Process simulation_Base

Kubovicsné Stocz Klára
2023 Q1

Célok

Szimmuláció alapjai
Mikor/hol használunk szimulációt
Milyen modellek vannak
Modell felépítésének lépései
Egyszerű üzemi modell: GFR 106-112 j. kolonna
PFD (P&I)-ból szim modell

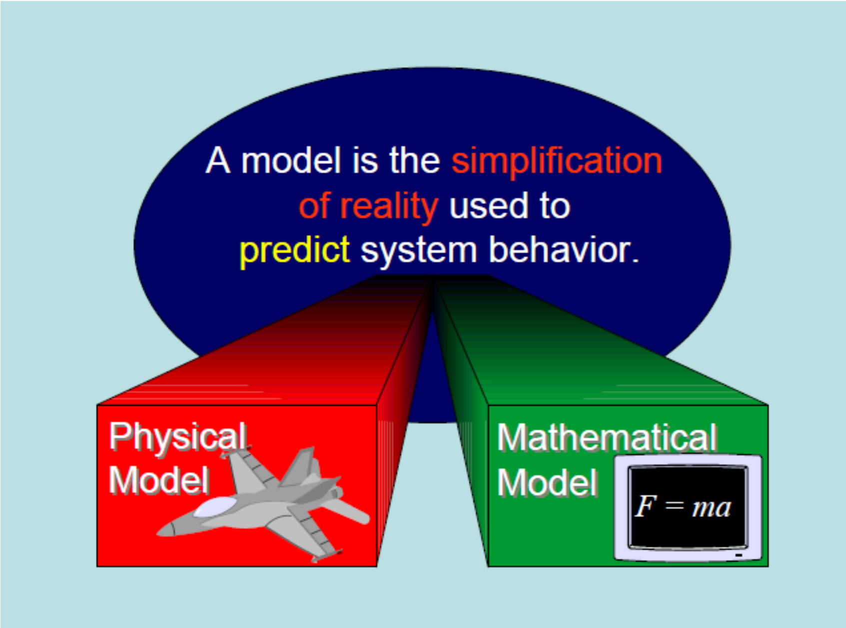
Mire jó a szimuláció ?

Miért, mikor?

Egyedi készülékek/egyszerűbb rendszerek
- Üzemi problémák megoldása
- Új javaslatok vizsgálata
- Mi lenne ha vizsgálatok
- Hogyan csináljuk, hogy
- Milyen hatása van ?
- Készülékek működésének vizsgálata

Bonyolultabb rendszerek….
- Teljes üzemi modellek
- Hőintegráció
- dinamikus modellek
- OTS
- Tervezési adatszolgáltatás (SCM)

Mi a szimuláció ?



Process simulation is a model-based representation of different type of processes.

Simulation programs perform **rigorous mass and energy balances** for wide range of chemical processes.

- Not necessarily a one-to-one correspondence between pieces of equipment in the plant and simulation model
- Always the task determine the depth of the model
- Always has to check the results are consistent and realistic
  - „Papír mindent elbír”

Szimuláció a Finomítóban

- Steady state szimuláció (állandósult állapot)
- Dinamikus szimuláció
- Hőcserélők/ hőátadás
- Hőintegráció
- Kemence
- Reaktor modellek
- Csővezetékek/Piping network
- Lefuvató rendszerek/Safety system

Szimuláció ?

Steady state szimuláció

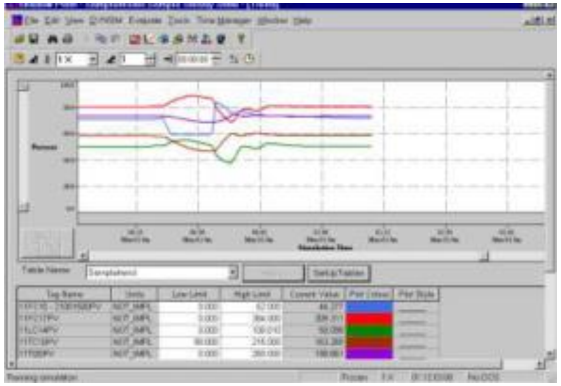
Időben állandó

anyag és energia mérlegek
különböző esetek vizsgálata
szűk keresztmetszetek vizsgálata
nem mérhető paraméterek meghatározása

Időben változó

Dinamikus szimuláció

szabályozó rendszerek modellezése
paraméterek időbeli változásának vizsgálata



Alapok

Mit csinálunk?

