REFINERY OPERATIONS

Engineering Solutions, Maintenance, Reliability, Automation and Equipment Relevant to Refinery Processing and Operations

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FEATURE

Applying Maximum Activity FCC Catalyst to Hydrotreated Feeds

Rosann Schiller, Yuying Shu, Ann Benoit and Rick Wormsbecher, Grace Davison

Severe FCC feed hydrotreating improves feed "crackability" while providing other measurable benefits to FCC units constrained by NOx and SOx limits (i.e., decreased sulfur and nitrogen content). However, relative to VGO feeds, important changes in operating conditions must be considered when processing hydrotreated feeds. For this type of "clean feed" processing, a refiner can benefit from a new catalyst system developed for maximum activity and coke selectivity.

This maximum activity catalyst technology was discussed at the recent Grace Davison Refining Technologies Seminar. A presentation, "*Alcyon*™: New Maximum Activity FCC Catalyst," (Schiller, et al) presented hydrotreated FCC feed cases for clean feed operations requiring maximum delta coke. The authors showed how the enhanced activity of *Alcyon*™ alleviates circulation constraints while improved coke selectivity provides increased conversion.

A moderate activity formulation of the *Alcyon*™ technology maximizes gasoline pool barrels while maintaining wet gas compressor load. Commercial trial observations graphically showed how this technology delivered additional delta coke at constant catalyst additions, in addition to improved coke selectivity and enhanced gasoline selectivity.

As previously noted, severe hydrotreating of FCC feedstock is one means to reducing sulfur and nitrogen while increasing hydrogen content. Typical ranges of feed hydrogen content are 11.8% (aromatic feeds) to 13.5% (paraffinic feeds). For a constant coke operation, the conversion level after hydrotreating can be calculated from the hydrogen balance. If the feed is hydrotreated, the hydrogen balance requires that conversion must increase for the same coke yield. For example, at 5 wt% coke in fresh feed, a hydrotreated feed (13.0 wt% hydrogen) will result in an 80 wt% conversion, while a VGO feed (12.5 wt% hydrogen) will result in a 70 wt% conversion.

More bonds are broken at higher conversion as measured by molar expansion (mol/mol basis). At constant coke, more bonds need to be broken to maintain the hydrogen balance after a change in feedstock quality. For example, at a constant coke of 3 wt%, a VGO feed shows a molar expansion of about 3.7 compared to a molar expansion of about 4.425 for a higher conversion hydrotreated feed. For reference, a molar expansion of 4.0 means that three bonds are broken in one feed molecule to produce four product molecules. At high conversion, more moles of product will need to be compressed, leading to concerns that the wet gas compressor may begin to limit the process.

Changes in Delta Coke

Contributions to delta coke change after hydrotreating (i.e., "clean" FCC feed). A significantly higher percentage of the delta coke needs to be supplied by the FCC catalyst with clean feed processing. This is because the delta coke contribution from feed carbon and contaminants have been significantly reduced after hydrotreating, relative to the amount of delta coke contributed by feed carbon and contaminants seen in VGO feeds.

In consideration of the shift in delta coke sources (i.e., catalytic) observed after hydrotreating, the *Alcyon*™ catalyst activity should provide the right amount of delta coke.

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Burning torch oil or recycling slurry to provide delta coke is detrimental to the operation. In addition, the decreased regenerator temperatures seen in units processing hydrotreated feeds lead to several operational concerns, including shifting sources of delta coke, increased circulation rates and potential emissions problems.

The *Alcyon*™ FCC catalyst technology has been developed for applications that require maximum activity and delta coke. At constant surface area or unit cell size (UCS), *Alcyon*™ is more active than a traditional catalyst; requiring less C/O to achieve conversion. Conventional routes to improved catalytic activity are increasing surface area and/or rare earth to increase the total number of active sites. The proprietary modification of Grace Davison's USY zeolite increases activity per unit of surface area (constant total active sites) by enhancing the surface concentration of reactants. The cracking rate (R) is proportional to the number of active sites (N) and the surface concentration of the hydrocarbons on the catalyst (θ):

