



Integrating a proprietary simulation tool into a commercial process simulator

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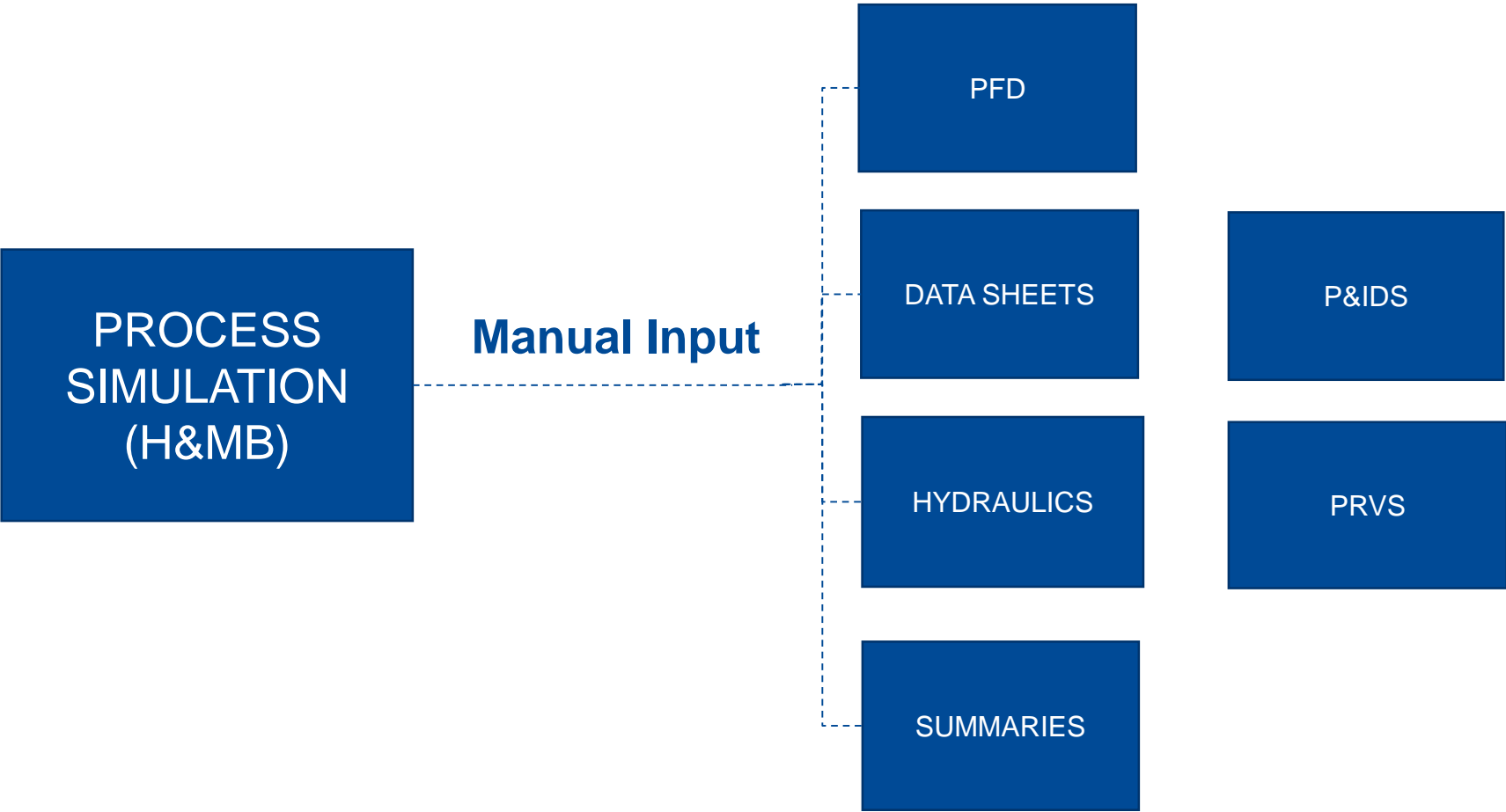
Motivation

