Maximize Profitability with a Refinery-Wide Process Model

Because of the fluctuations in oil prices, the refineries are legitimately cautious, at least till the market rebalances. The changing market dynamics and stricter environment norms have only added to the complexities in the refinery operations. The article identifies specific process areas for profit improvement, as the refineries generally operate with low margins and suggests the benefits of integrating planning and process simulation tools to enhance operability.

With relentless globalization in place, hyper market volatility is the new normal. This creates increased velocity in the marketplace with fluctuating feedstock pricing, incessant commodities trading, rapid demand and supply shifts, as well as rampant currency movements. In this industry shakeup, we see new market entrants challenging traditional market incumbents. For example, the Middle East continues to stake new ground with newly built refineries while the strongest North American shale players defend their market share with great resilience.

However, refineries are fairly cautious about rising crude oil prices. ConocoPhilips chief executive Ryan Lance is quoted in The Calgary Herald, "The volatility is here to stay. Market rebalancing will extend into 2017. The inventory levels are still quite high." This industry perspective buys refineries more time before pricier feedstock kicks in eventually.

Focusing on the macro economy, Channel News Asia reported on global oil majors shedding refineries, as crude oil price takes a grounded recovery trajectory. Companies, such as Chevron and Royal Dutch Shell, are auctioning small refineries off their portfolio to trim lower margin assets. Fearing higher crude oil prices will squeeze refining margins, oil majors with refineries are rushing for the exit. This is because refineries can generally be sold at better prices versus the beleaguered exploration and production assets belonging to these companies.

Changing Market Dynamics Add to Complexity

Demand is shifting toward lighter products, and the quality of oil is changing to more sour and heavy crudes. Environmental restrictions impose tighter fuel specifications in many locations. Processing is now more challenging, expensive and complex. Selecting crude oil slates that reach profitability goals and meet final product specifications is operationally complicated, especially when refinery complexity ranges from a simple topping operation to a deep conversion facility integrated with a petrochemical plant. The probability of sustained low oil prices is forcing owner-operators to adopt cost-cutting and performance improvement programs that focus on asset utilization, downtime reduction, improved product quality and greater yield.

The goals are simple, but refineries are not. The complexities of refinery operations and configurations make the decision-making process extremely difficult, especially given the uncertainty and differences in feed specifications, product demand and economic objectives.

Volatility Bites but We Have the Antidote

Companies no longer need to be at the mercy of industry trends, as market volatility can be mitigated. Besides being prepared for sudden market shifts, refineries should look to maximizing profit and derive greater business value from their assets by capitalizing on market opportunities. Companies can transform their fortunes by leveraging innovative technologies in a strategic manner. Holistically, asset optimization is an overarching approach that forms the basis of sustainable operational excellence and profitability. In optimizing asset performance, companies make better decisions.

More specifically, refinery-wide process models can be used to identify specific process areas for profit improvement, offer alternative improvement plans, and predict and compare the impact of each alternative on refinery profits. A refinery wide modeling capability can evaluate the impact of refinery expansions or improvements, and determine operational responses to unexpected events.

A New Refinery-Wide Model

Process simulation tools have helped refineries make the right decisions and respond to operational issues. However, the standard approach to simulating processes will not deliver the step change in performance that refineries need going forward. What is required is a complete and robust engineering system that can simulate the full refinery, offer decision-support tools for effective responses and calculate costs to align with economic objectives.

Existing refinery-wide models can be cumbersome and complex. A manageable and easy-to-use refinery-wide simulation model that facilitates better decision making will allow refineries to effectively identify specific process areas in need of improvement, generate alternative improvement plans and predict the impact of each alternative on overall profitability.

Refineries typically operate with low margins of around 5% or less, their operations are heavily influenced by rapidly changing market conditions. This means that margin analysis is a crucial exercise for refineries. It is also a necessity to consider advanced engineering process simulation software, which enables refinery wide process modeling

Such a refinery-wide process model is possible with the latest advancement in process simulation technologies. This innovative refinery-wide simulation model makes use of a mixture of short-cut and rigorous sub-models. Unlike conventional refinery-wide models, these models can be maintained in house and do not require extensive support from expensive third party consultants.

The first step in developing such a refinery-wide process model is to reproduce the refinery-wide planning model. This is enabled by "short-cut petroleum reactor sub models" available within some process simulators that are an exact replica of the reactor representation used in the planning model.

Integration is the key. This refinery wide model, which is a "clone" of the planning model, has the same level of sophistication and accuracy as a planning model. The rigor of the process simulation model can be further enhanced by selectively inserting rigorous models of reactor units using graphical engineering flowsheet technology. This is made possible by the availability of complete suite of refinery reactor kinetic models in advanced process simulation software suites. This approach allows refinery process engineers to control the robustness of the model, while ensuring the necessary rigor for accurate refinery margin analysis.

This refinery-wide model uses a hybrid approach of linear models for high-level performance analysis, and fully rigorous crude distillation and reactor models for more rigorous operational analysis. The refinery-wide model can be further extended to include other rigorous sub-models, as necessary, to support various business scenarios.

Such a refinery-wide process simulation model can be used to predict the impact of capital projects, such as reconfigurations planned to tailor the refinery to different crude and product mixes. It can also be used to evaluate the economic feasibility of operational improvements, such as a change in the catalyst for the FCC unit, or to determine the right response to unexpected events, such as breakdown of a key pump.

Integrating Planning and Process Simulation Tools with a Single Flow Sheet

Varying refinery operating conditions can cause planning models, used by refinery planners, to become outdated. This makes them ineffective for optimal refinery operations planning. This is a serious concern for most refineries, which typically run on low profit margins usually around 5%. Rigorous and predictive process simulation software can help refineries update their planning model. This enables them to operate so as to make the most profitable product slate out of the most economical feedstock.

The calibration facility in process simulation tools ensures that the refinery model simulated is an actual reflection of current

Best practices to reconfigure refineries include leveraging robust refinery wide simulation models that can be developed quickly and economically. Benefits include enhanced performance, better yield, stronger feedstock processing ability, improved operational efficiency and improved profit margin.

operating conditions. Key parameters obtained from the calibrated simulation model can be transferred into the planning tool so as to update the planning model used by the tool. By sharing the same crude oil assay information, planning and process simulation models are consistent and contribute to better operational performance. Crude distillation unit (CDU) models in advanced process simulation software can be calibrated to provide configuration parameters for planning model sloppy cuts to better match plant performance. The integration of CDU modeling in the planning and process simulation tools significantly simplifies the workflow used to update the CDU portion of the planning model.

Most importantly, the workflows involved in updating the refinery planning tools, as well as the new refinery-wide process simulation model, initiates a culture of true partnership between refinery planners and process engineers. It builds a system where planners use refinery-wide planning models to conduct rapid economic evaluations, while process engineers use refinery-wide process model to provide a more accurate profit margin assessment on a case-by-case basis. This collaborative use enables a holistic view of plant operations and supports flexible and agile refining operation.

Two is Better than One

Indeed, the integration of process simulation and planning functionalities right at the heart of the plant is the silver bullet to mitigate hyper market volatility. Similarly, locking in increased refinery profitability is crucial in a world where new competitors emerge regularly and traditional strongholds get broken down. Refineries do need to adopt operational excellence to derive the benefits of business sustainability and thrive in a world of increasing volatility. ●

Sandeep Mohan
Product Marketing
AspenTech
Email: Sandeep.RamMohan@aspentech.com

Sunil Patil
Business Consulting Director
AspenTech
Email: Sunil.Patil@aspentech.com