



BUILD REFINERY MODELS QUICKLY AND EASILY TO SUPPORT YOUR LP MODEL!

RASOOL BAROUNI

AGENDA

- **UniSim Design**
- **UniSim Design EO Environment**
- **UniSim Refining**
- **Q&A**

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UNISIM DESIGN

UNISIM DESIGN SUITE

Applications

Dynamics & Steady State

Operator Training Simulation (OTS)



Vertical Solutions

Upstream

NGL / LNG

Gas Processing

Syngas

EPC

Refining (Next Generation Models)

UniSim is the workhorse of many clients and also within Honeywell



UniSim Design | Links with Performance Solutions

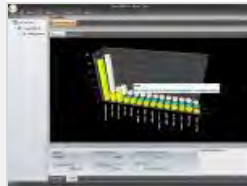
UniSim® Competency Suite

Process Operator
Training
Simulator



Predict® Suite

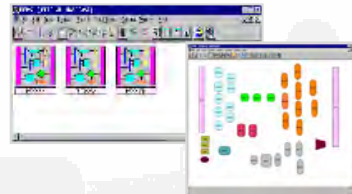
Real Time
Corrosion
Management



Symphonite™

RPMS

Supply Chain
Optimization

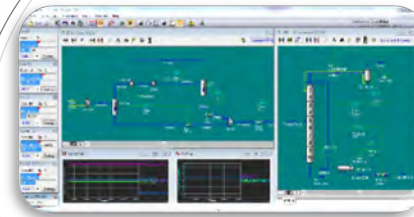


UOP CPS

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

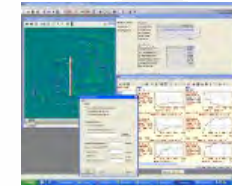


UniSim Design



Profit® Controller

Embedded APC in UniSim
Direct link to Profit
Controller



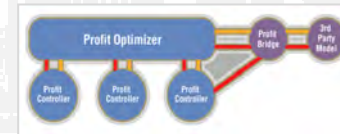
Uniformance® Asset Sentinel

Asset Performance
Calculation



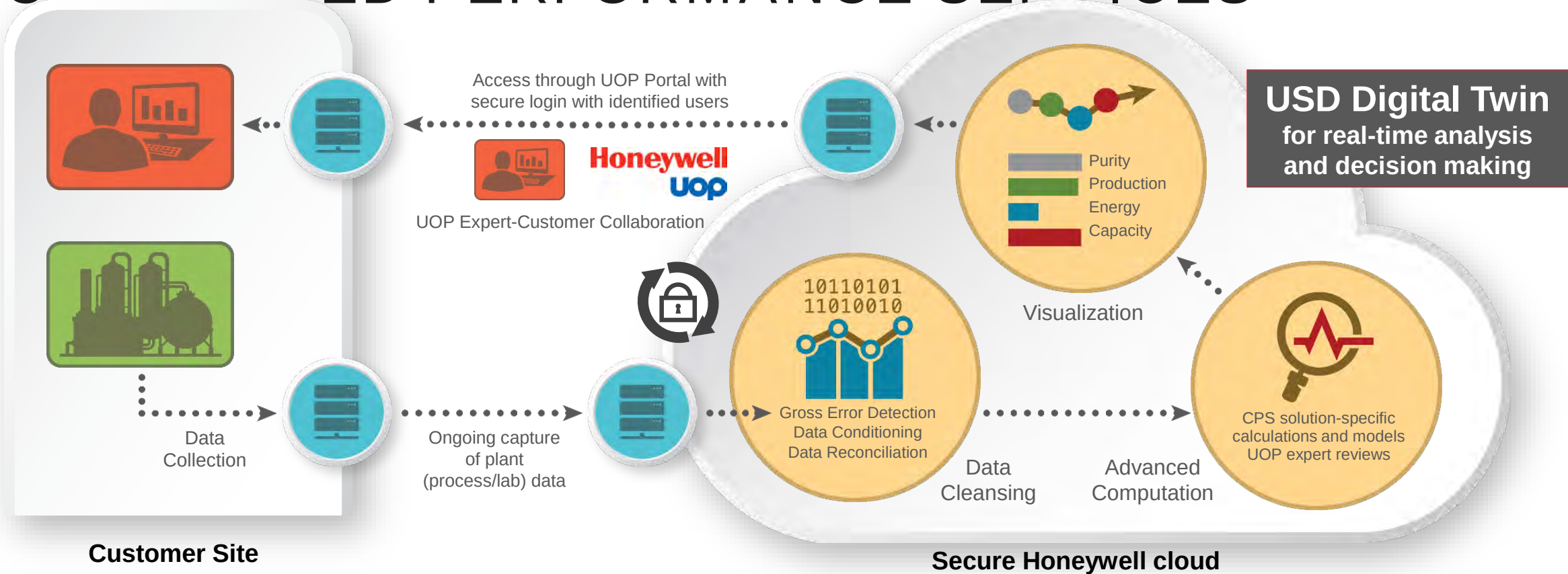
Profit® Optimization

Real Time Closed
Loop Optimization



UniSim Design is Pivotal to Many Applications

DEEPER DIVE | DIGITAL TWIN FOR CONNECTED PERFORMANCE SERVICES



Process Reliability

Process Optimization

Process Benchmarking

Predictive Maintenance

Customer Value (Incremental Operating Margin):

+\$0.30-0.50/bbl. in Refining

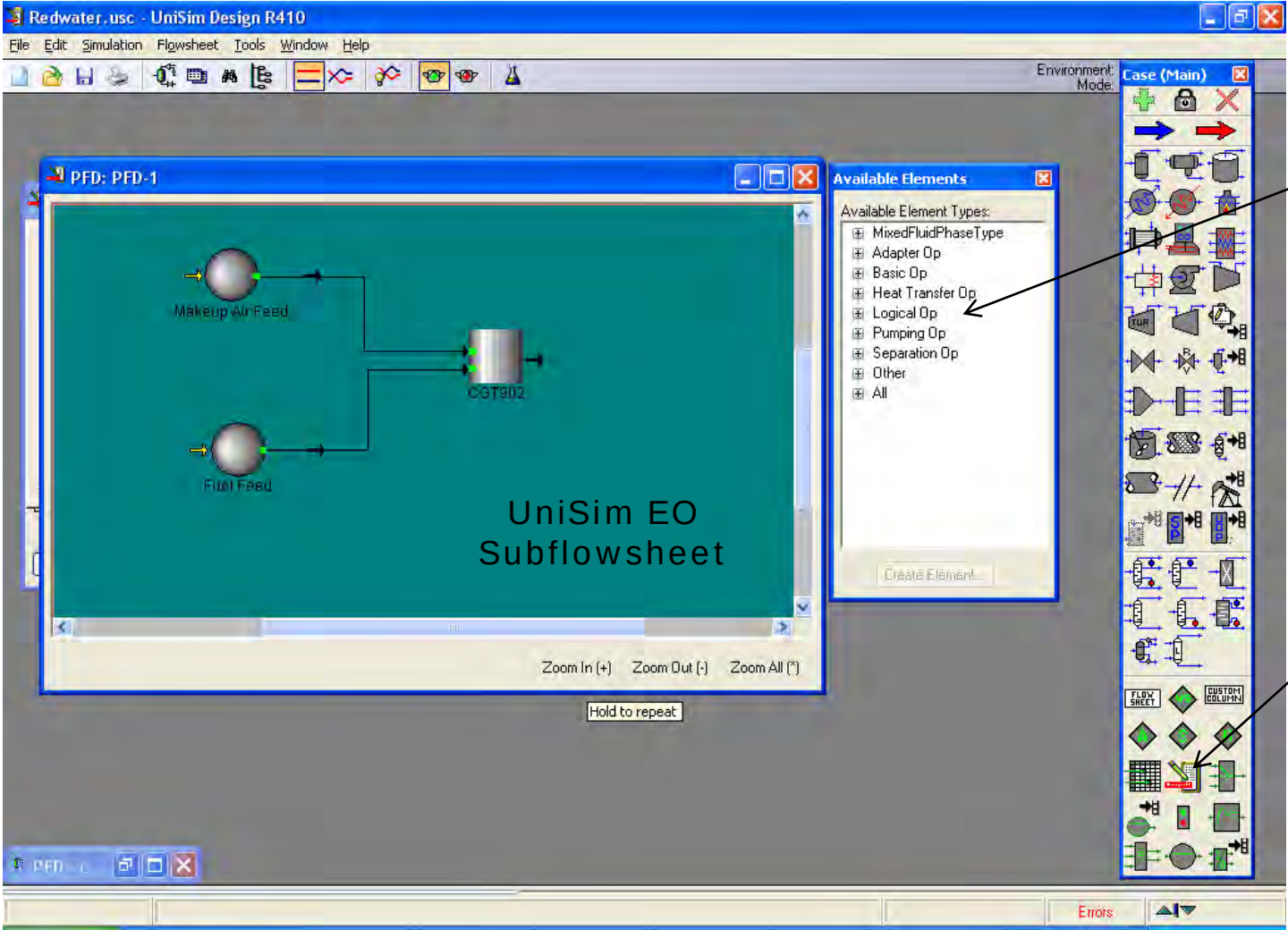
+\$10-20/MT in Petrochemicals

UNISIM DESIGN EO ENVIRONMENT

What is EO modeling?