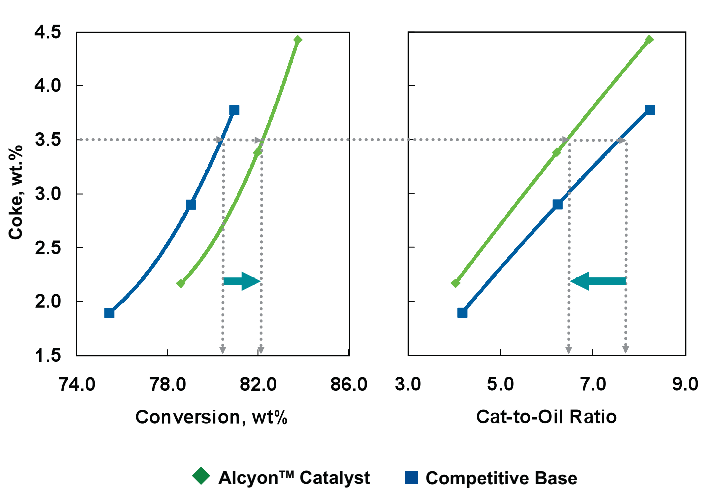
$$R \sim N \times \theta$$

Wet Gas Compressor Constraint

In one case where the FCC operator used a competitive benchmark technology to process hydrotreated feed, a wet gas compressor constraint became a concern. If ROT is reduced in this case, conversion targets cannot be achieved. However application of *Alcyon*™ can maintain conversion at reduced ROT. This catalyst technology will also provide high delta coke but improved coke selectivity, while also delivering excellent gas selectivity, creating room against the compressor constraint.

The catalyst's high coke selectivity and activity was demonstrated in another case comparing a competitive catalyst. At a constant coke of 3.5 wt%, the *Alcyon*™ catalyst was about 2.0 wt% higher in conversion and a C/O ratio that was almost 1.25 units lower than the competitive catalyst. The catalyst also delivers more activity, yet better coke selectivity

Figure 1



compared to the benchmark catalyst (figure 1). Even with higher conversion, the catalyst minimizes the load on the wet gas compressor, reducing the wet gas yield by as much as 5% compared to a competitive catalyst in one demonstrated case, in addition to the advantages shown in Table 1 and Table 2.

Table 1. At constant conversion, the higher activity *Alcyon*™ reduces dry gas, increases gasoline selectivity and makes lower coke.

	Alcyon™	Competitive Base
Delta Coke	0.54	0.46
C/O Ratio	6.4	9.2
Conversion	82	82
Hydrogen	0.05	0.12
Dry Gas	2	2.5
Propylene	5.5	6
Total C3s	7.2	7.7
Total C4 olefins	5.9	6.2
Total C4s	14.8	15.7
Gasoline	54.3	51.9
LCO	14	14
Bottoms	4	4
Coke	3.5	4.3

Table 2. At constant activity, *Alcyon*™ increases conversion, maintains dry gas, increases gasoline selectivity and decreases bottoms.

	Alcyon™	Competitive Base
Delta Coke	0.54	0.46
C/O Ratio	9.2	9.2
Conversion	84.7	82
Hydrogen	0.06	0.12
Dry Gas	2.5	2.5
Propylene	5.9	6
Total C3s	7.9	7.7
Total C4 olefins	5.9	6.2
Total C4s	16	15.7
Gasoline	53.9	51.9
LCO	12.3	14
Bottoms	3	4
LCO/Bottoms	4	3.6
Coke	5	4.3

Incresed Hydrotreater Severity

In the FCC, *Alcyon*™ will achieve conversion targets even at reduced ROT. In one commercial application where a refiner increased the severity of the FCC feed hydrotreater, new heat balance requirements had to be satisfied while remaining within circulation constraints and maintaining yield selectivity. In the trial objectives with *Alcyon*™,