EPC Work Flow



Motivation

Basic Engineering Work Flow



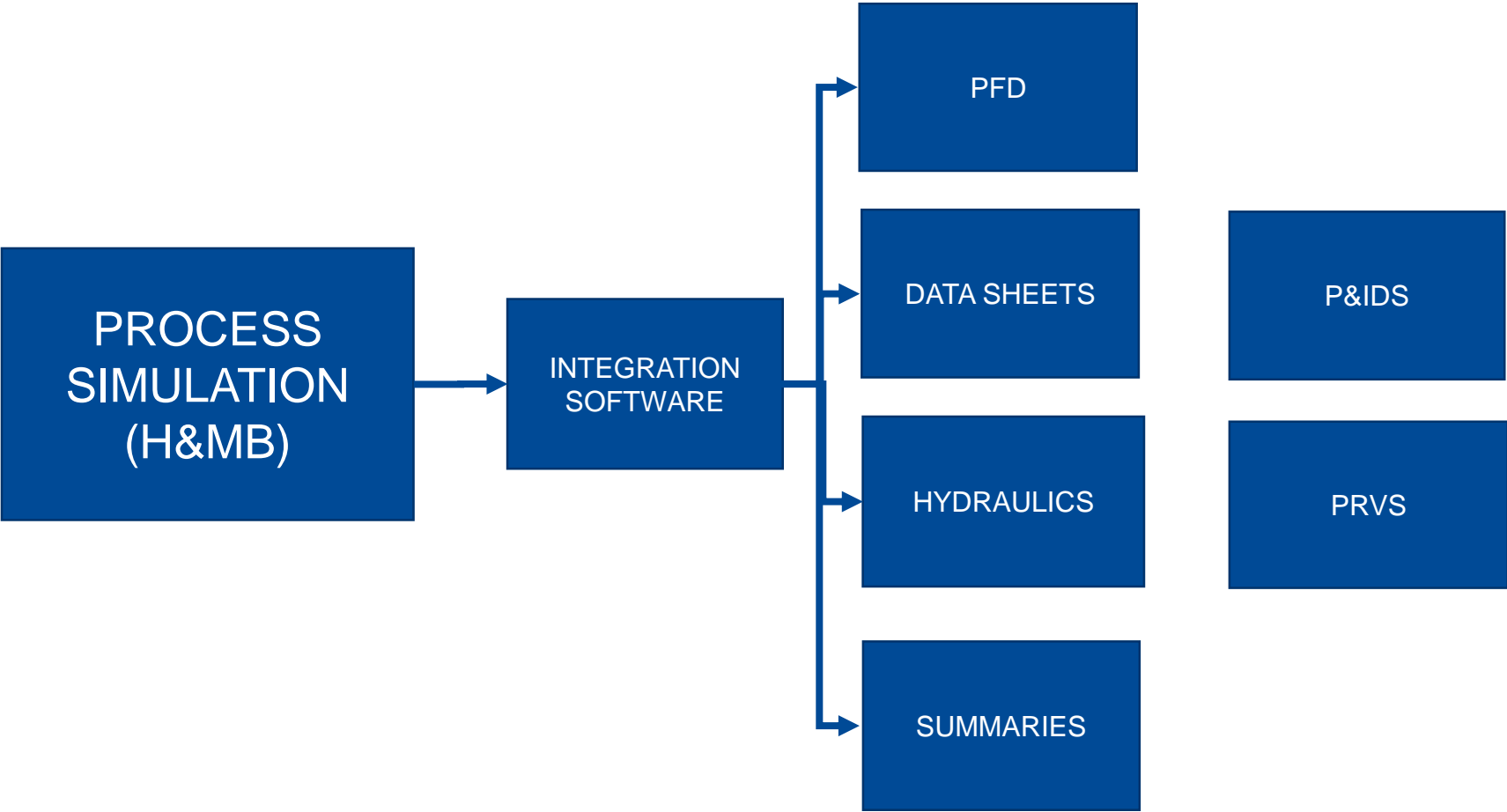
Disadvantages of manual data transfer in current workflow

- Breaks the digitalization process/flow
- Engineering workflow interrupted
- Time and resource consuming
- Prone to errors and inconsistencies
 - ▶ During creation of heat and material balance
 - ▶ When processing change requests
- Complicates collaboration as a global team, if e.g.
 - ▶ Heat and material balance
 - ▶ Equipment data sheets are generated in different office locations