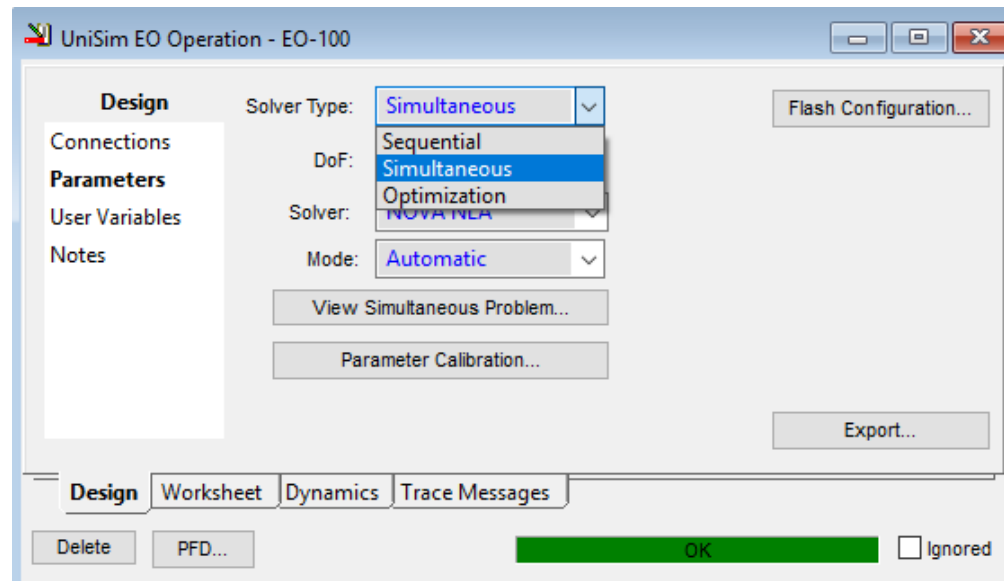
- EO is short for “Equation Oriented”
 - Equations are written in residual format to define the behavior of the units on the flowsheet, and all of the equations can be solved simultaneously.
- Due to its superior performance over sequential modular approaches for optimization, in recent years there has been more interest in using EO to solve some specific problems that are challenging for the traditional (SM).
- UniSim Design offers an EO platform (Equation Oriented platform), seamlessly integrated within UniSim Design native environment

UniSim EO Environment Access in UniSim



Motivation for Equation Oriented Modeling Development

- An Equation Oriented (EO) modeling capability is a great **complement** to a Sequential Modular (SM) capability
 - The strengths of EO are the weaknesses of SM and vice-versa
 - Combining the approaches broadens the potential for model based applications of the future
- EO Strengths/SM Weaknesses
 - Specification flexibility, lifecycle modeling, calculation parallelization potential, higher accuracy solutions, difficult recycle and highly interacting flowsheets, independent of solver technology, easier model code maintenance, analytical derivatives, online applications, **optimization applications**
- EO Weaknesses/SM Strengths
 - Ease of use
 - Difficult thermo
 - Diagnostics for solver failures



Some Models in UniSim EO Model Library

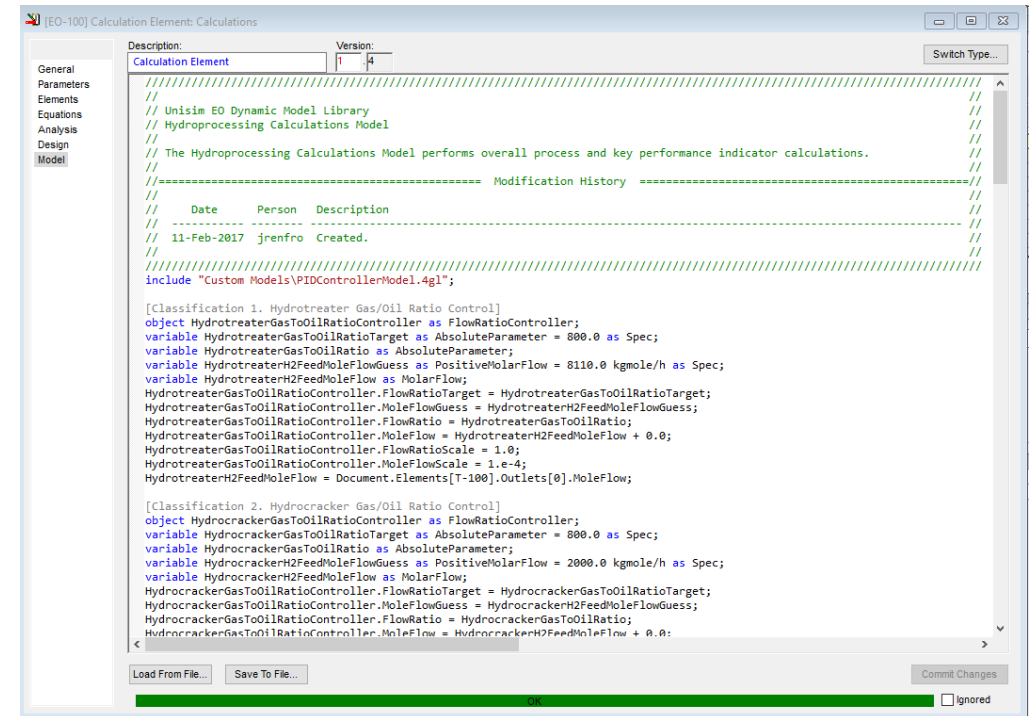
- **Streams**
 - Fluid Node
- **Heat Transfer Equipment**
 - Cooler
 - Heater
 - Heat Exchanger
 - Multistream Exchanger
- **Piping Equipment**
 - Pipe
 - Mixer
 - Tee
 - Valve
 - Orifice
 - Relief Orifice
 - Relief Valve
- **Rotating Equipment**
 - Centrifugal Compressor
 - Reciprocating Compressor
 - Expander
 - Centrifugal Pump
- **Separation Operations**
 - Separator
 - 3-phase separator
 - Phase Splitter
- **Column**
 - Tray Section
 - Pump Around
 - Reboiler
 - Partial Condenser
 - Total Condenser
 - Full Reflux Condenser
- **Reactors**
 - Alkylation
 - Catalytic Naphtha Reformer
 - Continuous Stirred Tank Reactor
 - Hydrocracker
 - Hydrotreater
 - Isomerization
 - Plug Flow Reactor
 - Fluid Catalytic Cracker
- **Electrical Network Operations**
- **Miscellaneous**
 - Adjust block
- **Custom Model**
 - 4GL Modeling Language

UniSim EO Integration in UniSim Design

- UniSim EO is actually a standalone environment with its own UI, but currently is integrated with UniSim Design and appears as a subflowsheet
- Users can select a UniSim EO subflowsheet operation and add that to their UniSim flowsheet
- Entering the UniSim EO subflowsheet, a new PFD environment can be accessed where an EO flowsheet model can be built from the EO model library
- The EO environment supports sequential and simultaneous solution modes
 - Sequential mode is useful for flowsheet model building and initialization
 - Simultaneous mode is useful for its specification flexibility and normally is the proper mode to work in for applications that require high performance
- The EO environment supports steady state and dynamic modes of UniSim
- Documentation is in the UniSim EO Environment PDF in the UniSim Design documentation directory

UniSim EO 4GL Modeling Language

- Process Modeling Domain Specific Language
 - Understands engineering units
- Can be used for simple or very complex models
- Supports object oriented class structures
- Integrated with UniSim Thermo
 - Can access UniSim Thermo fluid objects
 - Easy access to all fluid and component properties
- Models are checked for consistency
- Steady state and dynamic modes supported
- Default UI forms are configured for the model
- Can develop custom forms and icons for production models
- Great alternative to worksheets for overall model calculations that are readable and maintainable form