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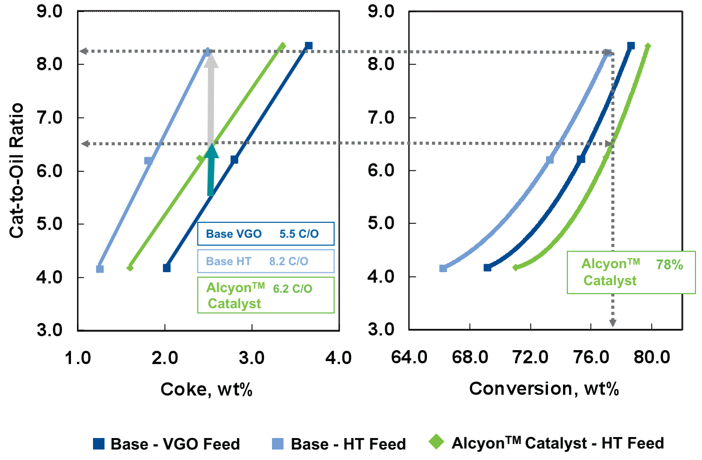
MAT increased by two units (2.0) at constant catalyst additions; regenerator temperature and circulation was maintained; improved coke selectivity was realized in spite of a higher delta coke (relative to base catalyst); and product yield was maintained. By delivering additional delta coke, the catalyst satisfies heat requirements at lower C/O yet still yields higher conversion.

At constant activity and C/O ratios ranging from 6.0 to 8.0, *Alcyon*™ delivers better selectivity when compared with a base catalyst, yielding slightly higher gasoline, even at lower C/O (figure 2). At constant coke, *Alcyon*™ was also shown to enhance gasoline yield, despite higher delta coke.

For gasoline pool maximization, the *Alcyon*™ G has the formulation flexibility to moderate activity for less severe operation. Some of the benefits include enhanced butylenes selectivity and maintained or reduced wet gas. At constant LPG, the new formulation has been shown to maximize gasoline pool barrels. ■

Editor's Note: This article was based on a presentation from the Grace Davison Refining Technologies 2010 Houston Seminar: "*Alcyon*™: New Maximum Activity FCC Catalyst." Further elaboration can be obtained by contacting the primary author, Rosann Schiller (rosann.schiller@grace.com).

Figure 2

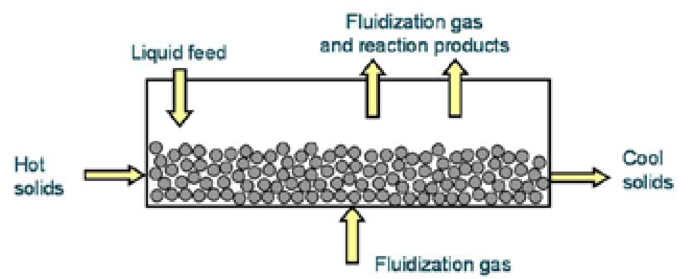


PROCESS OPERATIONS

Improving Upgrading Economics through Technology: Update on I^{Y}Q Upgrading

With a steady decrease in the API gravity of hydrocarbon feedstock there is a general consensus that additional upgrading capacity will be required in the 2015 time frame. In the current environment upgrading economics are challenged, related in a large part to the open art nature of the incumbent upgrading technology, delayed coking. Comparing upgrading technologies is surprisingly simple: The winner provides more high quality liquids at a per barrel capital investment that is no greater than the current benchmark. The advantage realized on netbacks can be leveraged in a number of ways, for example, by enabling the smaller scale required for upgrading at the resource, or by increasing the status of the upgrading investment beyond "maintenance of business".

ETX Systems Inc. has developed an upgrading technology that has the attributes required to challenge the current upgrading benchmark. The patented technology is able to increase the yield of valuable liquid products from a barrel of heavy Canadian crude from the Athabasca region by 9% (volume basis) while routing proportionally more hydrogen to these liquids from the native barrel. The innovation lies in how the benefits of coking on a fluidized bed can be achieved



at lower operating temperatures. ETX Systems has achieved this result by introducing the established cross-flow fluidized bed technology into coking service.