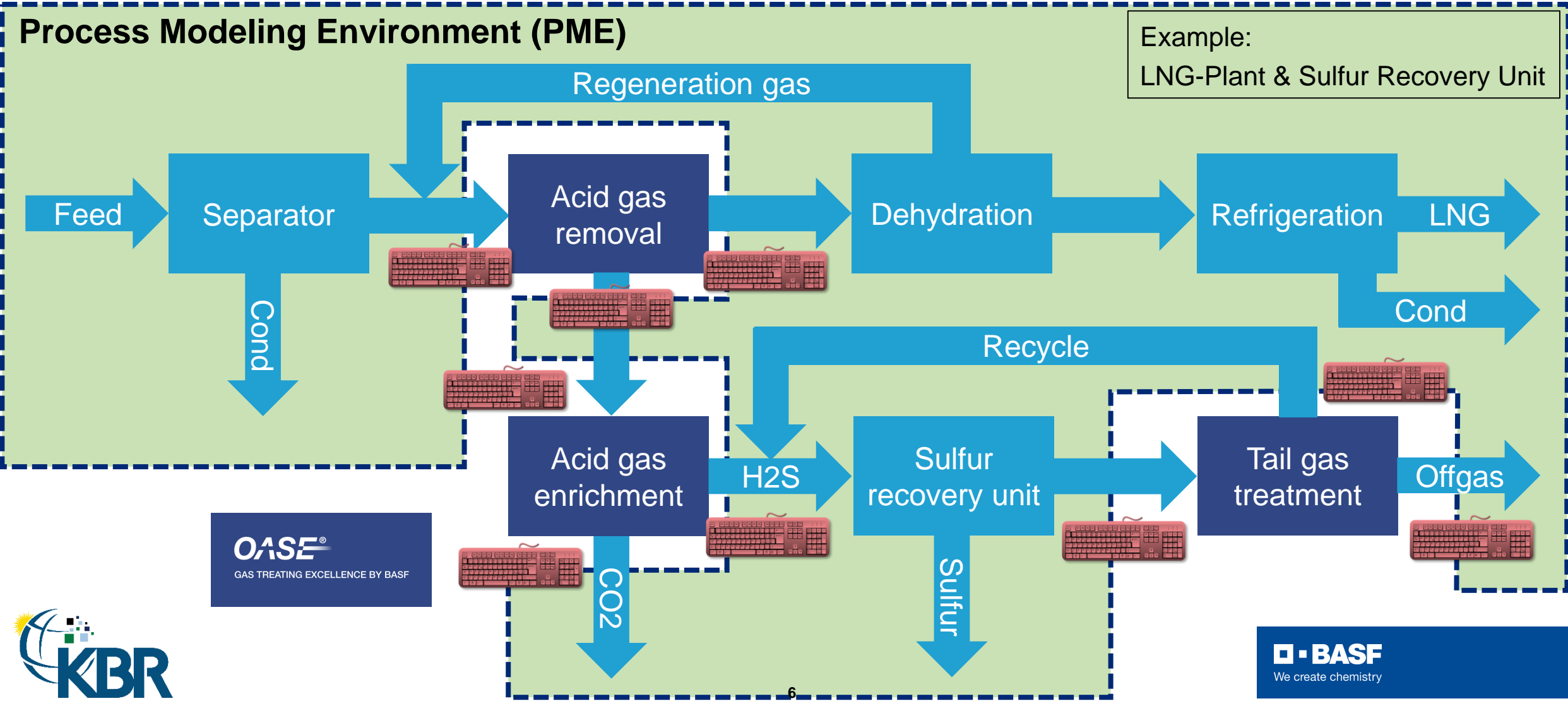


Motivation

Basic Engineering Work Flow



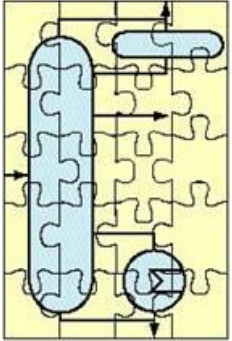
Interaction with in-house or proprietary simulation tools in process simulation → Manual transfer of input and output data required



OASE®
GAS TREATING EXCELLENCE BY BASF



CAPE-OPEN



■ The CAPE-OPEN Standard

- ▶ ... defines **rules** and **interfaces** that allow **CAPE** (Computer-Aided Process Engineering) applications to interoperate
 - Examples: Interfaces for **thermodynamic models** and for **unit operations**

■ CO-LaN (<http://www.colan.org/>)

- ▶ ... is a not-for-profit member society established in France in 2001
- ▶ ... **manages the CAPE-OPEN standard**
- ▶ ... facilitates the implementation of CAPE-OPEN interfaces through software tools and services



CAPE-OPEN interfaces – What are we talking about?

Process Modeling Environment (PME)

Software environment that supports

- construction of a process model
- process simulation or optimization

Flow sheet simulator, e.g.

- Aspen Plus[®]
- Aspen HYSYS[®]
- COFE
- ProMax[®]
- Pro/II
- UniSim[®] Design
- ...

CAPE-OPEN interface

Communication between CAPE applications

Process Modeling Component (PMC)

Software component, which is intended to carry out a well-defined function with limited scope

Examples:

- Computation of physical properties
- Simulation of a particular unit operation
- Numerical solution of certain types of mathematical problems