The screenshot shows the UniSim EO 4GL Modeling Language editor window. The title bar indicates the file is [EO-100] Calculation Element: Calculations. The window has a sidebar on the left with tabs for General, Parameters, Elements, Equations, Analysis, Design, and Model. The main area displays a calculation element model with a description, version, and a table of modification history. The code is written in a 4GL style, defining objects and variables for a hydrocracker gas/oil ratio control system. The code includes comments, variable declarations, and object definitions for the hydrocracker gas/oil ratio control system.

```

Description: Calculation Element Version: 1.4
//
// Unisim EO Dynamic Model Library
// Hydroprocessing Calculations Model
//
// The Hydroprocessing Calculations Model performs overall process and key performance indicator calculations.
//
//----- Modification History -----
//
// Date      Person  Description
//-----
// 11-Feb-2017 jrenfro Created.
//
//-----
include "Custom Models\PIDControllerModel.4gl";

[Classification 1. Hydrotreater Gas/Oil Ratio Control]
object HydrotreaterGasToOilRatioController as FlowRatioController;
variable HydrotreaterGasToOilRatioTarget as AbsoluteParameter = 800.0 as Spec;
variable HydrotreaterGasToOilRatio as AbsoluteParameter;
variable HydrotreaterH2FeedMoleFlowGuess as PositiveMolarFlow = 8110.0 kgmole/h as Spec;
variable HydrotreaterH2FeedMoleFlow as MolarFlow;
HydrotreaterGasToOilRatioController.FlowRatioTarget = HydrotreaterGasToOilRatioTarget;
HydrotreaterGasToOilRatioController.MoleFlowGuess = HydrotreaterH2FeedMoleFlowGuess;
HydrotreaterGasToOilRatioController.FlowRatio = HydrotreaterGasToOilRatio;
HydrotreaterGasToOilRatioController.MoleFlow = HydrotreaterH2FeedMoleFlow + 0.0;
HydrotreaterGasToOilRatioController.FlowRatioScale = 1.0;
HydrotreaterGasToOilRatioController.MoleFlowScale = 1.e-4;
HydrotreaterH2FeedMoleFlow = Document.Elements["T-100"].Outlets[0].MoleFlow;

[Classification 2. Hydrocracker Gas/Oil Ratio Control]
object HydrocrackerGasToOilRatioController as FlowRatioController;
variable HydrocrackerGasToOilRatioTarget as AbsoluteParameter = 800.0 as Spec;
variable HydrocrackerGasToOilRatio as AbsoluteParameter;
variable HydrocrackerH2FeedMoleFlowGuess as PositiveMolarFlow = 2000.0 kgmole/h as Spec;
variable HydrocrackerH2FeedMoleFlow as MolarFlow;
HydrocrackerGasToOilRatioController.FlowRatioTarget = HydrocrackerGasToOilRatioTarget;
HydrocrackerGasToOilRatioController.MoleFlowGuess = HydrocrackerH2FeedMoleFlowGuess;
HydrocrackerGasToOilRatioController.FlowRatio = HydrocrackerGasToOilRatio;
HydrocrackerGasToOilRatioController.MoleFlow = HydrocrackerH2FeedMoleFlow + 0.0;

```


UniSim EO 4GL Modeling Language

```
//  
// Stream declarations.  
//  
inlet Inlet;  
outlet Outlet;  
//  
// Variable declarations.  
//  
variable deltaP as DeltaPressure = 0.0 as Spec;  
variable dutyPerMole as MolarEnthalpy = 0.0 as Spec;  
//  
// Cooler mass balance.  
//  
Outlet.MoleFlow = Inlet.MoleFlow;  
//  
// Cooler component mass balance.  
//  
Outlet.MoleFractions = Inlet.MoleFractions;  
//  
// Cooler energy balance.  
//  
Outlet.MolarEnthalpy = Inlet.MolarEnthalpy + dutyPerMole;  
//  
// Compute cooler pressure drop.  
//  
deltaP = Inlet.Pressure - Outlet.Pressure;
```

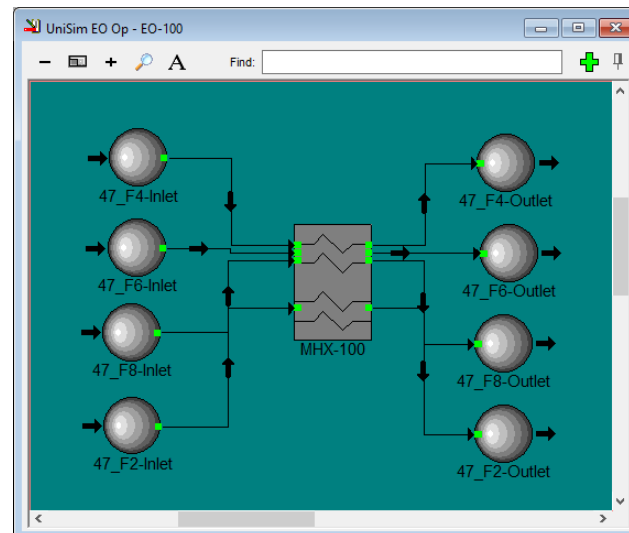
Cooler Model

MULTISTREAM HEAT EXCHANGER MODEL

The Multistream Heat Exchanger model is used to simulate multistream counter-current heat transfer equipment, such as LNG and cold box heat exchanger equipment

This model is suitable for online model based applications

Variables for calibration are incorporated in relevant structural parts of the model to allow matching operating data and enable predictive capabilities in the face of unknown internal geometry and energy losses and efficiency



MULTISTREAM HEAT EXCHANGER MODEL – GENERAL VIEW

[47NGL] Multistream Heat Exchanger: MHX-100

General

Parameters

Conditions

Properties

Composition

Equations

Analysis

Design

Model

Results

Name

MHX-100

Fluid Package

PROCESS Clone

Model Summary

Equations	{37}	...
Variables	{35}	...
Elements	{0}	...

Constants	{6}	...
Model Specs	{6}	...
Initial Estimates	{0}	...

Connections

Cold Inlets

47V203 [VapourProduct]

47FV186

47V201 [OverheadVapourOutlet]

Hot Inlets

47_S1

Cold Outlets

47_F5

47_F7

FUEL_GAS

Hot Outlets

47V202

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MULTISTREAM HEAT EXCHANGER MODEL – PARAMETERS VIEW

[47NGL] Multistream Heat Exchanger: MHX-100

General

Parameters

Conditions

Properties

Composition

Equations

Analysis

Design

Model

Results

Pressure Drops

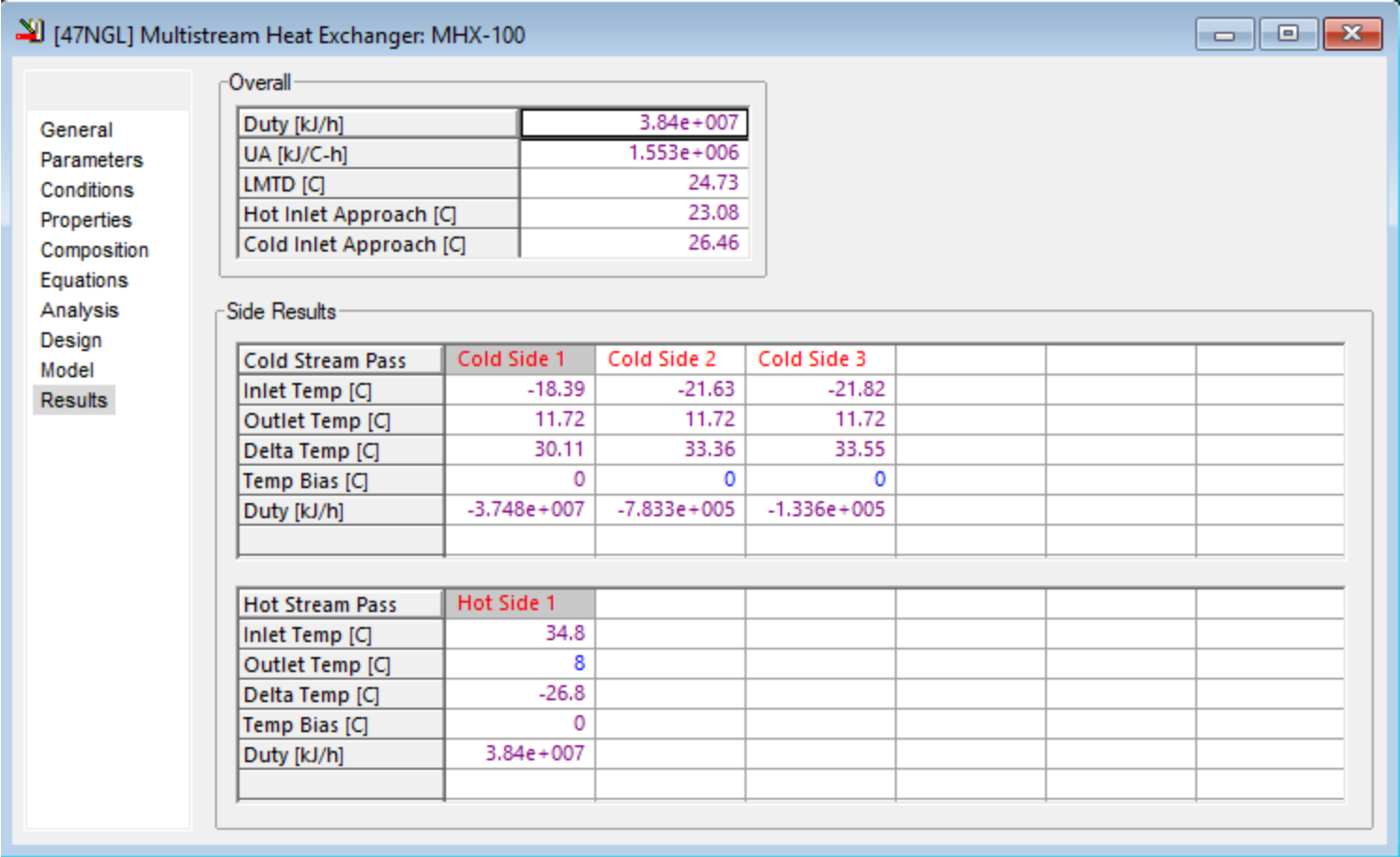
Cold Stream Pass	Cold Side 1	Cold Side 2	Cold Side 3			
Pressure Drop [kPa]	0	0	0			