As with other commercial fluidized coking technologies, the fluidized solids provide the heat required for the cracking reactions. However, due to the cross-flow nature of the bed, short circuiting of unreacted feed is eliminated, dramatically reducing the size of the reactor required for processing. The reduction in capital required gives the technology an economic edge on its competitors, which is partially leveraged to enable lower operating temperatures for the reactor, providing

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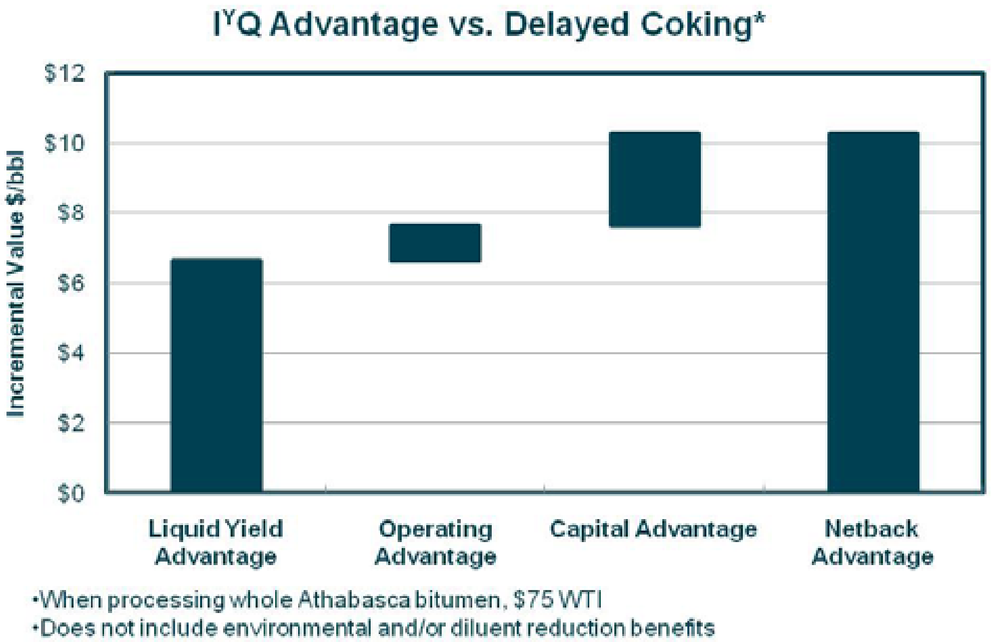
the bulk of the improved yields, without compromising quality by overcracking. From an integration perspective, the inert fluidization gas is used as a stripping agent for the feed, eliminating the need for atmospheric and vacuum topping. This reduces the capital intensity by 25%, compared to an equivalent delayed coking scope.

The development program of the IYQ Upgrading technology has progressed since 2000, with all aspects validated by independent third parties at defined stage gates. In 2009 the company completed a pilot demonstration aimed at validating the yield and quality claims of the technology. A number of configuration studies have been carried out by third parties, confirming the capital claims. The final step in the development of the technology is a demonstration of operability. This necessitates piloting at a 1,000 bbl/d scale. ETX Systems has sourced a site for this demonstration, with plans to integrate into existing infrastructure to minimize the capital outlay for the exercise. The feasibility study for this project has been completed, with the design basis memorandum scheduled for completion in 2011.



Company Profile

ETX Systems is a fit-for-purpose entity, incorporated to commercialize the IYQ Upgrading technology, which has been under development for over a decade. The technology currently enjoys active support across industrial, government and private sectors. The company owns all of the patents and intellectual property associated with IYQ upgrading. The company employs a complement of business, technical, and operations personnel assembled strategically to execute a focused business plan. For more information, please contact Wayne Brown, Chief Technology Officer, or visit us at www.etxsystems.com.

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Oxygen for Sulfur Recovery Plants

Projected increases in refinery hydrogen, oxygen and sulfur recovery capacity applications have many process engineers updating their understanding of new technology available from suppliers. While these applications are not new to the refining industry, it is the changes in refinery configurations required to remain competitive that has ushered improvements to these applications. The recent "Applications of Oxyfuel Technology" industry seminar held by Praxair in Houston, discussed existing and future applications in various industry segments. For the refining industry, Praxair's Senior Business Development Manager, Jack Olesen, overviewed oxygen (O2) enrichment applications relevant to FCC operations, sulfur recovery units (SRUs) and oxygen enhanced reforming (OER). The following are excerpts from Olesen's presentation specifically in the application of O2 enrichment to SRUs:

The refinery of the future will process heavier and more sour crude while also having to meet cleaner (lower sulfur) product requirements. These refinery configurations will include more coking capacity (i.e., generating higher H2S levels and bigger loads on the sulfur plants), more distillate capacity and less gasoline production. Additional sulfur recovery capacity is therefore required.