Folyamat ábra/Process flowsheet
P&I /PID

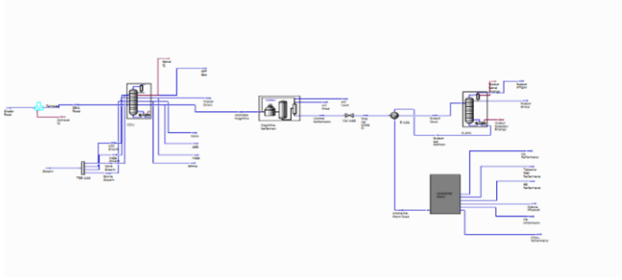
Equipments

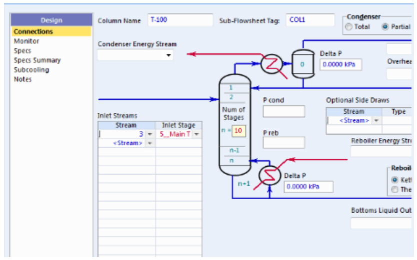
Szimulációs folyamatábra/Simulation flowsheet

Simulation unit

Mi kell hozzá?

- áram paraméterek
- Készülék paraméterek





MOL GROUP

Szimuláció lépései:

PFD
- Alapmodel építés
  - PFD, készülékek, áram kapcsolatok

M.e.
- Mértékegységrendszer meghatározása
  - SI/British, eltérések

Komp
- Komponensek
  - Összetétel, pseudokomponens, assay data

Termo
- Termodinamika
  - SRK/NTRL….

Áram
- Áram adatok/Áram tulajdonságok

Készülékek
- Készülék paraméterek

Run
- Model futtatása

Result
- Eredmények ellenőrzése

Gázfrakcionáló üzem

<u>Üzem feladata:</u>

Az üzem a PB kénmentesítő termékét (az AV-1, AV-2, AV-3 üzemek valamint a HDS és BEK-2 üzemek kénmentesített PB-jét), a Reformáló-4 üzemi PB-t és stabilgázt, valamint (téli időszakban) a GOK-3 üzemből származó PB-t dolgozza fel, ill. frakcionálja.

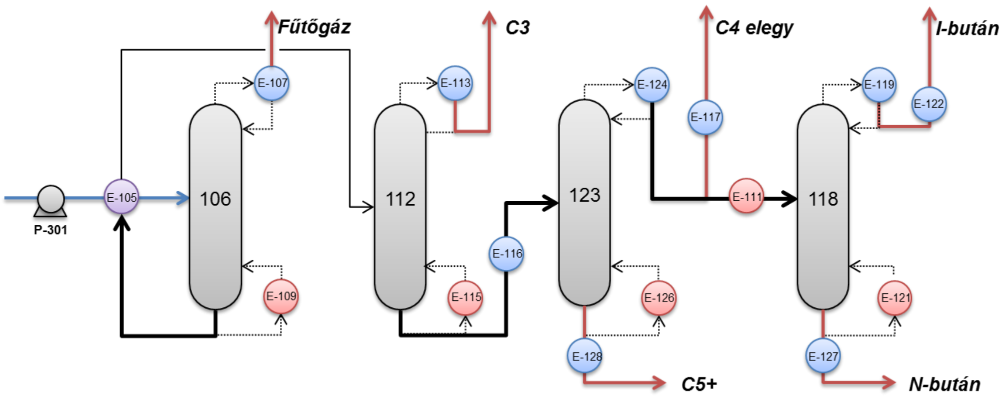
<u>A feldolgozás termékei:</u>

- ***Fűtőgáz:*** a fűtőgáz gyűjtő és elosztó gerincvezetékbe adják ki.
- ***Propán:*** a propánt PB keveréshez használják, vagy PAM üzembe
- ***Bután elegy:*** a bután elegyet PB, illetve benzinkeveréshez használják. Lehetőség van a vegyipari benzinbe történő kitárolásra is.
- ***Izobután:*** az izobután a HF Alkilezőbe adható tovább vagy a bután elegyhez hasonlóan használható.
- ***Normál-bután:*** a normálbutánt az MSA üzembe adható ki vagy a bután elegyhez hasonlóan használható fel.
- ***Pentán frakció (maradék):*** a maradékot motorbenzinbe vagy vegyipari benzinbe keverik.

