UniSim® Refining Reactors
Product Information Note

Process modeling software for process design, simulation, operations monitoring and debottlenecking, process optimization and business planning, serving the refining market.

The Challenge: Optimum Process Designs
Engineers in the refining industry must design processes that can process different crude feeds, accurately predict yields for the various refining products, and keep up-to-date their LP programs for scheduling and planning purposes. Process engineers are challenged with making timely business decisions while meeting the business objectives of designing and operating efficient, safe and profitable plants.

The Opportunity: Linking Business Objectives to Process Design
UniSim Design process modeling is a powerful technology that enables decision makers and engineers to link critical business objectives to process design, by:

- Utilizing the same technology and process model throughout a project or plant asset lifecycle by different functions and for multiple purposes.
- Ensuring process equipment is properly specified to deliver desired product throughput and specifications.
- Performing ‘what-if’ scenarios and sensitivity analyses to identify the optimal design based on operating and business targets.
- Evaluating the effect of feed changes, upsets and equipment downtime on process safety, reliability and profitability.
- Monitoring equipment/plant asset performance against expectations.

UniSim® Design Suite now includes modules that represent refining conversion reactors to better serve process engineers in the refining industry. UniSim® Refining Reactors are available within the UniSim EO environment, which is an integral part of the UniSim EVolution, high-performance, next generation platform. This platform allows for design and optimization under the same environment.

The UniSim Refining Reactors:
- Are rigorous, medium-high kinetic reactors.
- Can be easily calibrated with engineering or real-plant data.
- Can generate LP vectors for scheduling and planning tools.
- Can be leveraged as digital twins for online process performance monitoring solutions.

WHY DO CUSTOMERS CHOOSE OUR SOLUTION?

Best-in-Class Support
Our after-market services engineers, averaging 8 years of UniSim Support experience are:
- Responsive
- Knowledgeable
- Reliable
- With a solid process engineering

Robust Technology
UniSim Design Suite technology is:
- Robust
- Scalable
- Stable
- Accurate
- Fast
- A Life-Cycle simulation platform.

Innovation
Leveraging in-house process, control and software development expertise, we bring to market features:
- Developed with users
- For the users
- Adopting best practices & workflows recommended by the users.

Joint-Development
We actively engage in joint programs with customers to:
- Address specific customer needs
- Accelerate development
- Pilot new technologies.

Commercially flexible
Flexible licensing model aligned with customer expectations in terms of:
- Product Options
- Access Type
- Contract length.
The Solution: UniSim® Refining Reactors

The UniSim Refining Reactors are software options licensed under the UniSim® Design Suite, Honeywell’s leading multi-purpose, process simulation solution. UniSim Refining Reactors are unit operations built within the UniSim EO environment, which is an integral part of the UniSim® EvOlution, high-performance, next generation platform, which enables process design and optimization under the same environment. The UniSim Refining Reactors represent kinetic, medium-high fidelity unit operations that reflect refinery conversion units. The following modules are currently supported:

- UniSim® Hydrocraker
- UniSim® Hydrotreater
- UniSim® Catalytic Reformer
- UniSim® Isomerization Reactor
- UniSim® Alkylation Reactor

The refining reactors may be configured within the EO environment together with other unit operations to represent the entire refinery conversion unit. The EO flowsheets may in exchange be configured within the UniSim Design environment in order to represent multiple adjacent process units of the refinery, in order to examine the impact of design or operational changes across a larger scope of the refinery.

The refining reactor modules may be calibrated using engineering data or real plant data, leveraging the data reconciliation utility in UniSim Design. Also, in conjunction with the LP vector generation utility in UniSim Design, the refining reactors may be used to generate LP vectors, for use in scheduling and planning tools.

The Benefits

**Improved Process Designs**

Engineers can rapidly evaluate the most profitable, reliable and safest design. It is estimated that on-site design changes made during commissioning constitute 7 percent of the capital cost of a project. UniSim Design enables engineers to evaluate the impact of their design decisions earlier in the project. For new designs, UniSim Design enables users to create models quickly to evaluate many scenarios. The interactive environment allows for easy ‘what-if’ studies and sensitivity analysis. The top candidates can be used to create high fidelity models, in which additional equipment and process details are included.