Hot Stream Pass	Hot Side 1					
Pressure Drop [kPa]	0					

Heat Transfer

UA [kJ/C-h]	1.553e+006
Heat Loss Bias [kJ/h]	0
Heat Loss Efficiency	1
Heat Loss Weight	0.5

MULTISTREAM HEAT EXCHANGER MODEL – RESULTS VIEW



UNISIM REFINING

UNISIM DESIGN R470 **REFINING**

Reactor model development:

- Support from UOP experts
- Validated with UOP yield & pilot plant data
- Validated with customer data

Reactor Models Include:

- FCC
- Reformer (Gasoline and BTX)
- Hydrocracker
- Hydrotreater
- Isomerization
- Delayed Coker
- Alkylation

Other refining features developed and validated

- Product Blender
- Assay Synthesis
- LP Vector
- SRU
- Fired Heater model in EO

Refinery-wide Simulation Capability

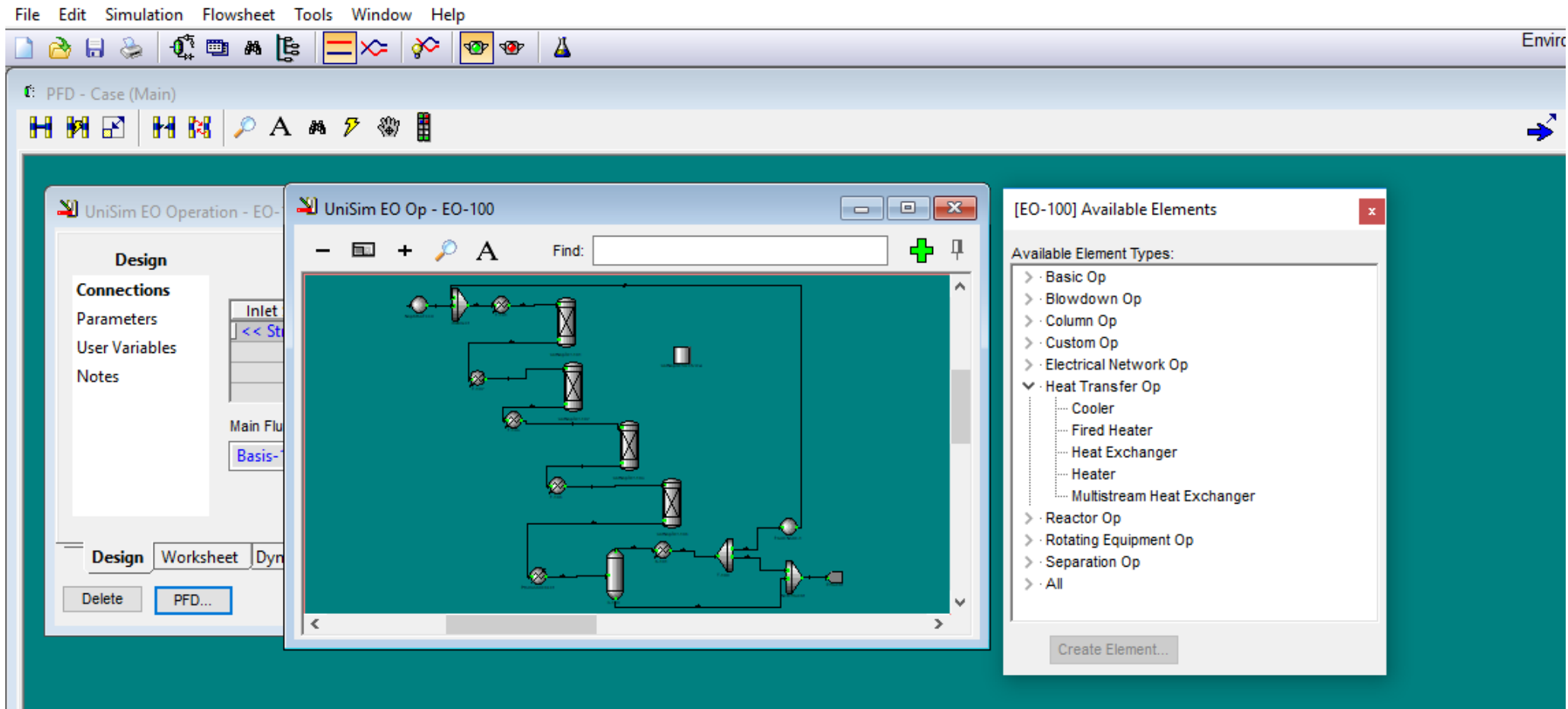
UniSim Refinery Simulation Applications

- Crude Assay Management
- LP Data Generation
- Unit Performance Monitoring
- Profit Improvement (Refinery Wide)
- Refinery-Petrochemical Integration
- Area Target Setting/Process Optimisation
- Process Engineering Studies
- Process Engineering Training & OTS
- Capex Studies (Feasibility, Configuration)



A flexible Flowsheeting Capability

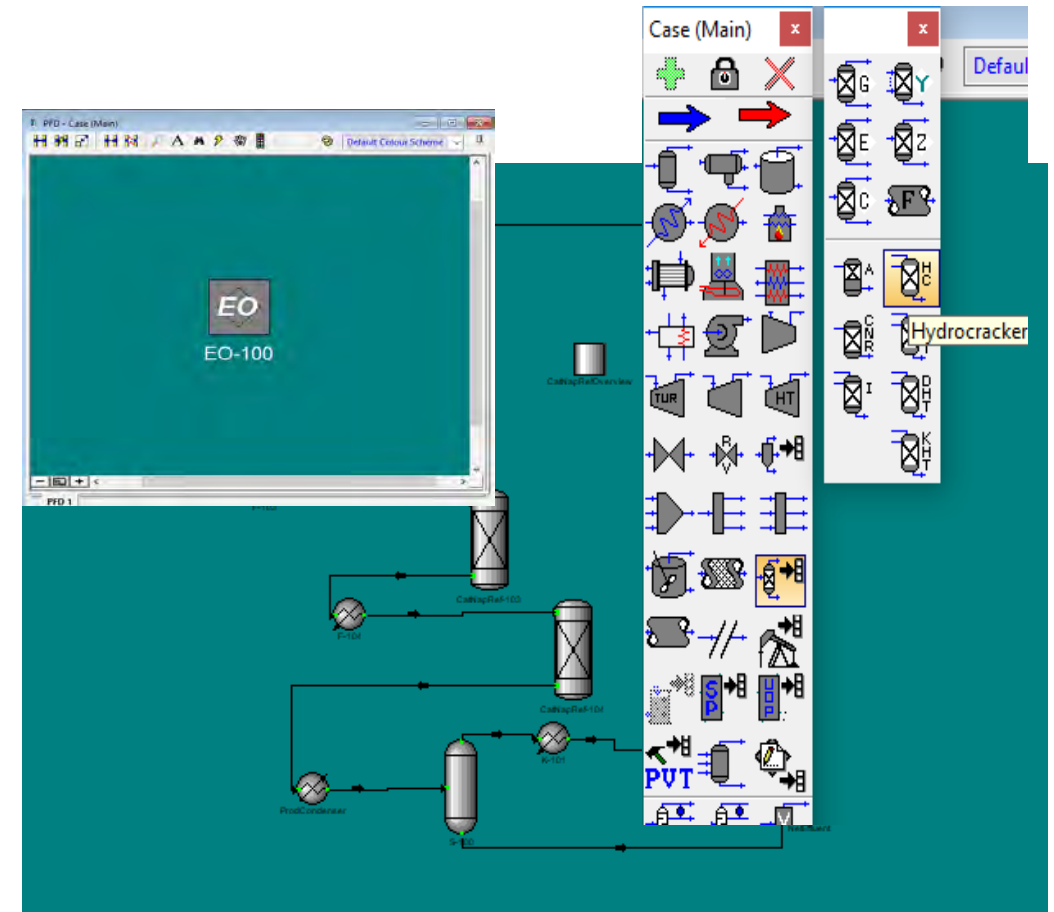
- Access to individual reactors and unit operations is possible in UniSim Design - not like other packages which define the conversion unit model as a block



