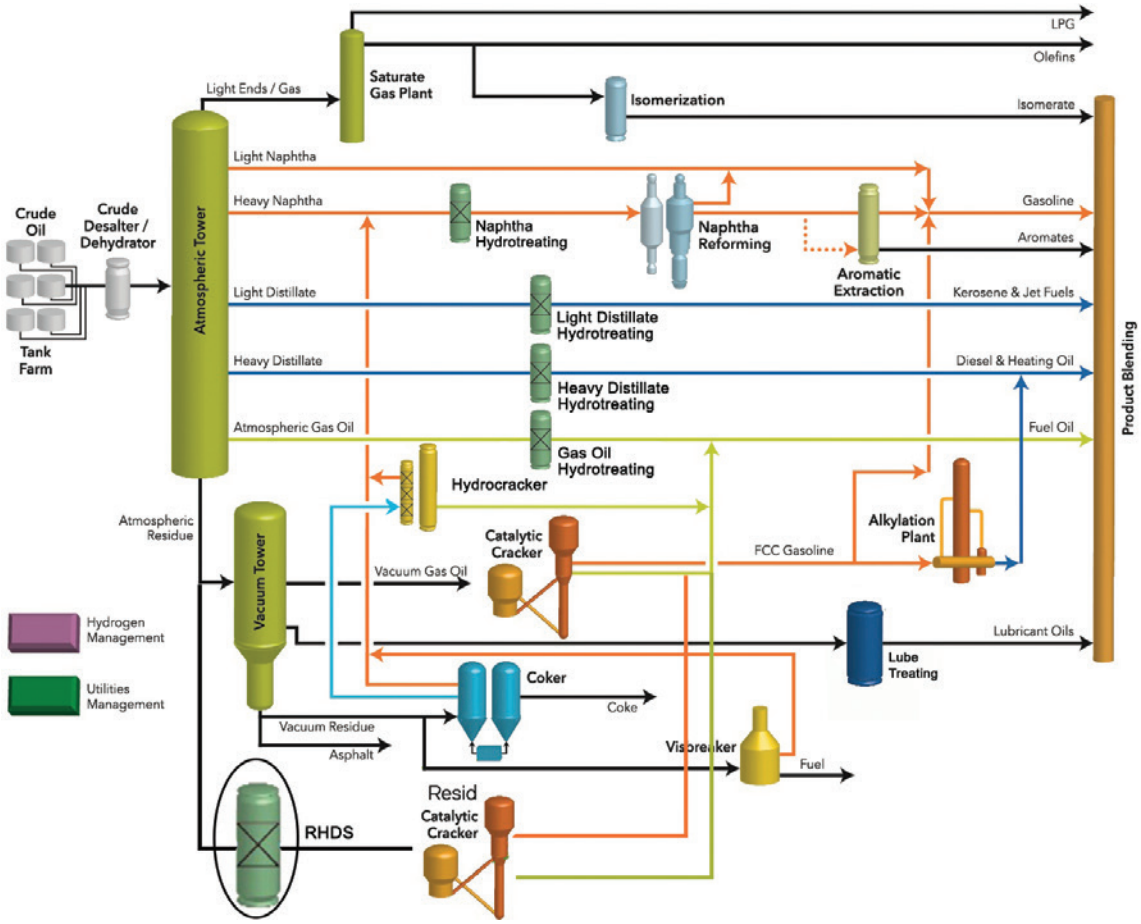
PRODUCT DATASHEET

ROMeo RHDS Reactor Model

In a refinery that processes heavy, high sulfur content crudes, the bottoms product of the atmospheric column, atmospheric resid (AR) has to go through a hydrotreating unit (Resid Hydro-DeSulfurisation units, RHDS) to remove excessive sulfur, Conradson carbon, and metals, before feeding into the reside Fluid Catalytic Cracking (FCC) unit. Similar to other hydrotreating reactor in a refinery, the RHDS reactor is a fixed bed reactor usually with multiple beds/reactors in series.



Business Driver and Solution

The RHDS unit is a critical unit to upgrade atmospheric resid and vacuum resid of high sulfur content crudes to low sulfur fuels that meet new environmental regulations. Its operation has great impact on which Residual Fluid Catalytic Cracking (RFCC) catalysts are selected and how the RFCC unit is operated. An FCC unit, depending on the production requirement, requires different crude blend feed stocks for the atmospheric column. To maximise the benefit of FCC operation, either in offline simulation and online optimisation, engineers need to include the atmospheric column in the scope, and connect the atmospheric column model with the FCC model through a model for the RHDS unit. The model for the RHDS unit needs to provide accurate prediction of the RFCC feed composition and properties.