Material Streams

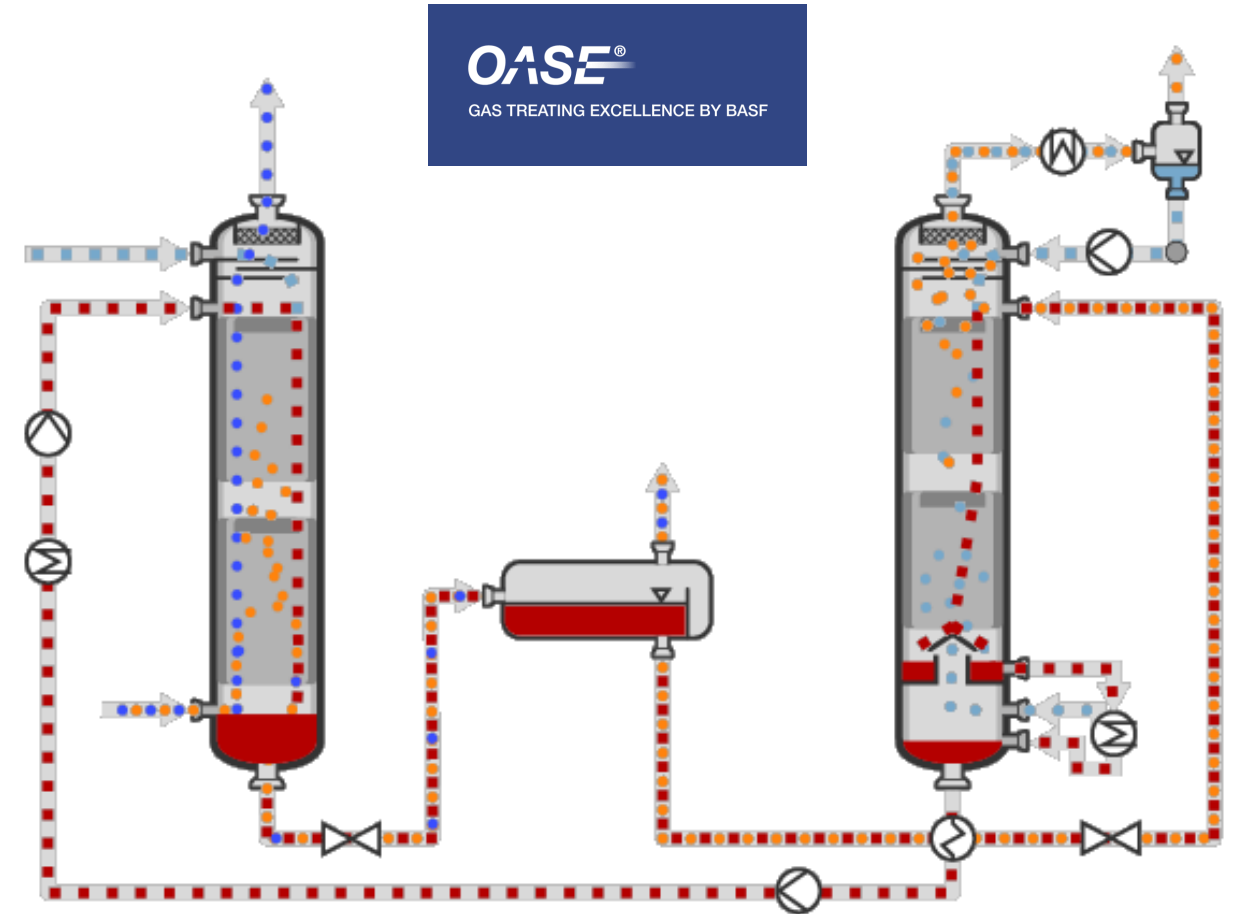
Energy Streams

Parameters

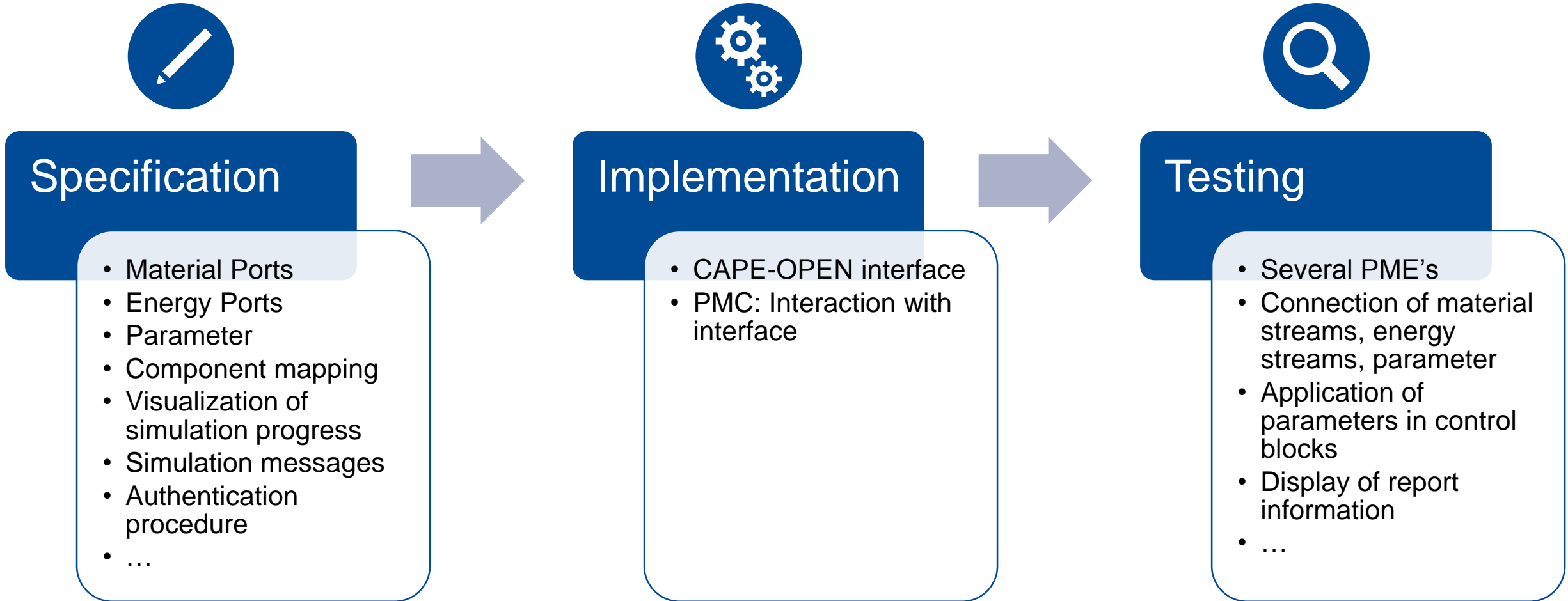
Others

Example for PMC

- BASF's OASE[®] gas treatment technology for removal of acid gases
- Acid gas removal unit (AGRU) is part of large production plants, e.g.
 - ▶ LNG plants / natural gas processing plants
 - ▶ Ammonia plants / synthesis gas plants
- **Proprietary simulation tool OASE connect:**
 - ▶ Allows rigorous calculation of BASF's OASE[®] gas treatment technology
 - ▶ Is provided as server client application



Realization of CAPE-OPEN interface in OASE connect



CAPE-OPEN interface allows communication between PME and PMC

Process Modeling Environment (PME)

CAPE-OPEN Interface for unit operation

Process Modeling Component (PMC)

OASE[®]