**Reduced Engineering Costs**

Simulating with UniSim Design reduces engineering costs by creating models that can be leveraged throughout the plant lifecycle, from conceptual design to detailed design, rating, training and optimization; providing a work environment that ensures work is completed quickly, effectively and consistently. This avoids the time-consuming and error-prone manual process of transferring, formatting and analyzing production and process data that can account for up to 30 percent of engineering time.

**Plant Safety and Reliability**

As a desktop application, UniSim Design empowers users to rapidly determine the feasibility of a design and the impact to the process of a design or operational change. For example, engineers can assess whether a new crude can be processed by the refinery and what the resulting product yields may be.

Featuring as the digital twin in an online or cloud-enabled solution, UniSim Design allows users to monitor the performance of refinery plant assets and equipment. For example, engineers monitoring and troubleshooting plant operations through online systems, can assess whether the plant/process unit is operating as expected and predict and prevent equipment failures.

**Common Features**

**Calibration & Data Reconciliation**

All UniSim Refining Reactors include the advanced optimization algorithms (SQP, MINLP, and NOVA) allowing the refining reactor calibration and a utility for data reconciliation which allows models to be matched to operational data.
UniSim® Design Suite supports open architecture with other applications through Active X, CAPE-OPEN and OPC compliance. Also, users can leverage within the UniSim Design environment custom unit operations, reaction kinetics and thermodynamic properties which they develop in any OLE controller language or the UniSim® Express, high-level modelling language.

**LP Vector Generation Utility**

The LP Vector Generation Utility generates LP vectors from a set of user-configurable independent and dependent variables, either from a simulation model or from historical plant data. The generated data can be used to tune scheduling and optimization applications, through copy/paste functionality and/or communications via OLE to excel.

The utility investigates a number of cases within an operating range for each independent variable and generates linear models with each dependent variable. Once the vectors are generated, the results can be visualized in plots, to compare how well the linear models match the data. In cases of non-linearity, the operational envelope can be broken down into smaller ranges and different LP vectors can be generated, to approximate linear behavior.

**Supported Refining Reactors**

**UniSim Hydrocracker**

This module represents a medium-high fidelity, kinetic hydrocracking reactor. This refining reactor breaks-down a heavy petroleum fraction (typically Heavy Vacuum Gas Oil) into lighter ones like Naphtha, Kero and Diesel using high amounts of hydrogen in the presence of a catalyst.

Each hydrocracking reactor may be configured to have up to 4 beds, with a hydrogen quench stream in between beds. The following kinetic reactions are considered:

- Paraffins cracking
- Naphthenes cracking
- Aromatics cracking
- Naphthenes hydrogenation (ring opening)
- Aromatics hydrogenation (ring saturation)
- Hydrodesulfurization
- Hydrodenitrogenation

Key performance indicators (KPIs) related to the operation of this reactor are displayed in the graphical user interface and they include but are not limited to the:

- Weighted Average Bed Temperature
- Liquid Hourly Space Velocity
- Total Bed Volume
- Mass Conversion (%)
- Hydrogen Partial Pressure
- Total Hydrogen Consumption

The UniSim Hydrocracker can process a wide variety of feeds and can be configured together with other unit operations under the same flowsheet to model all possible hydrocracking configurations:

- SSOT – single-stage once through
- SSREC – single-stage with recycle
• TSOT – two-stage once through
• TSREC – two-stage with recycle

The UniSim Hydrocracker can help users determine the:
• product yields and hydrogen consumption, for different feeds
• best operating strategy to meet production objectives, given the operational constraints
• optimal operation of VDU/HCU or FCCU/HCU combined.