UNISIM R470 – NEW REFINERY REACTORS

Refinery Reactor Models

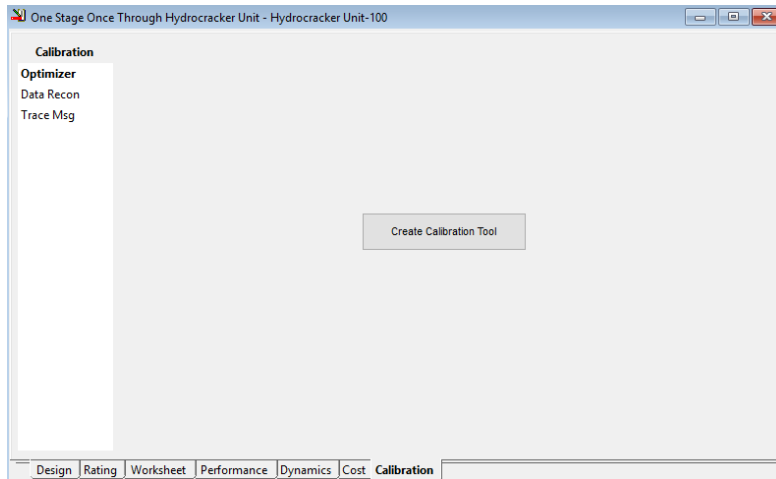
- Simple model creation with templates
 - ‘Drag & Drop’ a reactor block into your flowsheet
- Simple Tuning Parameters
 - Connects to operational data for tuning
- All include catalyst deactivation
- Built on the EO platform for model speed
 - Useful for optimization
- Simplified workflow easily links with multiple tools
 - Easily import crude assays
 - Export equations for planning optimization
 - Connected process & assets with Honeywell Forge integration



New models allow full plant optimization

USD R470 – PARAMETER CALIBRATION

Automatic Calibration



One Stage Once Through Hydrocracker Unit - Hydrocracker Unit-100

Calibration

Optimizer
Data Recon
Trace Msg

Name: **DataRecon Para** Scope Objects: **Hydrocracker Unit-100** Add **DRU Stream** ▼

Stream Filter: ☒ Inlet ☐ Outlet ☐ Energy ☐ Internal
☒ Set Up ☐ Data

DRU Streams	Inlet Streams	Multiple	Data Sets	Comp Basis
DRS-Make-up H2-TPL1	Make-up H2 @TPL1	☒	2	Mole Frac
DRS-Feed To HC-TPL1	Feed To HC @TPL1	☒	2	Mole Frac
DRS-FeedAlt1-TPL1	FeedAlt1 @TPL1	☒	2	Mole Frac
DRS-FeedAlt2-TPL1	FeedAlt2 @TPL1	☒	2	Mole Frac
DRS-FeedAlt3-TPL1	FeedAlt3 @TPL1	☒	2	Mole Frac

Stream Initialization | Parameter Fit | DCS Tags | Data Set Analysis

Number of Data Sets: **2** Manage Data Sets Fresh Attachments Error Type: **Squared** ▼

Run

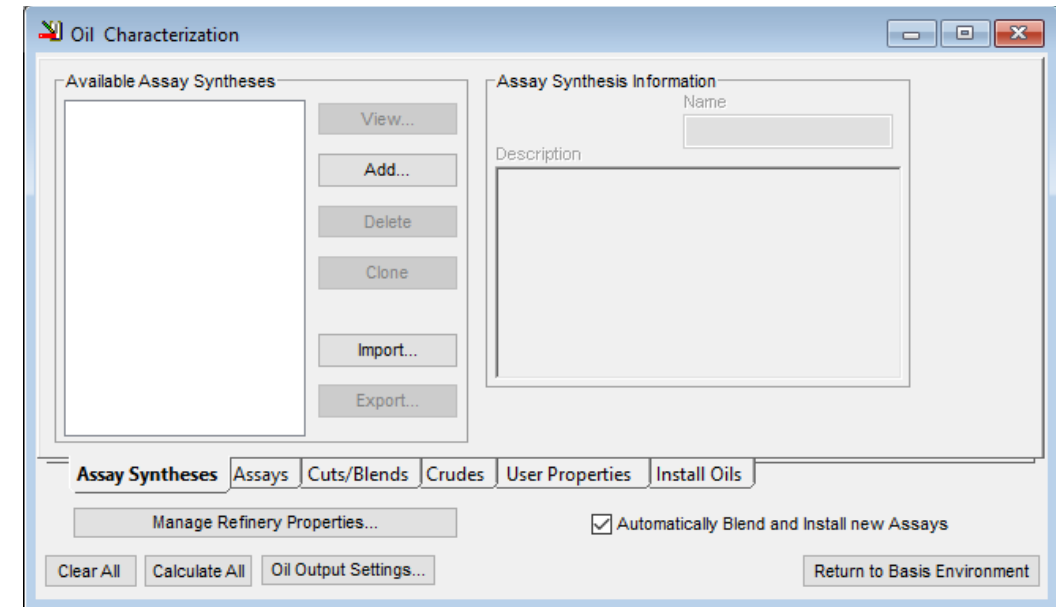
Design | Rating | Worksheet | Performance | Dynamics | Cost | **Calibration**

Calibration made easy and fast

ASSAY SYNTHESIS MODEL

UniSim Assay Management

- A New Assay Synthesis Model in UniSim Design
 - Improves the assay management in UniSim Design greatly
 - UniSim Design offers both Assay Importing and Synthesis
 - Add Crude Oils, Condensates, or any Oil Cut to a Case
 - Offers better functionalities than any other similar tool
 - Kept the legacy synthesis method of HYSYS
 - Applications:
 - Crude and Condensate Evaluation
 - Yield and Property studies
 - LP Vector for Assays
 - Etc.



ASSAY SYNTHESIS MODEL ONE VIEW

The screenshot displays the 'Assay Synthesis: AssaySyn-1' window. On the left, a 'View Navigation' panel lists options: 'Crude Identifier' (selected), 'Light Ends', 'Distillation Yield', 'Property Selection', 'Whole Crude', 'Individual Cuts', and 'Messages'. Below this is an 'Assay Syntheses' section with 'Manage R...', 'Clear All', and 'Calculate...' buttons. The main area contains input fields for 'Assay Synthesis Name' (AssaySyn-1), 'Linked Assay' (AssaySyn-1), 'Linked Blend', and 'Linked Stream'. A checkbox for 'Fit and set user and refinery props to light ends comps.' is present. The 'Crude Identifier' section includes fields for 'Crude Name', 'Country of Origin', 'Province/State', 'Region', 'Oil Field', 'Laboratory', 'Crude Owner', 'Sample ID', 'Sample Year', 'Sample Date', and a 'Sulfur Level' dropdown set to 'Low'. A large 'Crude Description' text area is on the right. A yellow status bar at the bottom reads 'Main distillation stage does not have enough input cut points'. A 'Synthesize' button is in the bottom right corner.

Available Assay Syntheses

AssaySyn-1

Assay Synthesis: AssaySyn-1

Assay Synthesis Name: AssaySyn-1 Linked Assay: AssaySyn-1 Linked Blend: Linked Stream:

☐ Fit and set user and refinery props to light ends comps.

View Navigation

- ☒ Crude Identifier
- ☐ Light Ends
- ☐ Distillation Yield
- ☐ Property Selection
- ☐ Whole Crude
- ☐ Individual Cuts
- ☐ Messages

Assay Syntheses

Manage R...

Clear All Calculate

Crude Identifier

Crude Name: Country of Origin: Province/State: Region: Oil Field: Laboratory: Crude Owner: Sample ID: Sample Year: Sample Date: Sulfur Level: Low

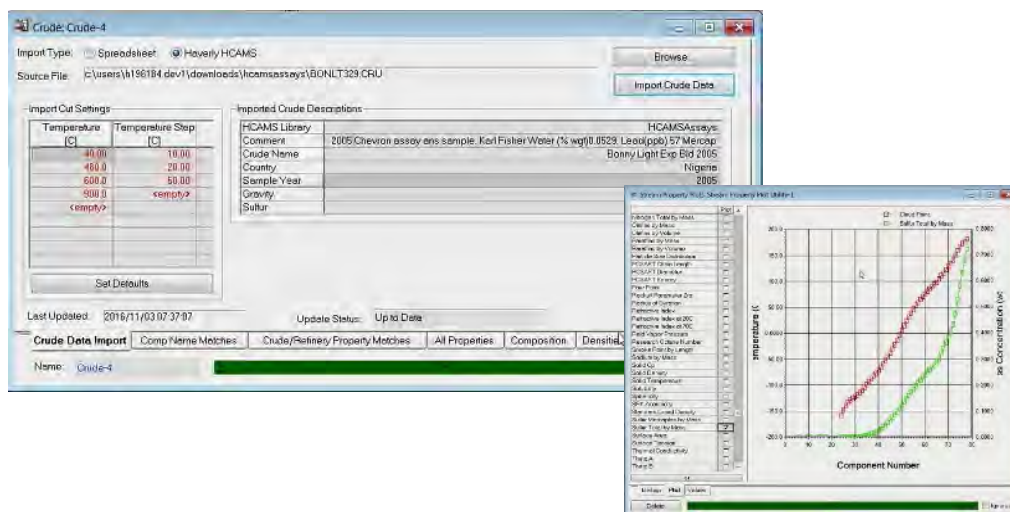
Crude Description:

Main distillation stage does not have enough input cut points

Synthesize

Crude Assay Management

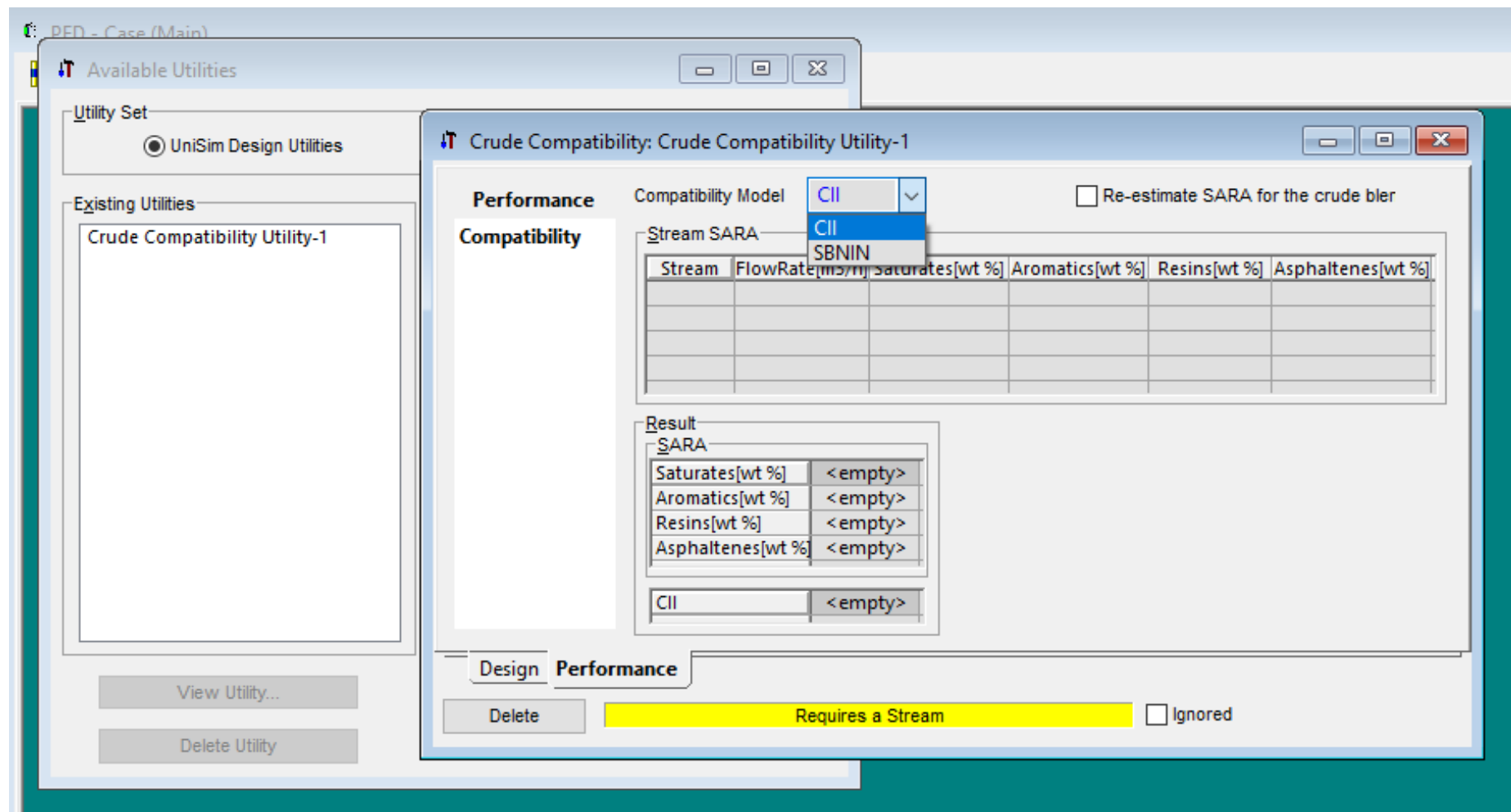
- UniSim Design links to Crude Assay Databases
- Haverly H/CAMS
- Spiral
- Other Databases
 - Possible to also include proprietary assays
- Assays are imported under the UniSim Crude Manager environment
- Assay Synthesis



- The crude assay import facility makes it easy to import and manage crude assays.
- This functionality increases engineering effectiveness, eliminates room for manual data entry, and makes it easier to model crude storage facilities and refining processes.