GAS TREATING EXCELLENCE BY BASF

Material inlet ports

Energy inlet ports

Inlet parameters

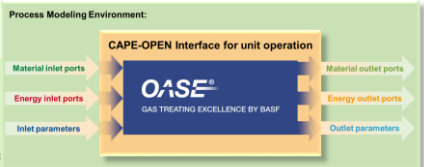
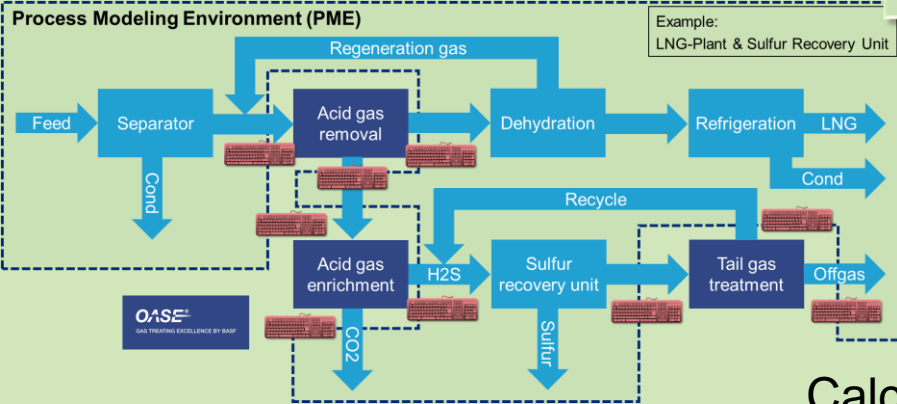
Material outlet ports

Energy outlet ports

Outlet parameters

Interaction between PME and OASE connect via CAPE-OPEN interface

Process Modeling Environment (PME)



BASF Server



CAPE-OPEN interface

Calculation in PME

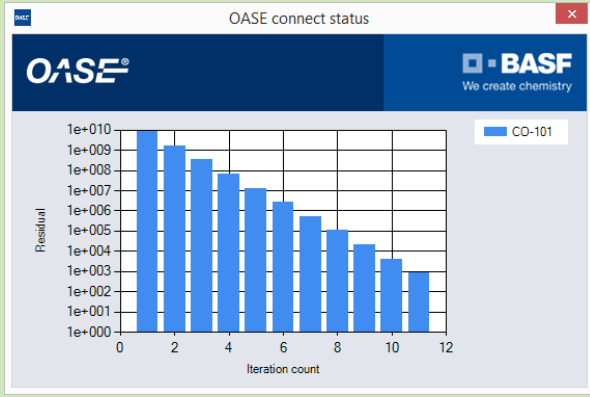
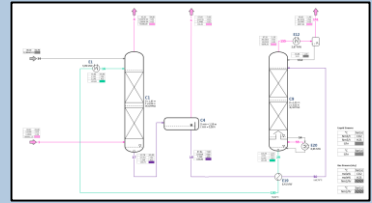
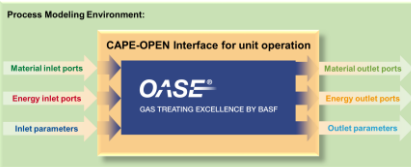
OASE connect input