MOL GROUP

Feladat/gyakorlat

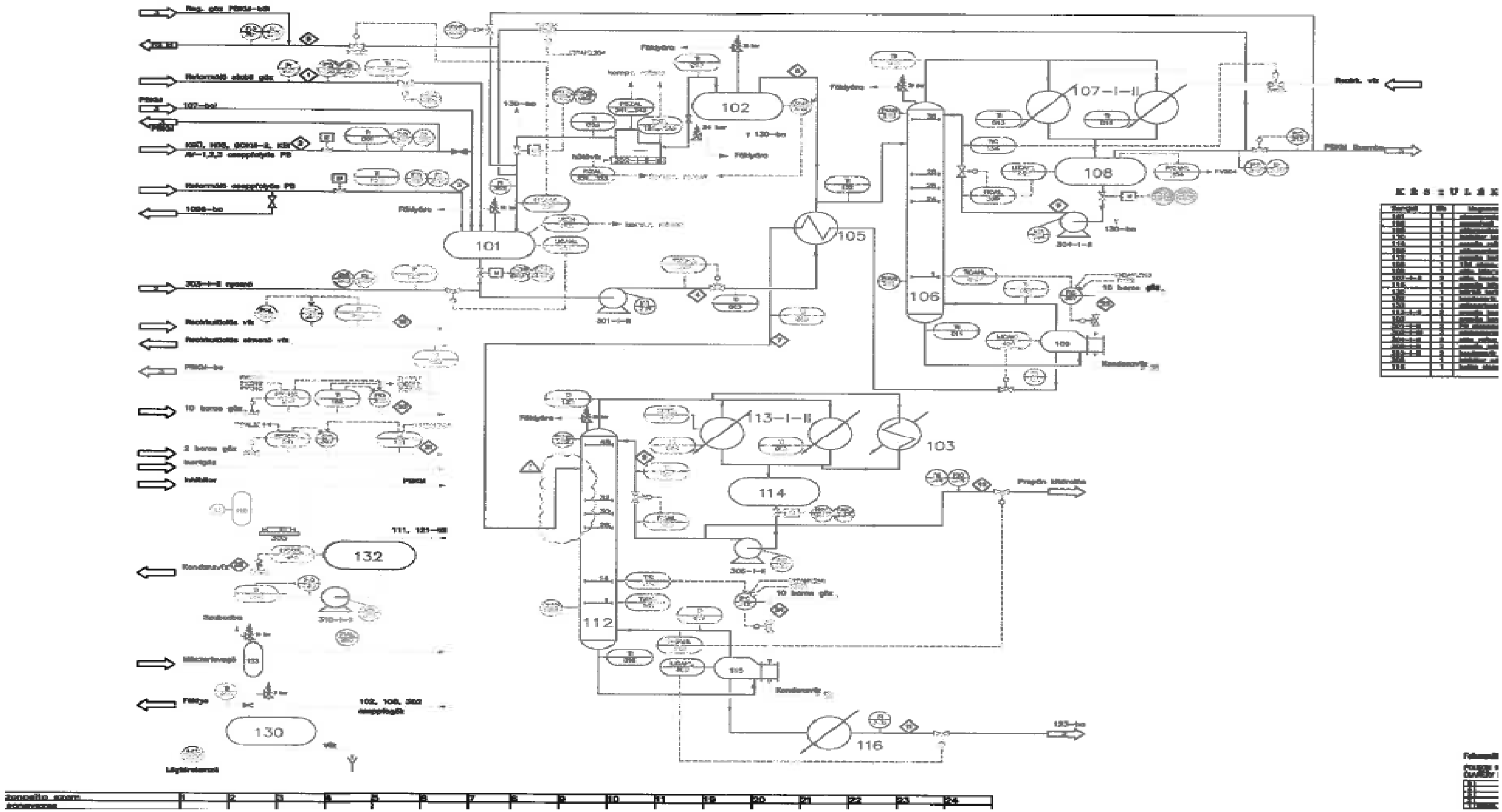
Feladat: GFR üzem első két kolonna modellezése



- PFD/P&I alapján rajzoljuk meg a sim, folyamatábrát, határozzuk meg mely készülékeket kell modellezni
- Indítsuk el a Petrosim-et
- Válasszuk ki az alkalmazott mértékegység rendszert (kg/h, C, barg)
- Válasszuk ki az alkalmazott termodinamikát
- Definiáljuk a komponenseket (következő slide, külön lap)

