a steady long-term trend in productivity and efficiency in refinery operations that are providing some well positioned technology suppliers with opportunities to further improve capacity and efficiency, while reducing regulated emissions, such as NOx.

Capital expenditure reductions since 2008 have compelled improvements in processing and operating strategies for running a “re-optimized” refinery at reduced rates for thermal processes (e.g., preheaters, crude unit furnaces, etc.) and major conversion units, including hydrocrackers. Some operators are making better use of the advanced process control systems they purchased in the robust years between 2005-2008, improving productivity against a backdrop of 80% or less utilization rates.

Productivity growth of about 1.5% in the second half of 2010 is significant. While this may seem small, a one-percentage point gain in annual productivity growth produces more than a 20% increase in output per hour. Improvements and falling prices for computers/servers, and analytical equipment (e.g., near infrared [NIR] on-line analyzers, vibration monitoring systems, etc.) will continue to help refiners get more work done.

Improved process technology plays a large role in productivity and efficiency

(e.g., less recycle, better thermal utilization, less catalyst consumption, etc.). While it may seem presumptuous to say that there’s plenty of cutting-edge technology already in existence yet not widely used, the point is that productivity could grow more than 1.5% annually if the industry makes full use of technology.

Moreover, productivity gains from cost cutting rounds implemented by refiners in the last two years are already starting to plateau. Most have little choice but to continue to do whatever cost cutting it takes to mitigate flat or negative margins, which is why many are learning to use the technology that they’ve already bought to enhance efficiency. For some refiners, such as some of those facilities on the US East Coast (PADD I), continued efforts to reduce costs eventually led to shutting down the refinery altogether.

For those facilities that continue to operate and have long-term plans to compete in the refining market, low cost/low risk technology investments that can increase unit efficiency in the current market is attracting their attention. This is where some of the recently announced low-cost technology designed to increase capacity and reduce emissions, such as the CONOx lance technology for increasing FCCU capac-

ity and reducing FCC regenerator NOx emissions is of keen interest to many refiners. The low-cost, easy-to-install technology that was jointly developed by Shell Global Solutions and Praxair can supplement or enhance existing NOx and CO reduction technology (e.g., FCC catalyst additives, regenerator re-design, etc.).

Another example worth mentioning is that it has taken a while for refiners to increase production and efficiency of recently installed hydrocrackers, not because of problems inherent with the technology, but because not enough feedstock (within a certain boiling point range) is available for these units. Utilization rates therefore fall short of productivity goals and expectations.

But the long-term challenges for many facilities still depend on how quickly they can respond to market and seasonal changes against a backdrop of more regulations. Going forward into 2011, the *Refinery Operations* website Refinery-Operations.com will serve as a repository for technical and operational practices in the refining industry, where archived publications, white papers, Q&A forums, etc., can serve as a basis for “data mining” of developments in refinery operations, maintenance practices, automation and turnaround procedures. ■



## CALENDAR OF EVENTS

### NOVEMBER

29 Nov- 1Dec. *ERTC 15<sup>th</sup> Annual Meeting*, Istanbul, +44 (0) 207 484 9700, [www.gtforum.com](http://www.gtforum.com).

### JANUARY

18-21, *Refineries Asia 2011*, IBC Asia Pte Ltd, Singapore, [info@ibcasia.com.sg](mailto:info@ibcasia.com.sg), [www.ibc-asia.com](http://www.ibc-asia.com)

23-26, *Chemtech World & Industry Automation & Control*, Jasubhai Group, Mumbai, India, [sales@jasubhai.com](mailto:sales@jasubhai.com), [www.jasubhai.com](http://www.jasubhai.com)

### FEBRUARY

13-16, *Hydrogen Conference & Expo*, National Hydrogen Association, Washington D.C., [info@hydrogenconference.org](mailto:info@hydrogenconference.org), [www.hydrogenconference.org](http://www.hydrogenconference.org)

23-25, *ERS FCC & Hydrocracking*, Eurotek Refining Services Ltd, Windsor, London, [enquiries@eurotek-refining.co.uk](mailto:enquiries@eurotek-refining.co.uk), [www.eurotek-refining.co.uk](http://www.eurotek-refining.co.uk)

### MARCH

20-22, *NPRA Annual Meeting*, San Antonio, Texas, +1 202 457 0480, [www.npra.org](http://www.npra.org)

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