Calculation in OASE connect

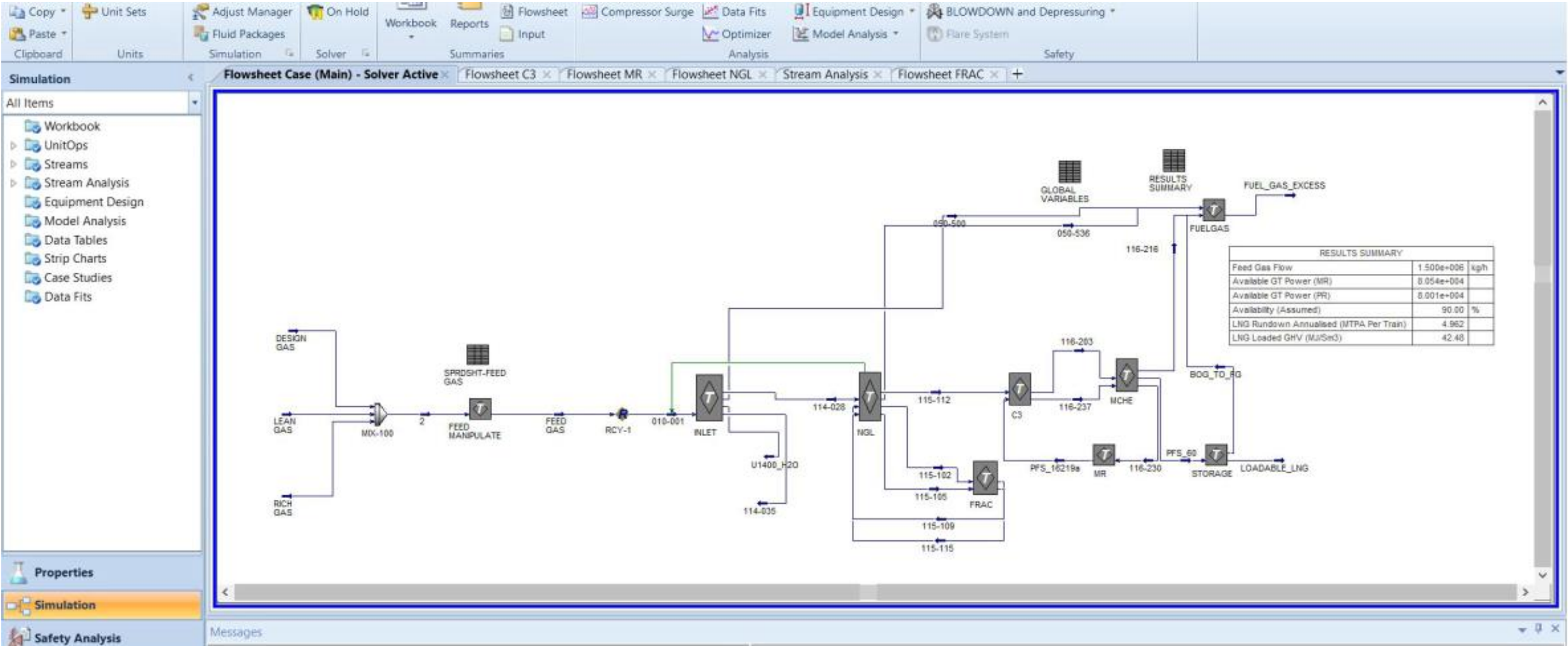


CAPE-OPEN interface

OASE connect output



Example: OASE connect embedded into KBR's LNG Model



Screenshot from Aspen HYSYS®



Example: OASE connect embedded into KBR's LNG Model

Simulation Flowsheet INLET (INLET) - Solver Active

All Items

- Workbook
- UnitOps
- Streams
- Stream Analysis
- Equipment Design
- Model Analysis
- Data Tables
- Strip Charts
- Case Studies
- Data Fits

Properties

Simulation

Safety Analysis

Messages

Simplified AGRU Model

AGR U REMOVAL:
CO2 TO 50 ppm
H2S TO 1 ppm
50% OF COS (ASSUMED) -
TBC WITH BASF

Screenshot from Aspen HYSYS®



Example: OASE connect embedded into KBR's LNG Model

The screenshot displays the Aspen HYSYS interface for a process simulation. The main window shows a complex flowsheet with various units including mixers (MIX-100, MIX-101), separators (114-V-001, 114-V-002), heat exchangers (U-1400), and control elements (SET-2, RCY-2). A red box in the Model Palette highlights the 'CAPE-OPEN 1.0 Unit' option. The interface includes a top toolbar with various manipulation tools, a left-hand 'Simulation' sidebar with a tree view of the model, and a bottom status bar showing solver information and responsiveness.

Selection of CAPE-OPEN unit operation

Screenshot from Aspen HYSYS®



Example: OASE connect embedded into KBR's LNG Model

The screenshot displays the Aspen HYSYS interface for the OASE connect simulation. The top navigation bar includes 'FILE', 'OPTIONS', and 'HELP'. The main window title is 'Project - OASE connect (05.6.20)'. The interface is organized into several panels:

- Left Panel:** Contains a 'Simulation' tree with items like Workbook, UnitOps, Streams, Stream Analysis, Equipment Desi, Model Analysis, Data Tables, Strip Charts, Case Studies, and Data Fits. Below this is a 'Properties' section with 'Simulation' selected, and 'Safety Analysis' and 'Energy Analysis' options.
- Top Panel:** Features the 'OASE[®] via Aspen HYSYS[®]' logo and three buttons: 'SETTINGS', 'SHOW FLASH CALCULATION', and 'SHOW OUTPUT'.
- Configuration Panel:**
 - Configuration:**
 - Absorption:**
 - C1 Absorber
 - E1 Solution Cooler
 - E15 Feed Gas Heater: Feed gas - Treated gas
 - E16 Feed Gas Heater: Feed gas - Lean solution
 - Backwash section
 - Flash:**
 - C4 HP Flash
 - Horizontal Vertical
 - E4 Heater upstream HP Flash
 - C10 Flash Gas Absorber
 - Semi lean solution from LP Flash Lean s from S
 - E10 Solution Cooler to Flash Gas
 - E18 Solution Cooler from Flash C
 - E23 Flash Gas Condenser
 - Flash Gas Recycling
- Flash Panel:** (Empty in this view)
- Diagram:** A process flow diagram showing two absorption columns (C1 and C9) and a flash unit (C4). Heat exchangers E1, E12, E19, and E20 are integrated into the process. Stream numbers like 10, 15, 16, 19, 20, 50, 54, 55, 114-030, and 114-E-003 are visible.
- Bottom Panel:** Includes a 'RETURN' button and an 'OUTPUT: Full View' dropdown menu.

Screenshot from Aspen HYSYS[®]



Example: OASE connect embedded into KBR's LNG Model

The screenshot shows the Aspen HYSYS interface with a process flow diagram on the right and a unit operation window for CO-100 on the left. The unit operation window is titled 'CO-100' and has tabs for 'Material Connections', 'Unit Variables', and 'General'. The 'Material Connections' tab is active, showing a table of material connections. A red error message at the bottom of the window reads 'Feed port FeedGas is not connected'. The process flow diagram includes various units such as CO-100, MIX-101, MIX-100, 114-E-001, 114-V-001, 114-E-002, and 114-V-002, along with streams like Acidgas, FlashGas, Treatedgas, and Bleed. A text box above the CO-100 unit reads 'AGRU REMOVAL: CO2 TO 50 ppm H2S TO 1 ppm'.