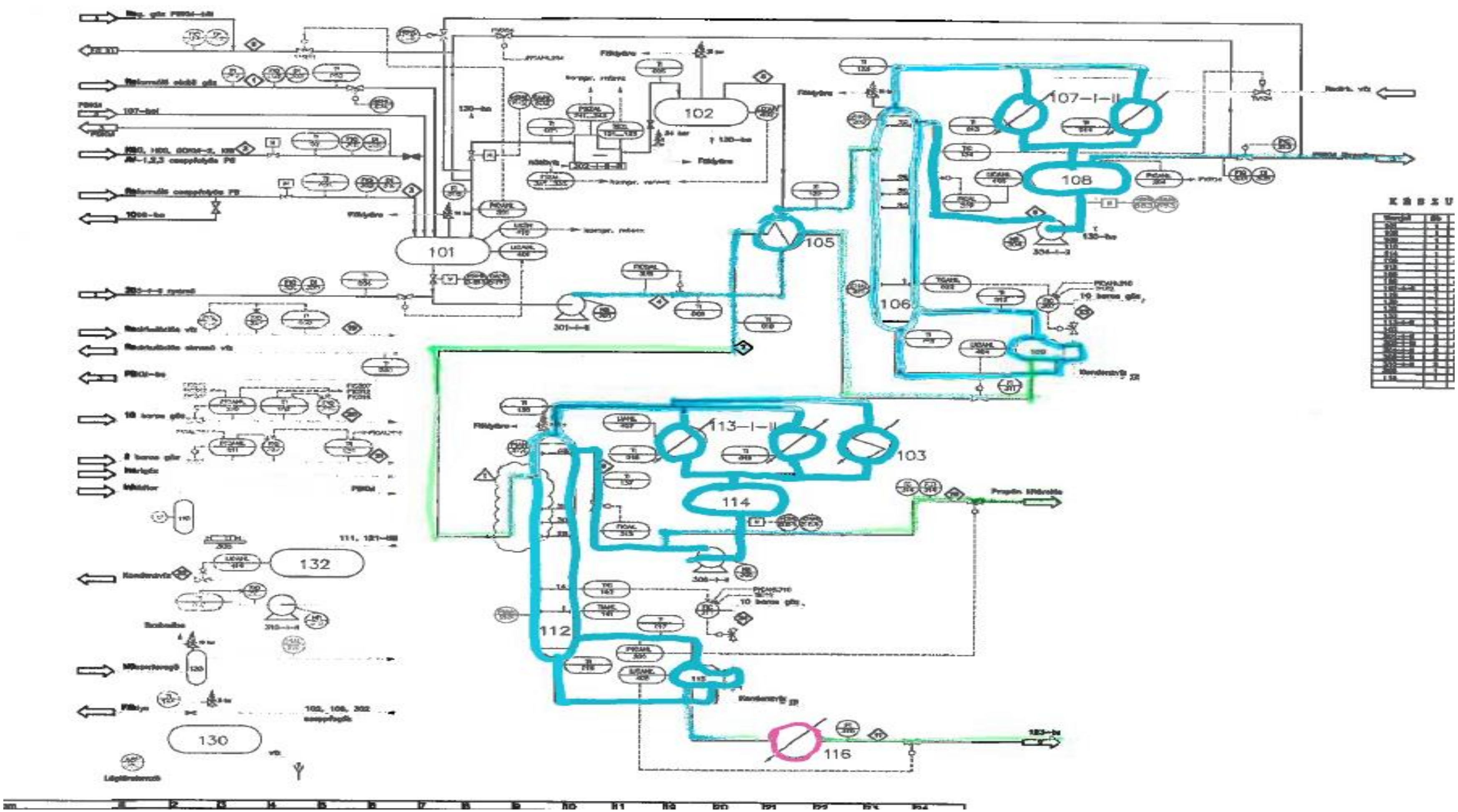
1. PFD –ből szimulációs folyamatábra

PFD → ME → Comp → Termo → Stream → Equipment → Run → Result



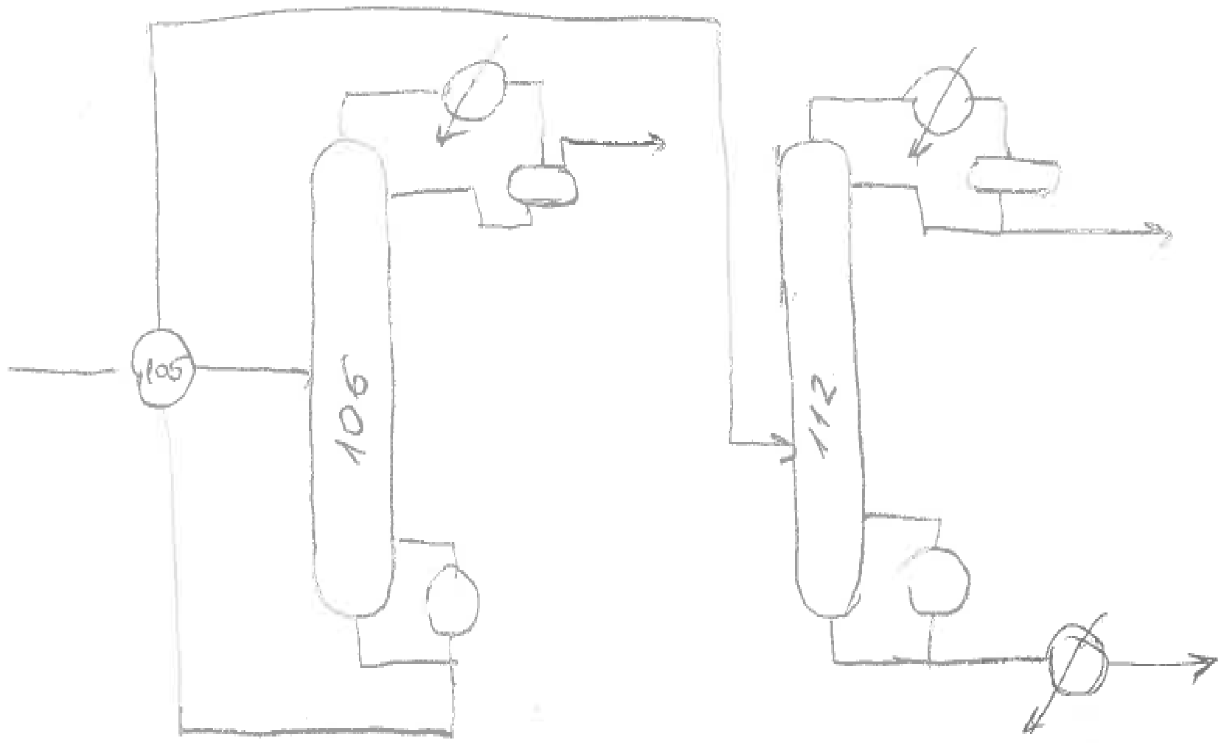
1. PFD –ből szimulációs folyamatábra

PFD → ME → Comp → Termo → Stream → Equipment → Run → Result



1. PFD –ből szimulációs folyamatábra

PFD | ME | Comp | Termo | Stream | Equipment | Run | Result



2. Mértékegységek

PFD ME Comp Termo Stream Equipment Run Result

Több lehetőség::
default:

Unit Set	EuroSI	Field	RefineryField	RefineryMetric	SI
Temperature	C	F	F	C	K
Pressure	bar	psia	psig	bar_g	kPa
Flow	kgmole/h	lbmole/hr	MMSCFD	kNm3/h	kgmole/h
Mass Flow	kg/h	lb/hr	lb/hr	tonne/hr	kg/h
Liquid Volume Flow	m3/h	barrel/day	barrel/day	m3/h	m3/h
Energy	kcal/h	Btu/hr	MMBtu/hr	Gcal/hr	kJ/h
Molar Density	kgmole/m3	lbmole/ft3	lbmole/ft3	kgmole/m3	kgmole/m3
Heat Capacity	kJ/kgmole-C	Btu/lbmole-F	Btu/lbmole-F	kcal/kgmol-C	kJ/kgmole-C
Actual Liquid Flow	m3/s	USGPM	barrel/day	m3/s	m3/s
Length	m	ft	ft	m	m
Length Small	mm	in	in	mm	mm
Time	seconds	seconds	hours	hours	seconds

térfogat:

Std m3/h (15 C ,1 bar)

