UniSim Design’ New Refining Reactors – Deep Dive
Agenda

- UniSim Design for Refining
  - Overview
  - Capabilities for Refiners
- UniSim Refinery Reactors – Deep Dive
UOP & HPS | Broad and Deep Solutions for Oil & Gas

**Upstream**
- Wellhead & Optimization
- Off-Shore
- Gas Processing

**Midstream**
- Pipeline Transportation
- LNG Liquefaction

**Downstream**
- Refining
- Petrochemicals Fertilizers

**HPS**
- Digital Suites™ for upstream productivity and safety
- Metering and information systems for marine and terminal storage
- Storage and pipeline SCADA solutions
- Fiscal metering
- Leading automation and safety solutions
- Fire and gas solutions
- Refining and petrochemicals process licensing and key equipment
- Catalyst and adsorbents
- Hydrogen recovery
- Engineering and software-enabled services

**UOP**
- Natural gas purification and separation
- Modular and offshore natural gas plants
- Clean natural gas for transport, separate NGLs for liquefaction
- Connected performance services
- Mobile business productivity tools and services
- Cyber security protection
- Technical services and field support
- Asset performance monitoring

**Cross-Stream Solutions**
- Smart field instrumentation
- Advanced DCS and controls
- Process optimization diagnostics and services
- Integrated safety and security solutions
- Lifecycle technology planning and support

**Honeywell Connected Plant**
- Lifecycle Approach to Optimize Asset Performance
UniSim Design | Links with Performance Solutions

- **UniSim® Competency Suite**
  - Process Operator Training Simulator

- **Predict® Suite**
  - Real Time Corrosion Management

- **Symphonite™ RPMS**
  - Supply Chain Optimization

- **UniSim Design**

- **UOP CPS**
  - Cloud-based service to monitor, predict, and improve plant performance

- **Profit® Controller**
  - Embedded APC in UniSim
  - Direct link to Profit Controller

- **Uniformalance® Asset Sentinel**
  - Asset Performance Calculation

- **Profit® Optimization**
  - Real Time Closed Loop Optimization

• UniSim Design is Pivotal to Refining Applications
The Platform | Next Generation Refining Capabilities

**High Performance EO Platform**
- Equations Oriented (EO) Platform
- Refining simulation and optimization in the same environment

**Easy to Tune and Deploy by User**
- Rapid Deployment & Conversions of Large Scale Flowsheets

**Refining Workflows**
- Efficient Workflow
- LP vector generation
- Crude selection and analysis,
  - Heat exchanger monitoring and optimization

**Refining Reactor Models**
- Equation Oriented Reactor Models
  - Validated by Honeywell UOP subject matter experts
  - Flexible and easy calibration with few parameters

**Refinery Modelling Infrastructure**
- Refining Properties
- Crude Environment - Assay Management
- Supply Chain Integration - LP Vector Generation

**Best In Class Technology - Design to Optimization**
- Improve Engineering Effectiveness
UniSim® Design capabilities

- UniSim® Design allows engineers in refining study scenarios with variation in crude feedstock, accurately predict yields for various refining products, and keep up-to-date their LP programs for scheduling and planning purposes.

- Generates LP vectors and the generated vectors can be used to tune scheduling and optimization applications for production planning.

- Capabilities to study & predict reactor performance & its contribution to a wider combination of units.

- Provides refinery unit level optimization capabilities.
UniSim Design Suite | Delivering Value to Refining Customers

Supply Chain Support
Ensure LP Vectors, used in feedstock planning, are updated to accurately reflect current refinery capabilities

Unit Level Monitoring
Real-time monitoring of refinery units, leveraging EO platform, to support operations
Provides insight into predicted performance vs actual

Off-line Optimization
Enables ‘what-if’ analysis to provide unit optimization across the refinery

Small Debottlenecking Projects
Supports process and project engineers doing sensitivity analysis and project option evaluation

Delivering Increased Refinery Profitability
Agenda

- UniSim Design for Refining
  - Overview
  - Capabilities to meet Refining requirements
- UniSim Refinery Reactors – Deep Dive
UniSim® Design | Refinery Reactors

