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# Improving profit margins with a refinery-wide process model

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Refinery-wide 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. Refiners can improve profit margins in a challenging, competitive environment by ensuring that their planning models are up-to-date using rigorous process simulation software.

Profit margin analysis is a crucial exercise for refineries, which typically run on low margins—often around 5% or less—and are heavily dependent on fluctuating market conditions.

**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 (FIG. 1).

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.

**A new model for a refinery-wide model.** Cutting through complexity and driving higher margins can be achieved with a refinery-wide process 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 optimize the full plant, offer decision-support tools for fast responses and calculate costs to align with economic objectives.

Existing refinery-wide models can be cumbersome and complex. A manageable and easy-to-use solution that facilitates faster and better decision-making will allow refineries to quickly identify specific process areas in need of improvement, generate alternative improvement plans and predict the impact of each alternative on overall profitability (FIG. 2). Aspen HYSYS is a comprehensive process modeling tool used by the world's leading oil and gas producers, refineries and engineering companies for refinery-wide process simulation and process optimization in design and operations.

Such refinery-wide models are a mixture of short-cut and rigorous sub-models, and they can eliminate third-party maintenance expenses and enable quick, accurate profit margin analysis.

**Integrating planning and process simulation tools with a single flow sheet.** Simulating the entire refinery-wide process in a single flow sheet enables the evaluation of strategic options for both current and reconfigured operations. Using the process simulation model, planners and process engineers can simplify updates of planning models, evaluate the economic impact of operational improvements and unexpected events, and suggest remedial actions.

Varying refinery operating conditions cause planning models to become quickly outdated, making them ineffective for optimal refinery operations. A rigorous and predictive process simulation tool, can help keep the planning model up-to-date, thereby enabling refineries to make the most profitable product slate out of the most economical feedstock.

The first step in developing a refinery-wide process model is to reproduce the refinery-wide planning model. This is enabled by a "short-cut petroleum shift reactor model" within the process simulator that is an exact replica of the reactor representation used in the planning model. With an expanded complete suite of rigorous reactor models available in the process simulation environment—including fluid catalytic cracking (FCC), hydrocracking and delayed coking—the process engineer can selectively upgrade sub-models to rigorous models within a single process simulation environment. This allows refinery process engineers to easily manage and maintain the model, while ensuring the rigor required for accurate refinery margin analysis.

The calibration facility in process simulation tools ensures that the refinery model simulated is an actual reflection of current operating conditions. Key parameters from the models can be transferred into the planning 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.

**An integrated process simulation environment.** A refinery-wide model uses a hybrid approach of linear models for high-level performance analysis, and fully rigorous crude distillation and reactor models for planning update and engineering studies. The refinery-wide model can be further extended to include other rigorous models, as necessary, to support various business scenarios.

Integration is key. A "clone" of the refinery model can be created, so a simple refinery-wide process model has the same level of sophistication and accuracy as a planning model. The rigor of the process model can then be enhanced by selectively inserting rigorous models of sub-units using graphical engineering flowsheet technology.

The refinery-wide process simulation model, enabled by an integrated process simulation environment, 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.

Most importantly, this capability initiates a culture of true partnership between planners and process engineers, building 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. ●

**FIG. 1.** Reaching profitability goals, meeting final product specifications and complying with tighter environmental restrictions are making processing more challenging, expensive and complex.

**FIG. 2.** Refiners can improve profit margins in a challenging, competitive environment by ensuring that their planning models are up-to-date using rigorous process simulation software like Aspen HYSYS.