Actual: adott paraméterek (T,p) mellett (általában ezt mérik az üzemek

Minden mértékegység módosítható, beállítható, egyéni rendszer elmenthető

3. Komponensek, áram összetételek

PFD | ME | Komp | Termo | Áram | Készülék | Run | Result

Komponens :

<u>egyedi komponensek</u>

jól definiált, többnyire ismert
szénhidrogén és egyéb egyedi
magas szénatomszámú komp (kevesebb)

pseudo(hypo) komponensek/petroleum/assay komponens

desztillációs görbe (több lehetőség)
sűrűség

Lehetséges problémák:

könnyű anyagáramok:	elemzési/mintavételi problémák
nehéz komponensek:	nem/nehezen beazonosítható komponensek, nincs a rendszerben meglelő komponens

Definiálható:

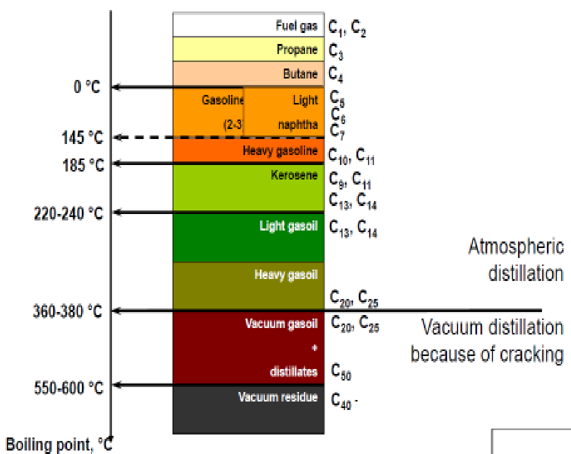
- név alapján
- képlet/összetétel alapján

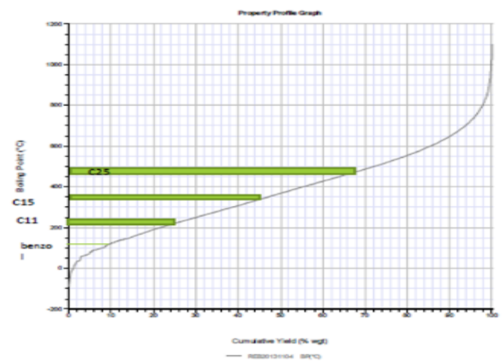
3. Komponensek, áram összetételek

Hypo/pseudo/petroleum komponens

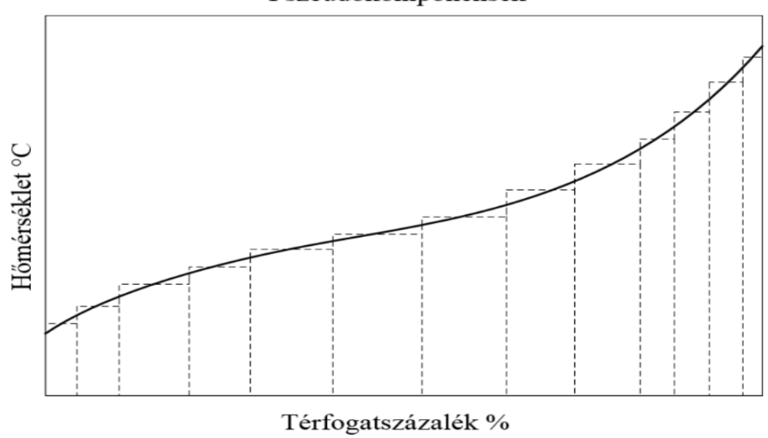
Komponensek generálása:

- sűrűség (sűrűség görbe)
- desztillációs görbe (ASTM D86,D1160,D2887..)
- könnyű komponensek (Lights end)
- viszkozítás(ok)





Pszeudokomponensek



4. Termodinamika/fluidpackage

PFD | ME | Komp | Termo | Áram | Készülék | Run | Result

Paraméterek, komponensek alapján

Peng Robinson az alapértelmezett (HYSYS)

Type of stream	Recommended Method
Atmospheric towers	PR Options, GS, TST
Vacumm towers	PR Options, GS, TST, Braun K, Esso Tabular
High H2 System	PR, ZJ, GS, TST
Steam System	NBS Steam, ASME Steam, CS, GS
Compression	MBWR
Amine system	Amine Pkg, DBR Amine Package
Sour water	Sour PR, Sour SRK