Refinery Reactor in UniSim R460

• UniSim® Hydrotreater for simulating Naphtha, Kerosene, Gas Oil, Slurry and Atmospheric Residue Hydrotreater reactor models
• UniSim® Hydrocracker for simulating Hydrocracker/Mild Hydrocracker and Base oil production
• UniSim® Reformer for simulating Naphtha Reforming
• UniSim® Isomerization for simulating Light Naphtha Isomerization
• UniSim® Alkylation for simulation Alkylation

Refinery Reactor in UniSim R470 (2019)

• UniSim® FCC Reactor for simulating FCC reactor models
• UniSim® Delayed Coker for simulating Delayed Coker

Kinetic First Principle Based Refinery Reactor modules
Deeper Dive | UniSim® Refinery Reactors

- Predictive Kinetic reactor model
- Implemented fully in the Next Generation Simulation Environment
  → Allows for switching of solver: Sequential, Simultaneous & Optimization
- Provides overall reactor performance information
- Catalyst Life Prediction
- Requires minimum configuration & Calibration time
- With Parameter Estimation capability within UniSim EO Operation which allows to tune the kinetic models to any catalyst, feed or operating conditions.
Example: Hydroprocessing Reactor

- Predictive Kinetic reactor model
- Covers all aspects of Hydroprocessing (HCU & HDT)
- Catalyst beds are modeled as a catalytic fixed bed which is effectively a plug flow reactor model with packed catalyst particles and downflow operating
- Reactor models a collection of catalyst beds and quench stages
- Rate constant data and stoichiometry are automatically generated once the component slate is known
- Master kinetic parameters are interfaced to the user
Refinery Reactor Parameter Calibration

- Refinery Reactor Parameter calibration helps tuning reaction kinetic parameter.
- It allows to match results (component yields, outlet temp) with desired results.
- The data input to parameter calibration can be pilot or real plant data.

- Parameter Calibration allows combination of optimizer & data reconciliation.
- Saves effort and time of manual parameter tuning.
- Input usually available from a DCS or Historian system. Outputs are the tuned model parameters that then matches the model to your plant data.
Questions
Deeper Dive | Refining Infrastructure

Refining Properties

- Base environment stream properties required to support Refining Flowsheet and Crude Environment
- RON, MON, RVP, Conradson carbon rate, carbon to hydrogen ratio, cetane index, refractive index, yield, Aniline, cloud, freeze, pour, smoke, softening, wax congealing and flash points, X-ring UV and IP391 Aromatics, Cx Asphaltenes, olefins, naphthalenes, naphthenes, n-paraffins, paraffins, polynaphthenes, mercaptans...
- Individual stream properties or multiple stream properties can be visualized using the stream plot utility

Crude Environment

- Environment for managing Crude Assay properties
- Direct link to Haverly H/CAMS crude assay library, can also be read from MS Excel files or manually entered
- Assays are mapped to components and pseudo components and propagated to flowsheet environment

Blending Rules

- Pre-defined non proprietary blending rules included
- Horizontal and vertical mixing
- Fully customizable

• Infrastructure & Unit Operations to Efficiently Create Complete Refining Flowsheet
Deeper Dive | Refining Capabilities Delivering Results

LP Vector Generation
- Generate LP vectors from user-configured independent and dependent variables using simulation model or plant data
- Tune and maintain business planning, scheduling and optimization applications
- Easy workflow between process engineering and supply chain ensures continuous improvement of planning models and profitable refinery operation
- Reduce plan-vs-actual gaps, deliver lost opportunity with realistic and optimal plans that successfully achieve targets

High Performance Optimization
- Proprietary NOVA solver for online, real-time optimization across all process industries
- Well suited for solving hundreds of thousands of equations with up to thousand degrees of freedom
- Unlocks new value with existing assets

Crude Pre-Heat Exchanger Monitoring
- Exchanger Network Design, Pinch Analysis and Operational Analysis solution with UniSim ExchangerNet & ExchangerNet Ops
- Perform “what-if” scenarios, retrofits, cost optimization and cleaning cycle optimization decisions
- Optimize energy consumption while maintaining product quality and yield

Delivering Value through Engineering and Operations Effectiveness