Port ID	Port type	Direction	Material name
FeedGas	Material	Inlet	
WaterMakeUp	Material	Inlet	
TreatedGas	Material	Outlet	Treatedgas
AcidOffGas	Material	Outlet	Acidgas
Bleed	Material	Outlet	Bleed
FlashGas	Material	Outlet	FlashGas
Purge	Material	Outlet	
E20	Energy	Outlet	
E1	Energy	Outlet	
E12	Energy	Outlet	

Feed port FeedGas is not connected

Connecting the CAPE-OPEN unit operation

Screenshot from Aspen HYSYS®



Example: OASE connect embedded into KBR's LNG Model

The screenshot displays the OASE connect (v5.6.20) interface, which is integrated into the Aspen HYSYS environment. The main window is titled "New Project - OASE connect (v5.6.20)". On the left, there is a navigation pane with a "Simulation" section containing various analysis tools like Workbook, UnitOps, Streams, and Stream Analysis. The main area is divided into a left sidebar with menu items (FEED GAS, OASE SOLVENT, CONFIGURATION, SPECIFICATION, ABSORPTION, FLASH, REGENERATION, INTRA PROCESS HEAT EXCHANGERS, CAPE OPEN, STATUS, INFO) and a central workspace. The workspace shows a "Component mapping" table with columns for "via Aspen HYSYS®", "Mapping", and "OASE connect". Below the table are buttons for "RETURN" and "OUTPUT: Full View". At the top right, there are buttons for "SETTINGS", "SHOW FLASH CALCULATION", and "SHOW OUTPUT".

Component	Mapping	OASE connect Component
Hydrogen	CAS	H2
Helium	CAS	HE
Nitrogen	CAS	N2
CO2	CAS	CO2
H2S	CAS	H2S
Methane	CAS	CH4
Ethane	CAS	C2H6
Ethylene	Unspecified	Unset

Screenshot from Aspen HYSYS®



Example: OASE connect embedded into KBR's LNG Model

OASE[®]
via Aspen HYSYS[®]

SETTINGS SHOW FLASH CALCULATION SHOW OUTPUT

FEED GAS mole % (wet) 874901.92 Nm3/hr

OASE SOLVENT CONFIGURATION SPECIFICATION

ABSORPTION FLASH REGENERATION INTRA PROCESS HEAT EXCHANGERS CAPE OPEN STATUS INFO

RETURN

OUTPUT: Full View

CO2	1.9995	H2S	3.9332E-04	N2	1.4997
CH4	90.6313	C2H6	4.7649	C3H8	0.6419
C4H10	0.1940	i-C4H10	0.1100	C5H12	0.0720
C6H14	0.0280	C7H16	0.0130	C8H18	0.0070
C9H20	0.0040	C10H22	0.0020	CH3SH	2.2288E-04
C2H5SH	0	C3H7SH	0	COS	7.4372E-04
O2	0	HE	0.0050	Benzene	0.0050
Toluene	0.0050	Ethylbenzene	5.0016E-04	o-Xylene	3.3000E-04
m-Xylene	3.3000E-04	p-Xylene	3.4000E-04	H2O	0.0100
H2	0.0050				