Crude Compatibility Utility

- A New Utility to Evaluate the Compatibility of Crude Oil Blends

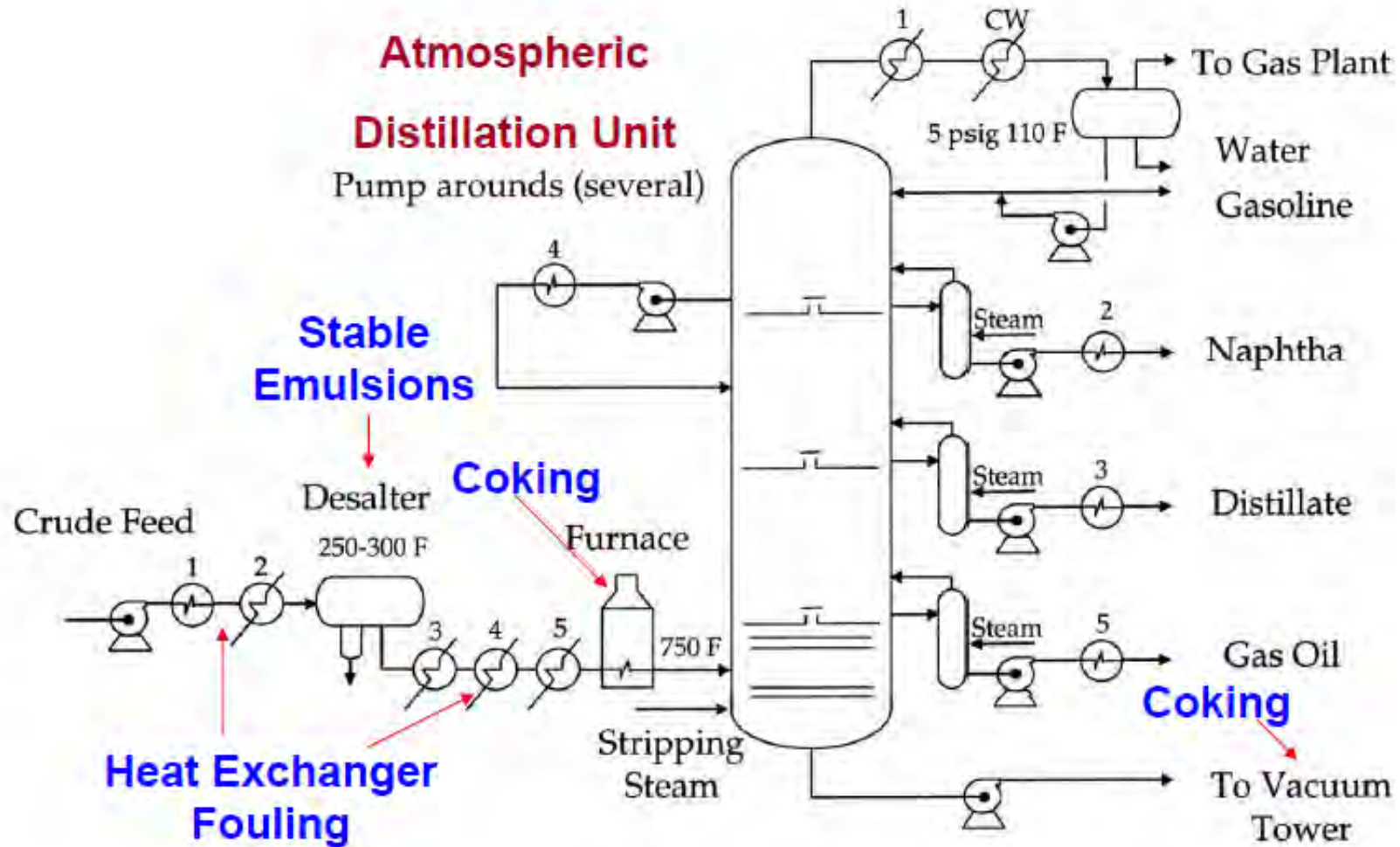


Crude Compatibility Utility

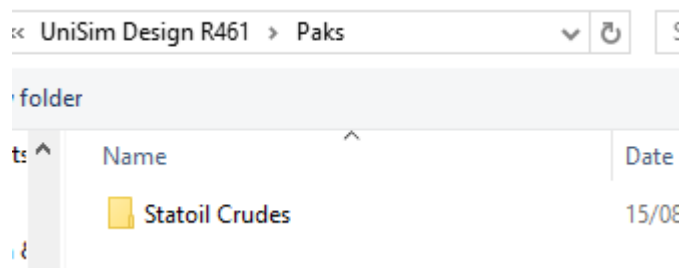
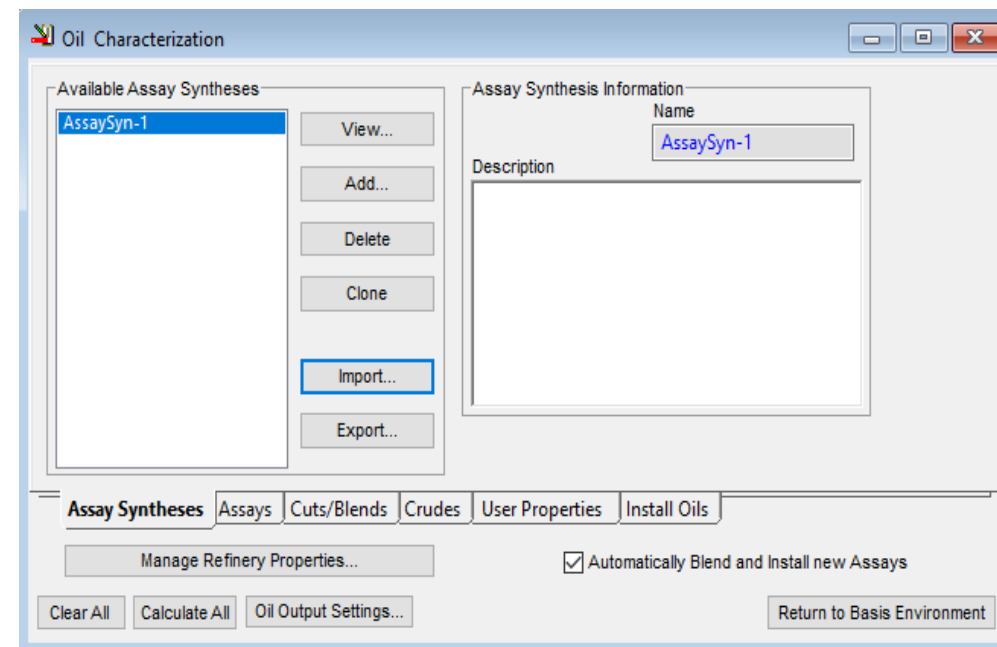
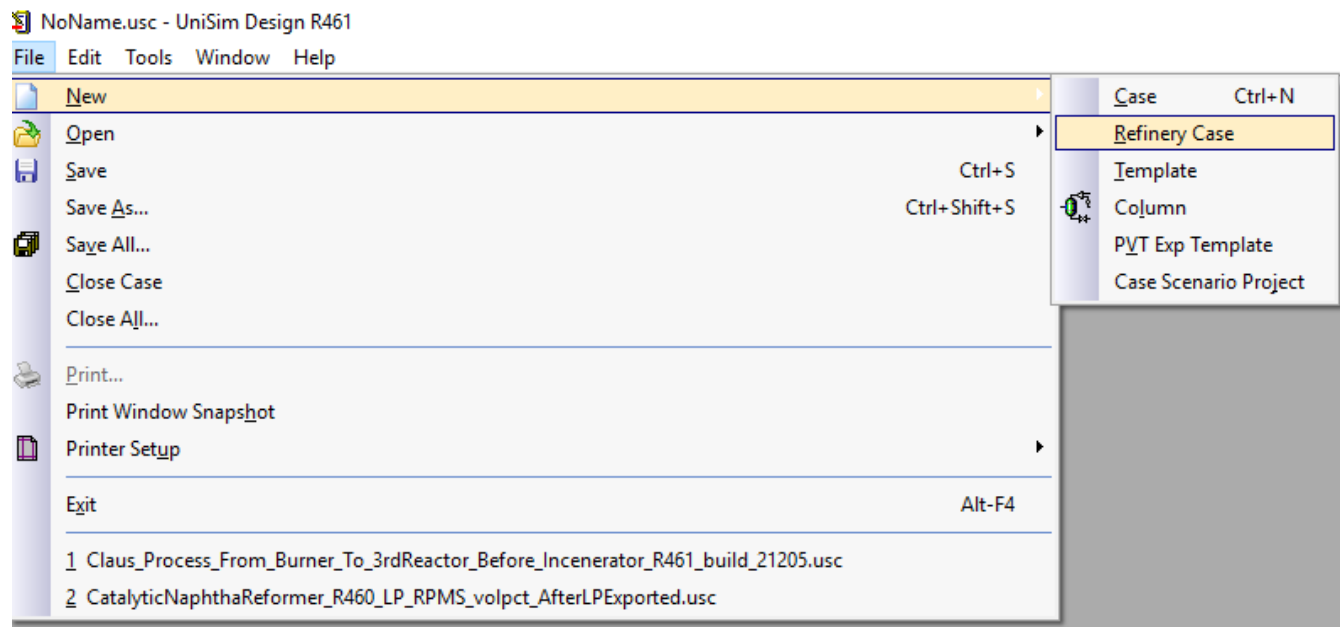
Benefits

- Allows evaluation of opportunity crude oils and condensates for processing by the refinery
 - Shale Oil, Tight Oil, etc.
- Makes it possible to evaluate and minimize risk of damage by non compatible feedstock
- Supports better crude blending practices
 - Adjusting the ratio of incompatible crude oils

Where it can happen?



Refinery Modelling Made Easy



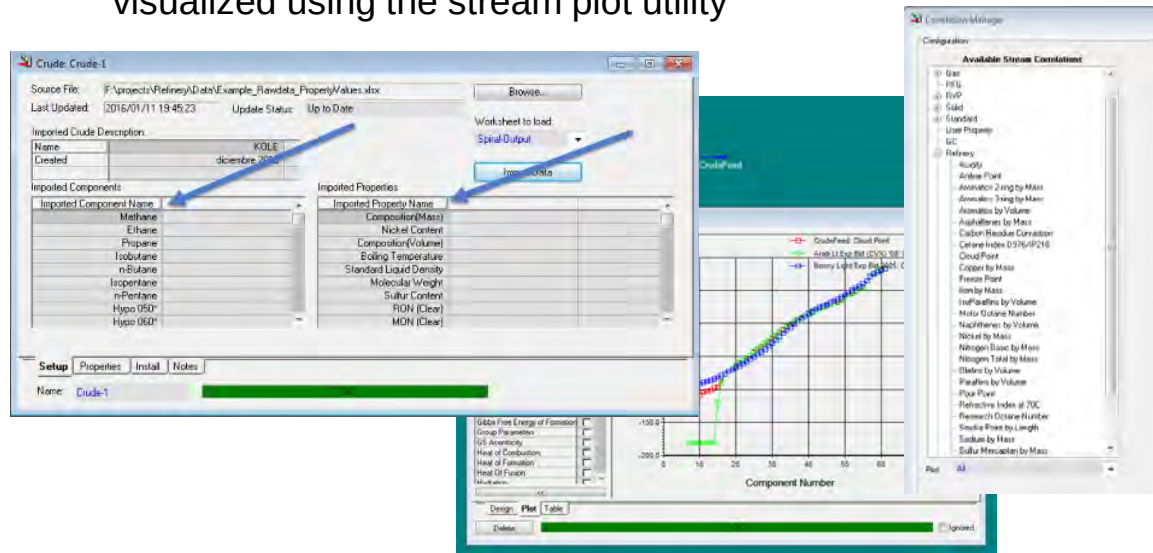
Paks > Statoil Crudes

Name	Date modified
AASGARD-BLEND-2016-01.xls	16/03/2017 12:59
GRANE-BLEND-2017-01.xls	16/03/2017 12:59
GUDRUN-BLEND-2016-02.xls	16/03/2017 12:59
MONDO 2016 08.xls	16/03/2017 12:59
OSEBERG-2016-04.xls	16/03/2017 12:59
statoil-01032017-quality-overview-crude...	16/03/2017 14:03
statoil-01032017-quality-overview-crude...	16/03/2017 12:59
Statoil-AGBAMI 2012 03 (1).xls	16/03/2017 12:59
Statoil-AGBAMI 2012 03.xls	16/03/2017 12:59
Statoil-ALBA-2012-01.xlsx	16/03/2017 12:59
Statoil-ALGERIAN-Cond-2010-11.xls	16/03/2017 12:59