In the modified Claus process, sulfur recovery efficiencies approach 97%. Effluent gas (tail gas) is either routed directly to a tail gas incinerator or to a tail gas clean-up system (TGTU). The gas clean-up step involves sub-dewpoint adsorption, direct oxidation and reduction with amine scrubbing. This step is expensive and O2 can help because it improves sulfur recovery. Oxygen enrichment also helps in the destruction of ammonia.

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Praxair has been supplying SRU O2 enrichment capabilities since 1983. In the industry, more than 100 refinery SRUs using O2 enrichment are based on three possible modes, including simple enrichment (< 28% O2), enrichment where the SRU burners are designed for O2 concentration higher than 28% (> 28% O2), and very high O2 enrichment (80-100% O2).

With simple enrichment, capacity is increased by 20-30% by enriching the air up to 28% O2 in the existing air blower discharge with the burners and metallurgy being the limiting factor. For those cases where the burners are designed for 29-45% O2 enrichment, capacity can be increased by 75% with reaction furnace temperatures being the limiting factor. Capacity can be increased by 150% for the very high oxygen enrichment mode (up to 100% O2). Addition of O2 at such high levels typically requires retrofits, such as inter-stage cooling or a second reaction furnace. ■

Note: For further elaboration, contact Jack Olesen at Praxair (jack_olesen@praxair.com).

UOP's Steven Kleinman Elaborates on How Legacy Refineries Can (and Must) Improve

For many years, manufacturing operations have been moving from North America and Europe to developing countries in Asia and elsewhere. The refining industry has not been spared and recently the trend has accelerated due to new construction and overcapacity. But the reasons underlying the transformations occurring in refining are different than in other types of manufacturing and therefore the responses to remain competitive are different.

Labor expenses make up a large percentage of the cost of assembling discrete items, be they children's toys or computers. Salaries are a much smaller fraction of the costs of refined products – raw materials, energy, and capital costs are the major expenses. The unit costs of these items are not very different from one geographic location to another. The advantage these new, larger refineries hold over the older refineries is in the efficiency of manufacturing provided by their scale and newness. And with newness comes updated technologies, the ability to handle a wider range of crudes, higher conversions and lower energy usage.

But older refineries have a couple of offsetting advantages. They are typically closer to the consumer, reducing transportation costs. Capital expenses have been paid off, eliminating financing costs. But the scale advantage may still be too much if the facility does not take steps to close the efficiency gap.

Investments that enable the legacy refinery to process less expensive feedstocks, such as heavy bitumen crudes can provide a cost advantage. Upgrades that reduce or eliminate low value products such as fuel oil and coke can pay off generously. Building in the flexibility to respond to changing product demand, by trading off gasoline production for aromatics or diesel products can increase a refinery's profits. Improving the value the refinery adds to its product slate is the way to remain competitive. UOP is uniquely positioned with the expertise and technologies to examine a refiner's current operations and help organizations remain viable in this challenging environment. ■

INDUSTRY NEWS

Avoiding Capital Cost of Flue Gas Scrubbers

With the high capital cost of wet gas scrubbing, more refiners are considering alternative approaches to controlling emissions of SOx, NOx and particulate matter (PM) by combining FCC additives and off-gas filtration. There are almost no capital cost requirements with environmental additive use. Hardware based filtration technology is currently available to meet future PM reductions to perhaps 10-30 mg/Nm^3.

The catalyst additive/filter approach according to a paper co-written by Pall Corporation and Intercat Inc. at the 2009 NPRA Annual Meeting takes note that "the barrier filter allows a refiner to optimally dose additives to control SOx and NOx in a dry state without any increase in PM emissions.[1] ■

1. Sawyer, John, Hanif Lakhani and Kurt Schuttenberg, Pall Corp., and Ray Fletcher and Martin Evans, Intercat Inc., "An Alternative to FCC Flue Gas Scrubbers," paper # AM-09-38, 2009 NPRA Annual Meeting, San Antonio, March 22-24.