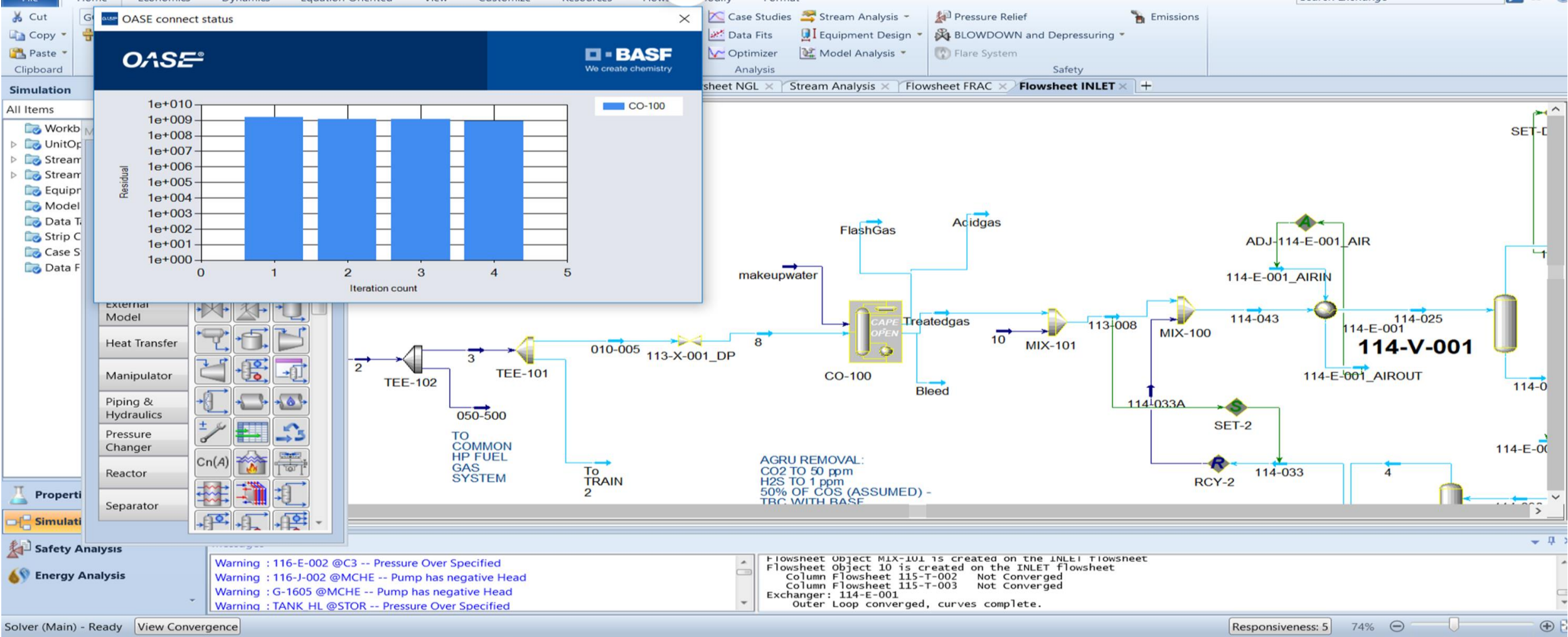
Total percentage
100 %

Tip: To set the total percentage to 100%, right-click the input field and choose "Fill to 100%"

Screenshot from Aspen HYSYS[®]



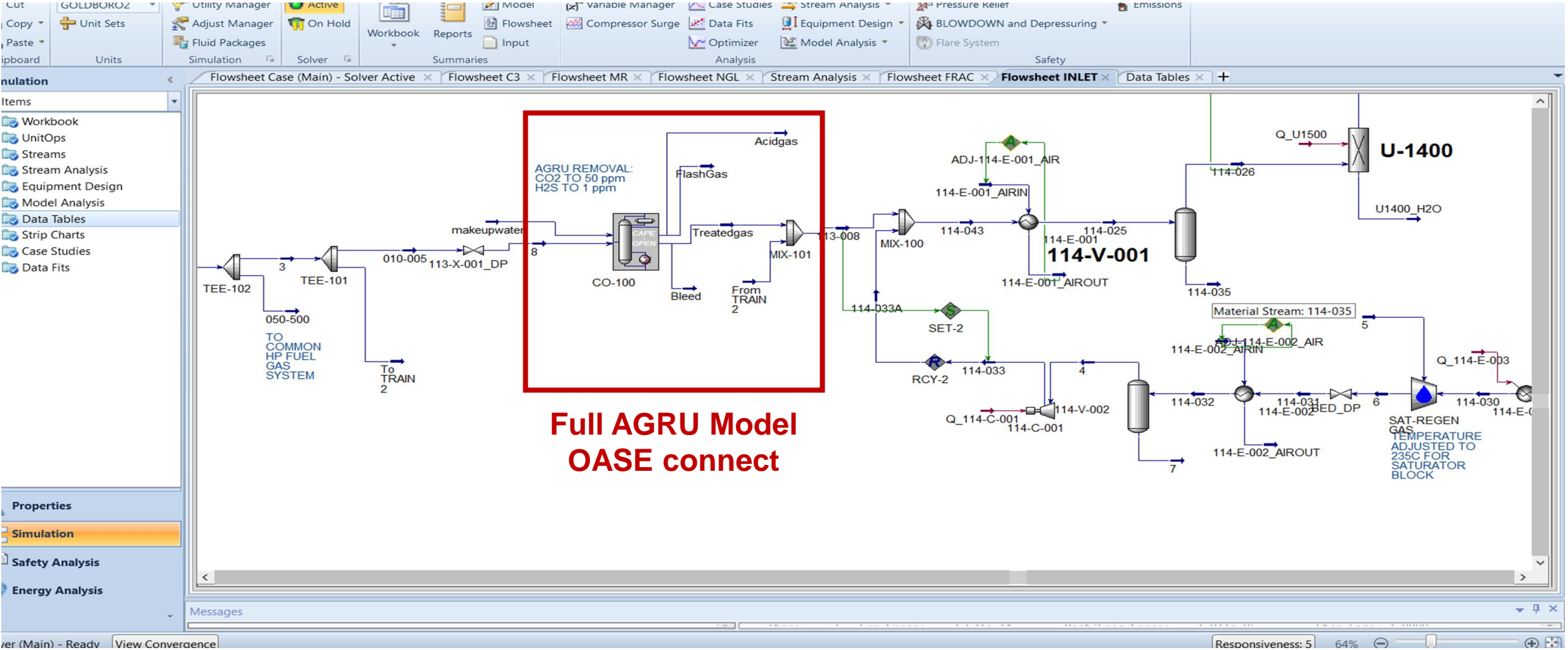
Example: OASE connect embedded into KBR's LNG Model



Screenshot from Aspen HYSYS®



Example: OASE connect embedded into KBR's LNG Model



**Full AGRU Model
OASE connect**

Screenshot from Aspen HYSYS®

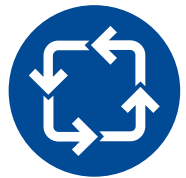


Embedding OASE[®] connect into a Process Modeling Environment via the CAPE-OPEN interface

Benefits:



Provide a **fully closed heat and material balance** as basis for the **generation of technical datasheets** and **further equipment design**



Changes in operating or design parameters are automatically reflected in all connected downstream engineering steps



Boosts the **efficiency of collaboration** in **teams with a global setup**



Significant savings in

Time



Resources



Money