**UniSim Hydrotreater**

This module represents a medium-high fidelity, kinetic hydrotreating reactor. This refining reactor removes sulfur and nitrogen by converting them to hydrogen sulfide (H2S) and ammonia (NH3) with the use of hydrogen, in order to obtain low-sulfur products which can be then further used in other conversion processes (like Naphtha Reforming, Isomerization, FCC, Hydrocracker) to obtain high-quality products.

The UniSim® Hydrotreater can handle multiple types of feeds, such as:
• Naphtha
• Light Distillate
• Heave Distillate
• Gas Oil

Each hydrocracking reactor may be configured to have up to 4 beds, with a hydrogen quench stream in between beds. The following kinetic reactions are considered:
• Paraffins cracking
• Naphthenes cracking
• Aromatics cracking
• Naphthenes hydrogenation (ring opening)
• Aromatics hydrogenation (ring saturation)
• Hydrodesulfurization
• Hydrodenitrogenation

The UniSim Hydrotreater can be configured together with other unit operations under the same flowsheet to model all possible hydrotreating or hydrotreating – hydrocracking configurations.

The UniSim Hydrotreater can help users determine the:
• Hydrogen consumption for different feeds and process conditions
• Operations strategy to reach reduced sulfur targets in the middle distillates

**UniSim Catalytic Reformer**

This module represents a medium-high fidelity, kinetic naphtha catalytic reforming reactor. This refining reactor converts low-octane petroleum naphtha into high-octane gasoline called reformate. Additional byproducts are aromatics known as BTX (benzene, toluene, and xylenes) and Hydrogen (H2). Typical naphtha feedstocks are hydrotreated naphtha (straight-run naphtha from the crude unit is the most common feed), but gasoline-range streams from catalytic crackers, hydrocrackers, cokers and visbreakers can also be routed to the catalytic reformer to increase the octane number.

The UniSim Catalytic Reformer module can be configured either as a fixed-bed (semi-regenerative) or a continuous catalytic reformer. The reactions that are considered are:
• Dehydrocyclization of Paraffins
• Dehydrogenation of Naphthenes
• Hydrocracking and Dealkylation
• Isomerization of Paraffins to iso-Paraffins

A catalytic reformer unit may be represented by configuring under the same flowsheet multiple reactors (typically 3 or 4) and other unit operations, such as heaters, a recycle compressor, separator drums, and a stabilizer column.

Key performance indicators (KPIs) related to the operation of this reactor are displayed in the graphical user interface and they include but are not limited to:
• RON / MON

The UniSim® Refining Reactors available within the UniSim EO environment enable the design and optimization of refinery conversion units. They are medium-high fidelity kinetic reactors, which provide yield estimates, can easily be calibrated with engineering or plant data, and can provide LP vectors for use in scheduling and planning applications.
UniSim® Refining Reactors bring value to users for both offline and online applications. As a desktop application, UniSim Refining reactors help users determine yields, best operating strategies to reach production targets, and generate LP vectors for the scheduling and planning tools. As part of an online application for plant performance monitoring, UniSim Reactors can help track catalyst deactivation, derive insights on optimal operation, and prevent equipment failures which may result to process downtime.

- Reformate Yield
- H2 Yield
- Reactor temperatures
- Aromatic Hydrogenation
- Naphthene Isomerization
- Ring Opening
- Cracking

Key performance indicators (KPIs) related to the operation of this reactor are displayed in the graphical user interface and they include but are not limited to:

- PIN
- RON
- MON
- Product Yields

The UniSim Isomerization Reactor can help users understand the effects on the isomerization unit by:

- processing different crudes
- changing cut-points on the crude unit

and the effects on the yields and downstream separation and gasoline blending pool by changing the:

- operation of the isomerization reactor
- cut point on the naphtha splitter to optimize the performance of the combined reformer/isomerization operation

**UniSim Isomerization Reactor**

This module represents a medium-high fidelity, kinetic isomerization reactor. The unit operation may be configured to represent a C4 or C5-C6 isomerization reactor. C4 isomerization provides suitable feedstock for Alkylation. C5-C6 isomerization increases the octane number in light naphtha and manages content of benzene in gasoline products.