Increases in Main Fractionator Fouling

There appear to be several different types of fouling in main fractionator bottoms (in the slurry circuit) occurring in the industry, depending on the feedstock and operating conditions, including precipitation of asphaltenes, coke polymerization found more commonly with paraffinic feeds, inadequate bottoms cracking, etc.

Coking capacity that started coming on line after 2007 has resulted in higher levels of fouling directly attributed to processing large amounts of heavy coker gas oil. This type of fouling can be attributed to coke precursors in the thermal cracked stocks. The fouling tendency is heavily influenced by the FCC main fractionator bottoms temperature. While many operators limit bottoms temperature to about 680°F, some units run as high as 700°F without serious fouling problems. Residence time is also a factor, and certain refiners target a net bottoms rate of 5-8 vol% of feed.

Coking in the main fractionator is a function time, temperature, FCCU severity, and chemical treatment programs. For example, fractionator bottoms residence time can range from about 10-20 minutes. This residence time interval is calculated from the fractionator bottom volume and the total liquid rate of HCGO plus wash. The maximum bottoms temperature is about 700°F and is a function of riser severity.

Chemical treatment programs help limit FCCU bottoms circuit coking and fouling are available from a variety of technology suppliers, such as ITW in Italy (www.itw.it). There are a variety of specialized companies capable of addressing this problem and should be deferred to for additional detail. ■

Increasing Run Lengths

With the under-utilization of refining capacity still expected to be continuing into 2011, particularly in mature markets, continuous improvement in efficiency and reliability is the current emphasis. Despite reduced refinery utilization that began in late 2008, there is a strong effort to extend run lengths. For example, typical FCCU run lengths between planned maintenance turnarounds have been averaging about four years. At utilization rates falling below 80%, extending the turnaround interval to five years is a reasonable target for refiners.

The benefit of the reduced downtime incurred by extending run lengths of major units must be weighed against the cost of a potentially longer turnaround, and higher operating cost toward end of run (EOR). The lengths of time between turnarounds and causes for unplanned feed outages are dependent on equipment and hardware reliability as well as consistent operations.

In between runs, it is important for operating personnel to have the training and experience to be able to anticipate potential causes for operating problems. If problems do occur, a good operating staff may have the know-how to return the unit to stable operation as quickly as possible. During the past five years, some of the more frequent FCCU operating problems have been related to unexplained or increasing catalyst losses, erratic catalyst circulation, circulation problems in transfer lines linking the reactor and regenerator, main fractionator hydraulic problems and regenerator afterburn, to name a few.

All of these, separately or in combination, affect impact unit reliability. The more complex the unit, the higher the probability something can go wrong. Each of the potential problems mentioned occurs periodically in most FCCUs. Recognizing the symptoms and rectifying the upset condition in a timely manner is essential to maintaining a stable and profitable operation while minimizing unwanted feed outages. ■

Applying Quench in Hydrocracking

Recent increases in unplanned hydrocracker shutdowns has resulted in higher awareness of reliable flow measurement of quench and hydrogen recycle gas for safety. Since hydrocracking is an exothermic reaction, hydrogen (with its high thermal conductivity) is used to cool the hydrocracker's reactor beds.

The number of reactor beds of course depends on the size of the hydrocracker. Some of the newest reactor vessels recently announced are over 2000 tons. At this size, one can expect at least a half-dozen or more reactor beds.

Designers normally employ specialized flow meters. The hydrogen is used as a quench gas (for cooling) and then recycled (i.e., hydrogen recycle gas). One flowmeter is installed on each quench line leading into the reactor bed.