Refining Infrastructure

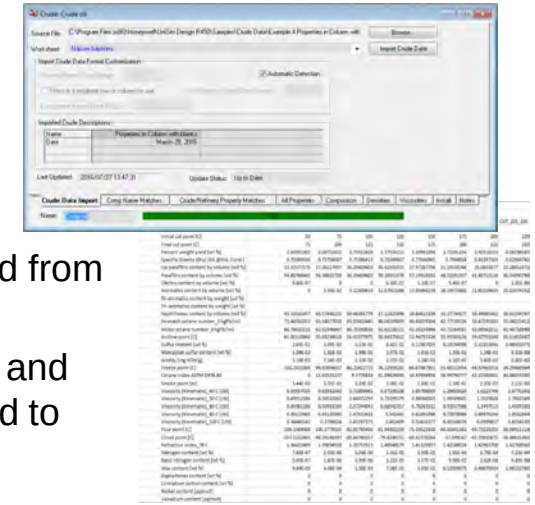
Refining Properties

- 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



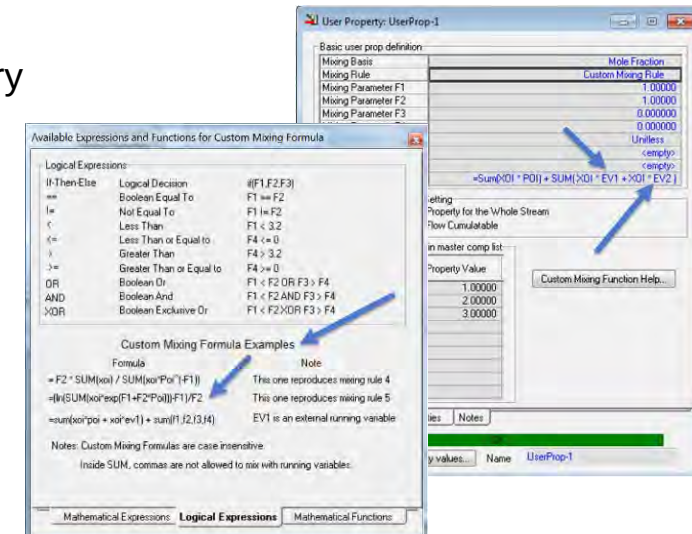
Crude Environment

- 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
- Fully customizable

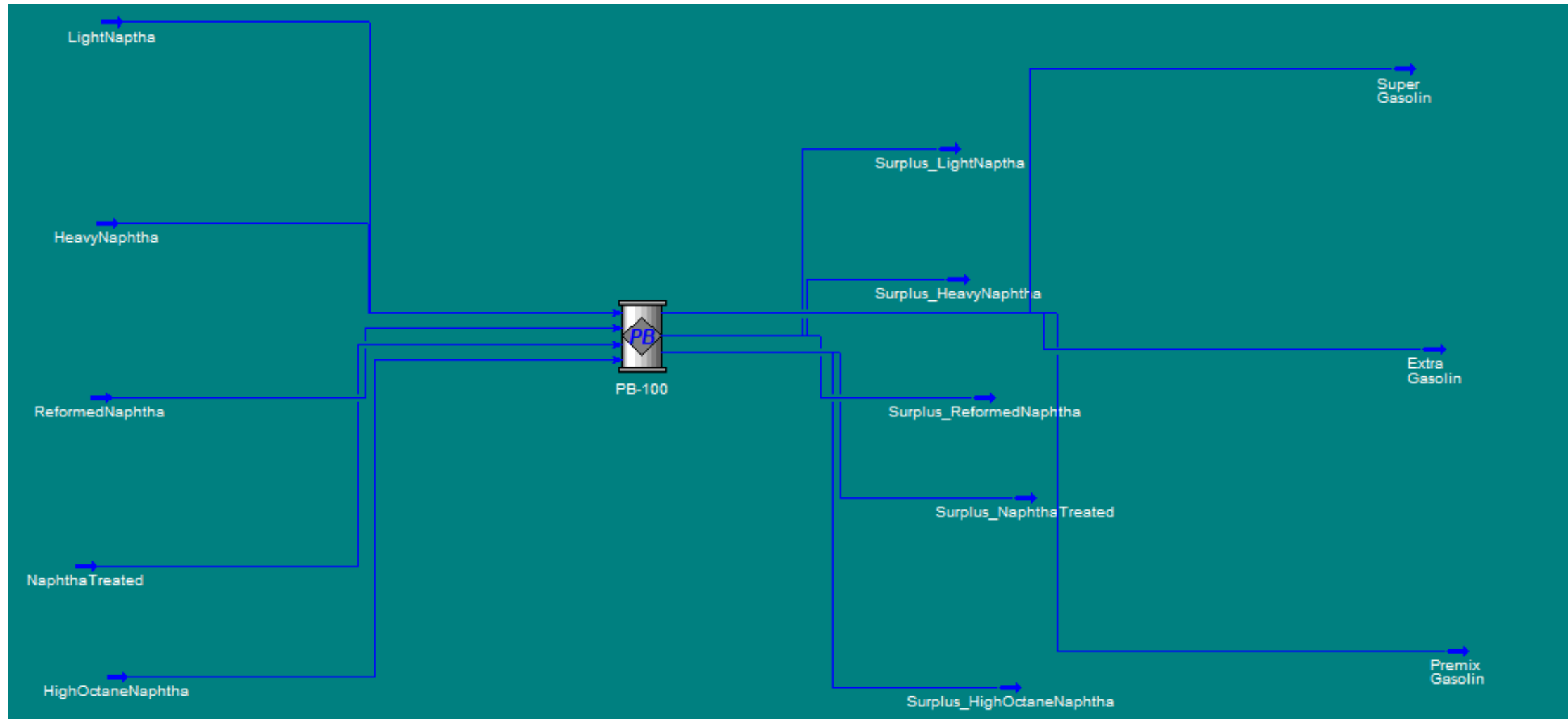


Product Blender

Benefits

- Allows economic optimization of recipes and Refinery-wide modelling
- Avoid quality give away
- Provides refinery-wide modelling capability
- Can use it as a stand-alone blender model or as part of a flowsheet

Product Blender Model in UniSim Design



Core to the Honeywell Connected Plant

Product Blender

Benefits

- Produce on-spec finished products
- Enables calculation of bio component requirements
- The same model can be used for gasoline, gasoil or fuel oil blending
- Evaluate options for IMO 2020 compliance

Product Blender View in UniSim Design

PB-100

Design

Connections
Parameters
Split Fractions
User Variables
Notes

Feed Split Fractions

	Super Gasolin	Extra Gasolin	Premix Gasolin		Surplus
LightNaptha	0.6296	0.3406	0.0298		0.0000
HeavyNaptha	1.0000	0.0000	0.0000		0.0000
ReformedNaptha	0.4230	0.5688	0.0082		-2.220e-016
NaphthaTreated	0.2678	0.1122	0.0017		0.6183
HighOctaneNaptha	0.8736	0.0141	0.0000		0.1123

Design | Quality | Worksheet | Performance | Dynamics | Cost

Optimizer Status : Success

Delete OK ☐ Ignored Run Optimizer

SRU Model

Benefits

- SRU model allows to comply with strict environmental regulations to avoid:
 - Paying penalties
 - Forced refinery shut-down
- Avoid production loss and fines
- SRU model is part of UniSim Design Platform

SRU Model

Benefits

- Readily available to be integrated within your full Upstream, Gas Processing, or Refining flowsheet
- Sulfur recovery model can also be used as a standalone model
- Ease of use
 - Simple configuration & calibration
 - Templates available
 - Configuration flexible

SRU Model

- Makes evaluation of additional sulfur recovery requirements possible
 - Need for additional SRU capacity
- Validated by Honeywell subject matter experts
 - Ortloff Engineers
- Evaluation of unit revamps
- Available at no additional cost within UniSim Design R470

LP Vector Generation

- This is now automated to export data to templates for RPMS, GRTMPS, PIMS, etc.

Export LP Value to a Microsoft Excel file : RPMS Demo

Target File: T:\LP_Export_TEST.xlsx Browse...

Worksheet: Sheet1 Export

Starting at Cell: A1 ☐ Transpose Table

LP Value

Independent States Tag	Ind_Tag1	Ind_Tag2	Ind_Tag3	Ind_Tag4	Ind_Tag5	Feed Flow	WAIT	H2/HC
Feed Flow [kg/h]	1.324e+005	1.324e+005	1.324e+005	1.324e+005	1.324e+005			
WAIT [C]	515.0	515.0	515.0	515.0	515.0			
H2/HC	6.300	6.300	6.300	6.300	6.300			
Pressure [kPa]	1050	1050	1050	1050	1050			
Dependent States Tag	D_Tag1	D_Tag2	D_Tag3	D_Tag4	D_Tag5			
H2 Yd vol%	1.8758e+01	1.8758e+01	1.8758e+01	1.8758e+01	1.8758e+01	5.883e-006	-2.716e-002	-3.596e-002
Methan Yd vol%	3.0912	3.0912	3.0912	3.0912	3.0912	-1.114e-005	4.937e-002	4.737e-003
Ethane Yd vol%	4.1740	4.1740	4.1740	4.1740	4.1740	-1.724e-005	7.872e-002	1.418e-002
Propane Yd vol%	7.3401	7.3401	7.3401	7.3401	7.3401	-2.989e-005	0.1307	2.785e-002
Reformate Yd vol%	5.9291e+01	5.9291e+01	5.9291e+01	5.9291e+01	5.9291e+01	7.410e-005	-0.3299	-1.763e-002
I-C4 Yd vol%	0.9217	0.9217	0.9217	0.9217	0.9217	-7.725e-006	3.226e-002	4.931e-002
n-C4 Yd vol%	6.4234	6.4234	6.4234	6.4234	6.4234	-1.399e-005	6.596e-002	-4.249e-002

Last Updated: 2019/01/29 10:12:14 Update Status: LP Value Exported

Q & A



THANK YOU FOR ATTENDING

Honeywell