**UniSim Alkylation Reactor**

This module represents a medium-high fidelity, kinetic alkylation reactor, which converts C3-C5 olefins in the presence of acid catalyst to high-quality gasoline blending products (alkylates).

The UniSim Alkylation reactor may be configured to represent either HF or H2SO4 alkylation. The following reactions are supported:

- Initiation
- Primary Alkylation
- Secondary Alkylation
- Self-Alkylation
- Disproportionate Cracking
Key performance indicators (KPIs) related to the operation of this reactor are displayed in the graphical user interface and they include but are not limited to:

- Isobutane to Olefins Ratio
- RON
- MON
- RVP
- Product Yields

The UniSim Alkylation Reactor can help users understand the effects on alkylate qualities and yields with different:

- feeds
- catalyst activities
- isobutene to olefins ratio.
# UniSim® Design Suite System Requirements

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<th>PARAMETER</th>
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| PROCESSOR SPEED                  | Minimum: Intel i3 3.6 GHz or better  
Recomended: Intel multicore i7 4.6 GHz or better                                           |
| RAM REQUIREMENTS                 | Minimum: 4 GB RAM  
Recomended: 8 GB RAM                                                                 |
| DISK SPACE                       | Minimum: 25 GB of free disk space  
Recomended: 50 GB of free SSD space                                                        |
| DISPLAY                          | Minimum screen resolution: 1280 x 720  
Recomended screen resolution: 1920 x 1080 with graphics card.                                |
| DESKTOP CLIENT OPERATING SYSTEM  | Microsoft Windows 7, 8.x (Home, Business, Ultimate or Enterprise - 32 and 64 bit)  
Microsoft Windows 10 (32 and 64 bit)                                                      |
| SERVER OPERATING SYSTEM          | Microsoft Windows Server 2008  
Microsoft Windows Server 2012  
Microsoft Windows Server 2016                                                             |
| DESKTOP WEB BROWSER             | Microsoft Internet Explorer version 8, 10 or later  
Microsoft Edge  
Mozilla Firefox  
Google Chrome                                                                            |
| MICROSOFT OFFICE COMPATIBILITY   | Microsoft Office 2013  
Microsoft Office 2016  
Microsoft Office 365                                                                       |
| VIRTUALISATION COMPATIBILITY     | VMWare EXSi  
MS Hyper-V                                                                               |
UniSim® Design Suite

Giving users the power to determine process work flows, equipment operation and implementation requirements, UniSim Design Suite products help capture and share process knowledge, improve plant profitability and maximize returns on investments in simulation technology.

UniSim Design Suite offers:

- An integrated steady-state and dynamics environment to easily re-use, update and transition the process models throughout a project or plant asset lifecycle.
- A user-friendly interface which helps engineers to easily access and visualize the process information and identify trends.
- Built-in industry standards that minimize the need for literature search when sizing and rating equipment.
- Integration with 3rd party specialty technologies which allow for the best technical solution for process simulation.
- Interfacing capabilities with process historians, DCS & safety systems, and other advanced applications that maximize the benefits for green-field, brown-field and revamp projects.

Honeywell's UniSim Design Suite, is also the core of a number online and off-line process design, optimization, and operational monitoring and training solutions, as follows:

- **UniSim Competency Suite** to plan, deploy and manage a structured program to develop and maintain operator competency
- **UniSim Optimization Suite** to integrate Profit Suite, Honeywell's comprehensive advanced control and optimization technology, with UniSim Design models for APC design and pre-tuning.
- **Uniformance Sentinel** to monitor processes and equipment in real-time; enables industrial facilities to predict and prevent asset failures and poor operational performance.
- **Honeywell UOP CPS** to monitor, predict, and improve plant performance; this is a cloud-based service.

For More Information

Learn more about how Honeywell’s UniSim Design Suite can improve process design, visit [www.hwll.co/uniSimDesign](http://www.hwll.co/uniSimDesign) or contact your Honeywell Account Manager or authorized distributor.

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