If the proper amount of hydrogen is not present, the reactor vessel can overheat and explode. While a detailed discussion of all factors affecting hydrocracking safety, such as recycle compressor failure or reactor internals failure, is beyond the scope of this discussion, failure of quench control is cited in certain cases. Little or no quench flow could occur as the result of either controller failure or quench control valve failure. In either case, reactor temperatures would rise as a result of heat removal loss. Recovery from the failure is nonetheless possible, but the onus is on preventing the situation to begin, which is the reason for considering more sophisticated flowmeters to improve overall hydrocracker safety integrity levels. ■

Turnaround Cost Escalation Factors

Overall costs for refinery turnarounds, revamps and new projects are expected to increase. Metallurgical, refractory and hardware costs are expected to increase by over 35% per year up to 2011. Even though many downstream projects have been postponed or cancelled since mid-2008 (i.e., less than projected demand for reactor vessels, refractory, pumps, air grids, etc.), one would intuitively conclude that cost escalation factors would decrease as well. However, for certain prime movers, such as turbine/compressors systems (e.g., main air blowers [MABs], wet gas compressors [WGCs], cost escalation was 100% or higher between mid-2007 and mid-2008.

Cost escalation factors are expected to remain higher than expected due to the limited amount of fabricators, millwrights and other specialized suppliers that were in existence prior to mid-2008. Many of these small-to-medium sized job shops have heretofore shut down due to lack of operating capital while they idle "waiting for the big one."

Project development costs in the downstream industry are rising. Scarcity of labor among engineering, procurement, and construction companies, the combination of a record number of projects and a decrease in the number of skilled engineers (due to retirement), has led to project cost increases. However, Premium steels and basic commodities such as cement, copper, and diesel fuel are no longer tight in many regions as compared to early 2008.

Projects that were economically viable 18 months ago may obviously be no longer attractive.

Complicating the picture, the costs for various components of project development have not risen in unison. For example, as refinery operating costs increase, so too does the cost of operating a major unit, such as an FCCU. To name just a few cost components, the unit requires more frequent laboratory testing and unit-wide monitoring capabilities; catalyst costs have increased (as expected for ZSM-5 based systems); insurance rates that refinery/FCC contractors/licensors must carry have increased; and higher operating severities and run-lengths will require upgrades to existing hardware. To be sure, only recently has the downstream process industry begun to factor in costs from cap and trade regulations.

As previously noted, costs have escalated dramatically over the past few years for the technical expertise and services that have added value to FCCU projects. In addition, these FCCU projects must frequently be coordinated or synergized with other major projects, such as a crude vacuum unit upgrades or expansion of hydrotreater and hydrogen production/recovery projects. ■

AUTOMATION

Facility Integrity Strategies Improves Uptime and Operational Preparedness

Analytical based frameworks capable of improving uptimes, plant performance and reliability of crucial assets seems to have developed at a faster pace for the upstream oil and gas exploration and production business, relative to the downstream refining and petrochemical processing business.

With the amount of unscheduled maintenance currently reported in the downstream refining and petrochemical business, these predictive, analytical based frameworks may become more desirable to refining enterprises in order prevent disruptions of refinery operations.

The refining industry is heavily focused on understanding the present and future state of equipment, processes and environmental concerns. In many cases, the processing industry has modeled potential safety and reliability events based on historical data. While this is an important component, total dependence on historical data has in many times resulted in over-investment (e.g., fractionation towers with expensive metallurgy [310 SS] instead of cheaper carbon steel) to avoid unplanned unit shutdowns.

It would be more cost-effective if refiners could instead identify potential problems before they result in an "event." This helps maximize asset availability and investor confidence in the facility's potential for long-term profitability.

According to SAS Global Oil and Gas Practice's Director, Advisory and Business Development, Horia Orenstein, "Maintenance is too intensive for prevention and too inefficient for correction. Reliability risks are seldom adapted to the true facility condition, leading to plant safety issues and economic loopholes."

Orenstein noted that the industry typically assumes the process should behave as planned. If a bottleneck or failure does indeed occur, it is treated as an exception and there is an effort to limit the impact if a failure does occur.

An important aspect with the use of predictive models for effective asset management, according to Orenstein, is to "filter" patterns of symptoms which lead to disruptive events, notify operators of the impending disruptive event and automatically trigger appropriate measures and automated procedures to avoid the negative event (e.g., turbine/compressor failure, alkylation unit accident, etc.). ■

Sharing Information to Improve APC's Effectiveness

Application of advanced process controls (APC) in hydrocarbon processing applications to increase throughput has expanded to nearly all major refinery and petrochemical processes. In this effort, some end-users' have adopted a philosophy of having a single APC vendor for all unit applications.