ROMeo RHDS Reactor Model is a rigorous kinetic model for the RHDS units that works seamlessly with the ROMeo Process Optimisation open equation platform. With the Model, the user can calculate the product yields and qualities of the RHDS unit, which are usually not measured frequently. When the model is connected to an RFCC model downstream, the properties of the RFCC feed, which is the heaviest product from the RHDS unit, are available to the RFCC model. This will improve the model prediction accuracy of the RFCC model. With the model, the user now can connect CDU and RFCC models to do engineering studies such as what is the best crude blend to maximise the overall benefits, and how FCC operation demands may impact the operation of the crude unit.

Key Differentiated Features

ROMeo RHDS Model key features

- Rigorous kinetics and thermo for accurate modeling of the processes in wide operating ranges
- Structure-oriented lumping (SOL) approach for more detailed and accurate feed and product representation for components with 5+ ring structures and boiling temperatures up to 850C. Unlike the boiling temperature based pseudo-component approach, the SOL components are real molecules or lumped isomer molecules. The properties such as sulfur, nitrogen, PONA and metals are calculated from composition directly, rather than imposed to the pseudo-components.
- Feed characterisation/synthesis utilising feed distillation data, gravity, and sulfur and nitrogen contents, and/or PONA to generate feed SOL components included
- Very flexible configuration, can be configured to have one or more reactors and each reactor with one or more beds
- Predicts product composition and properties such as sulfur and nitrogen contents, Conradson carbon, and PONA
- Catalyst activities and reaction constants tunable while the model is online to maintain model accuracy with changing feeds and operating conditions
- Rigorous kinetics for metal (Ni, V and Fe) removal for accurate prediction of metal contents in the product

Configuration

The RHDS reactor model is composed of two main components, Feed Synthesis (characterisation), and Reactor.

Feed Synthesis: Generate feed composition from the reference feed by matching the plant property measurements. The measurements include distillation curve, API (or specific gravity), sulfur, nitrogen, and/or PONA.

Reactor: includes models for bed(s) and inter-bed mixer. The bed is a PFR kinetic model that includes reactions such as desulfurisation, denitrgenition, demetalisation, cracking, and saturation. There are 8 tuning parameters including overall catalyst activity, and the tuning parameters for 7 individual types of reactions. The tuning parameters for different beds can be tuned individually, or share the same values for all beds in a reactor.

The downstream separation and distillation can be modeled using ROMeo Process Optimisation standard modules. The downstream can use the same SOL component slate used by the feed synthesis and reactor, or can use a lumped NBP based component slate to save solving time. The Lump/Delumper is used to do the lumping and delumping for the recycle treat gas streams.

Summary

RHDS Reactor Model provides a key component of the refinery, RHDS units with the ROMeo Process Optimisation modeling offer. RHDS units can be simulated, monitored and optimised, alone, or with Crude and RFCC units. Rigorously tested and proven on industrial units with flexibility and accuracy, the model provides the flexibility to tune reaction parameters online, providing an accurate representation of your RHDS reactor.

Business Value

- Insight into the RHDS process such as how the operating condition can affect product yields and properties, and its impact on downstream RFCC unit such as the selection of RFCC catalysts and operating condition
- Debottleneck and drive process improvement studies such as tighter sulfur content requirements for RFCC naphtha and diesel products
- Monitor, track and report RHDS operation, i.e, tracking reactor bed temperatures and catalyst activity for peak performance and predict when catalyst should be changed
- Maximise profit by optimising the RHDS unit preferably with crude and RFCC units continuously. The integrated CDU-RHDS-RFCC RTO improves the optimisation benefits comparing to running CDU and RFCC separately by adjusting crude blending and CDU operation to maximise the benefit of integrated RTO, not just the CDU

Applications

- Offline modeling and simulation of the RHDS unit and integrated with crude and RFCC units for understanding the characteristics of the RHDS unit, the interaction between the RHDS and upstream/downstream units, and the impact of the feed stock crude characteristics and crude blends on the operation
- Real-time optimisation of the integrated crude, RHDS and RFCC unit for maximising the benefit of combined unit and for optimising the blending ratios of different crudes
- Operator and engineer familiarisation for better understanding of the RHDS process
- LP Planning model updates based on current RHDS unit characteristics and operating conditions, and crude selection when running with and without crude and RFCC units
- Online performance monitoring of the operation and catalyst activities of the RHDS unit, standard alone or with crude and/or RFCC units
- Offline engineering & process improvement studies with offline SIM4ME® Portal excel interface

ROMeo Refinery Modeling

ROMeo Process Optimisation is a unique solution that enables scalable refinery-wide modeling & optimisation. While traditional modeling solutions can only simulate individual process units or provide point solutions to solve a specific problem, ROMeo Process Optimisation provides a scalable platform that enables companies to optimise refinery-wide performance as well optimise other aspects of refinery profitability such as utilities and instrument/equipment health monitoring. Additional benefits are derived from leveraging data generated from rigorous models to enhance planning and scheduling decisions, leading to increased refinery margins.