Some APC experts explain that the definition of an APC "vendor" has expanded over the past few years to describe a variety of information and automation technology companies with specific areas of expertise brought together under one "brand." Many have argued that this approach is needed because of the ever-increasing sophistication of the APC technology required to analyze process data and adjust distributed control system (DCS) setpoints.

Relative to the cost of major capital equipment, such as reactors, compressors, furnaces, etc., the cost of APC systems are relatively low in terms of the benefits they deliver in improving efficiency of the continuous processes seen in the refining industry. On other projects currently being reviewed by end-users, the focus seems to be on initial price of APC implementation instead of life cycle costs, potentially leading to substantially higher overall life-cycle cost to the end-user. Some of the major factors to increasing life cycle costs with less than optimum APC/DCS include costs to keep current with required system upgrades. ■

EDITORIAL SPEAKING

Industry Improvements in 2011

This year has been extremely challenging for the refining industry. The global economy, while remaining vulnerable, continues to show signs of stabilization and improvement. If world gross domestic product (GDP) growth approaches 3% as predicted for the remainder of 2010 and 2011, we should then see responsive demand for increased electric generating capacity, chemical production and refined petroleum products.

The World Bank said in a report issued earlier this summer that global GDP is expected to expand between 2.9% and 3.3% in between now and the end of 2011. This is particularly true in economically active countries such as India and China. Eastern Europe will continue to experience substantial growth as well, with Russia and Turkey being the fastest growing economies in that area.

In the U.S. there are indications of recovery in the domestic power production industry, which could spread to other energy related industries, such as refining. Internationally, there is certainly a need for increased power production in developing countries, but new construction will be tied to the growth of other industrial entities that require substantial amounts of electricity to operate. To a significant extent, these same areas may also require significant increases in transportation fuels.

Addressing the U.S. refining industry directly, economic conditions have restricted investments in new construction. In the petrochemical industry (e.g., ethylene, aromatics, etc.), the circumstances that chemical producers face in the U.S. create exceptional opportunities for those who can develop technologies and engineer improvements that result in increased efficiency of existing process facilities.

Rene Gonzalez, Editor,
Refinery Operations

Even though there has been no growth in U.S. ethylene production capacity, U.S. based technology suppliers are participating in the expansion of China's ethylene manufacturing capacity both as a construction partner and licensor of the production technology.

In downstream petrochemicals, declining margins for operators and rising feed costs in the Americas and Western Europe have shifted new grassroots projects to low cost feedstock regions such as the Middle East and high demand growth countries such as China. Downstream projects in the USA and Europe will primarily involve smaller revamp and capital spending programs aimed at meeting increasingly stringent safety, security and environmental controls. Meanwhile, optimization of asset performance will be a priority in both upstream and downstream markets.

While the news for the energy industry seems cautiously upbeat, an important business issue is the rapid and massive transformation that is taking place in the corporate world and the effect it is having on business in general. The importance and influence of the national oil companies (NOC) continues to grow. They control most of the large, newly discovered fields. Their increased financial strength and capabilities are creating powerful new entities that operate in their own right. These powerful NOCs, and their governments, are demanding much more than oil revenues. ■

CALENDAR OF EVENTS

OCTOBER

10-13 *NPRA Q&A and Technology Forum*, Baltimore, (202) 457-0480, www.npra.org.

12-13 Central & Eastern European Refining & Petrochemicals, 13th Annual Meeting, Budapest, Hungary, +44 (0) 207 067 1800, www.wraconferences.com.

19 *ERTC Energy Efficiency Conference*, Amsterdam, +31 (0) 20 62 34 255; (fax) +31 (0) 20 62 52 997, www.gtforum.com.

27 Oct-4 Nov, *Singapore International Energy Week*, "Fueling the Smart Energy Economy," +65 6835 8000, www.singapore.iew.com.sg.

NOVEMBER

29 Nov- 1Dec. *ERTC 15th Annual Meeting*, Istanbul, +44 (0) 207 484 9700, www.gtforum.com.

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