Komponens listához lehet/**kell** igazítani

egy modellen belül váltható

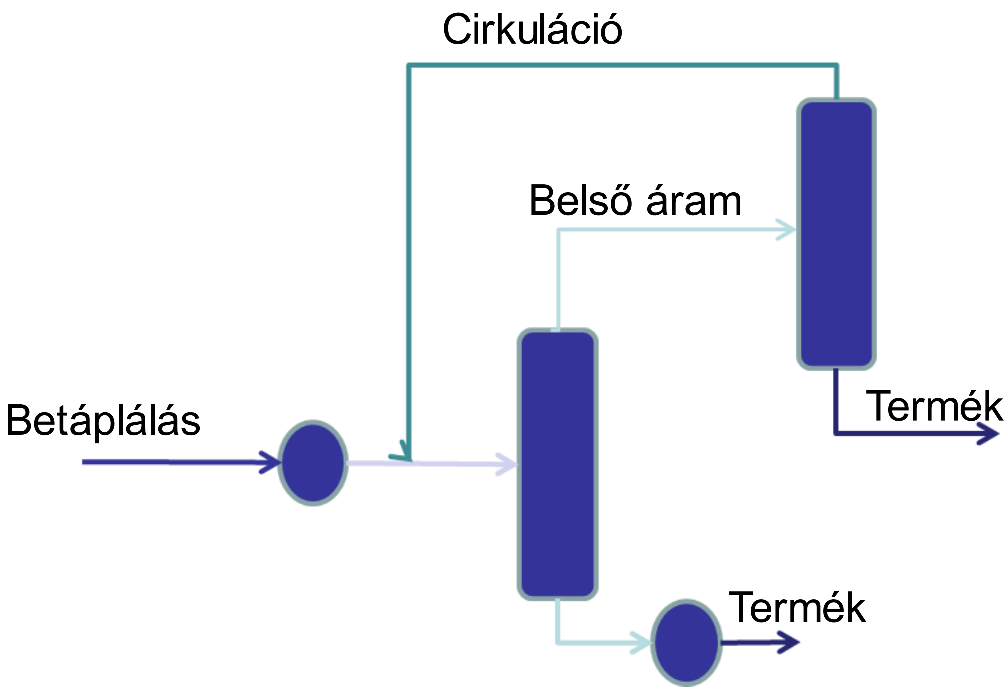
hőmérséklet és nyomástartomány is befolyásolja

5. Áramok

PFD | ME | Komp | Termo | **Áram** | Készülék | Run | Result

Áram típusok:

- Betáplálás
- Termék
- belső áram
- Cirkuláció
- reference áram



Referencia áram: más áramból vagy készülék belső pontja alapján definiált áram

5. Áramok

PFD › ME › Komp › Termo › **Áram** › Készülék › Run › Result

Áram tulajdonságok:

hőmérséklet
nyomás
mennyiség
összetétel

Betáplálás: definiálni
Termék/belső áram: számolt
Cirkulációs áram: indító érték

Számolt paraméterek

- fix tulajdonságok
  - MW,
  - Liq. Molar volume
  - Carbon Number
  - Chemical formula
  - Critical p, T
  - Critical volume
  - Flash point
  - Freezing point
  - GHT (gross heating value)
  - LHV (lower heating value)
  - Normal boiling point
  - Specific gravity
- hőmérséklet függő
  - Liquid density
  - Thermal conductivity
  - viscosity
  - Vapor pressure

Gyakorlat:

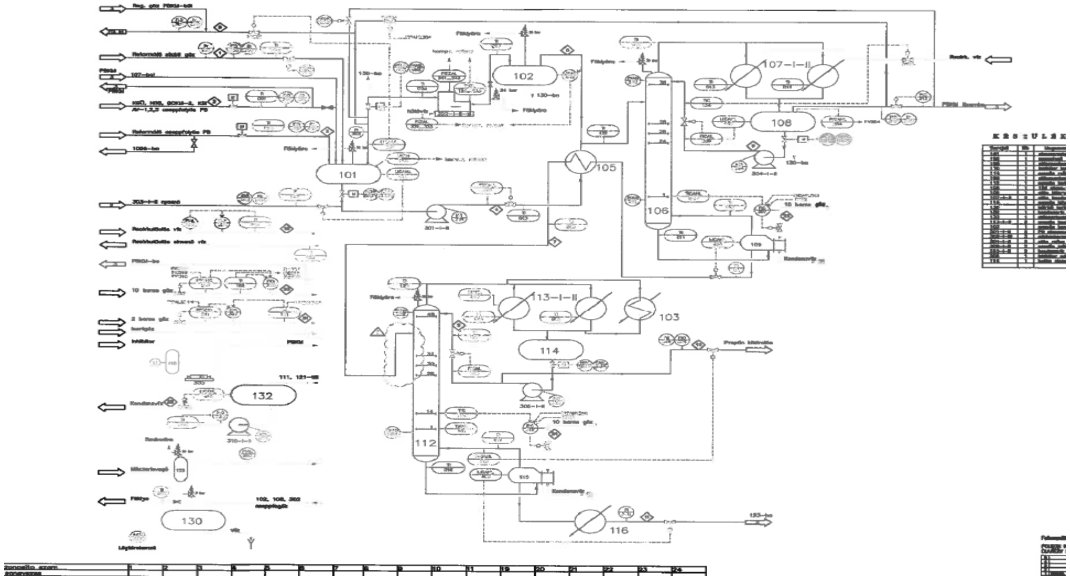
PFD	• Egyszerű folyamatábra vs PFD
M.e.	• Mértékegységek
Comp	• Komponensek/Áramok
Termo	• Select the thermodynamic method •SRK/NTRL.... Critical and important step
Stream	• Process stream data •Thermal condition, flowrates, composition...
Equipment	• Equipment data/Process unit data/Connection
Run	• Run
Result	• Checking the results

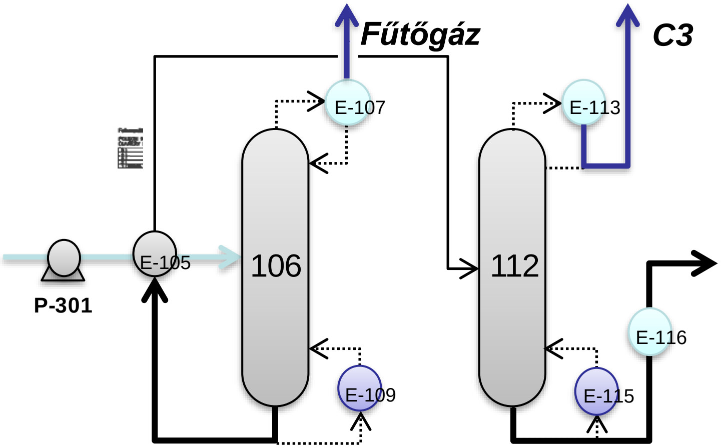
MOL GROUP

Gyakorlat

PFD → ME → Comp → Termo → Stream → Equipment → Run → Result

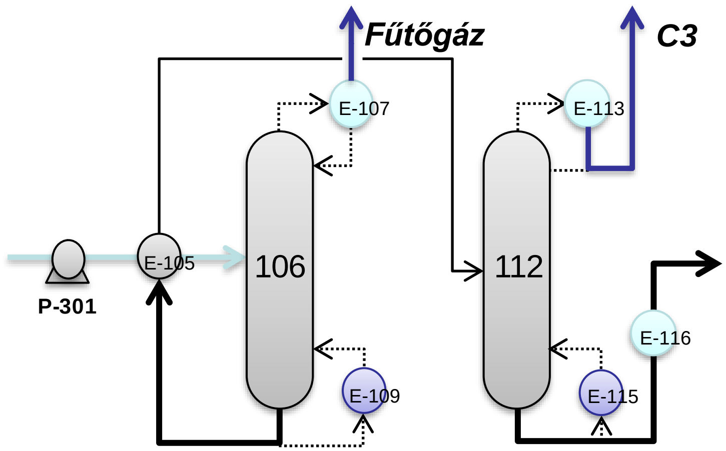
1. PFD – process flows simulation flowsheet





SIMULATION EXCERCISE

	106_alapanyag m/m%
HIDROGEN	0,089
METAN	0,206
ETAN	3,609
ETILEN	0,003
PROPAN	35,862
PROPILEN	0,042
I_BUTAN	20,950
N_BUTAN	36,119
I_BUTEN	0,100
1_BUTEN	0,037
CIS_2_BUTEN	0,020
TR_2_BUTEN	0,038
I_PENTAN	2,134
N_PENTAN	0,473
C6_ES_NEH_M	0,144
SZENMONOXID	0,060
NITROGEN	0,109
H2S	0,003



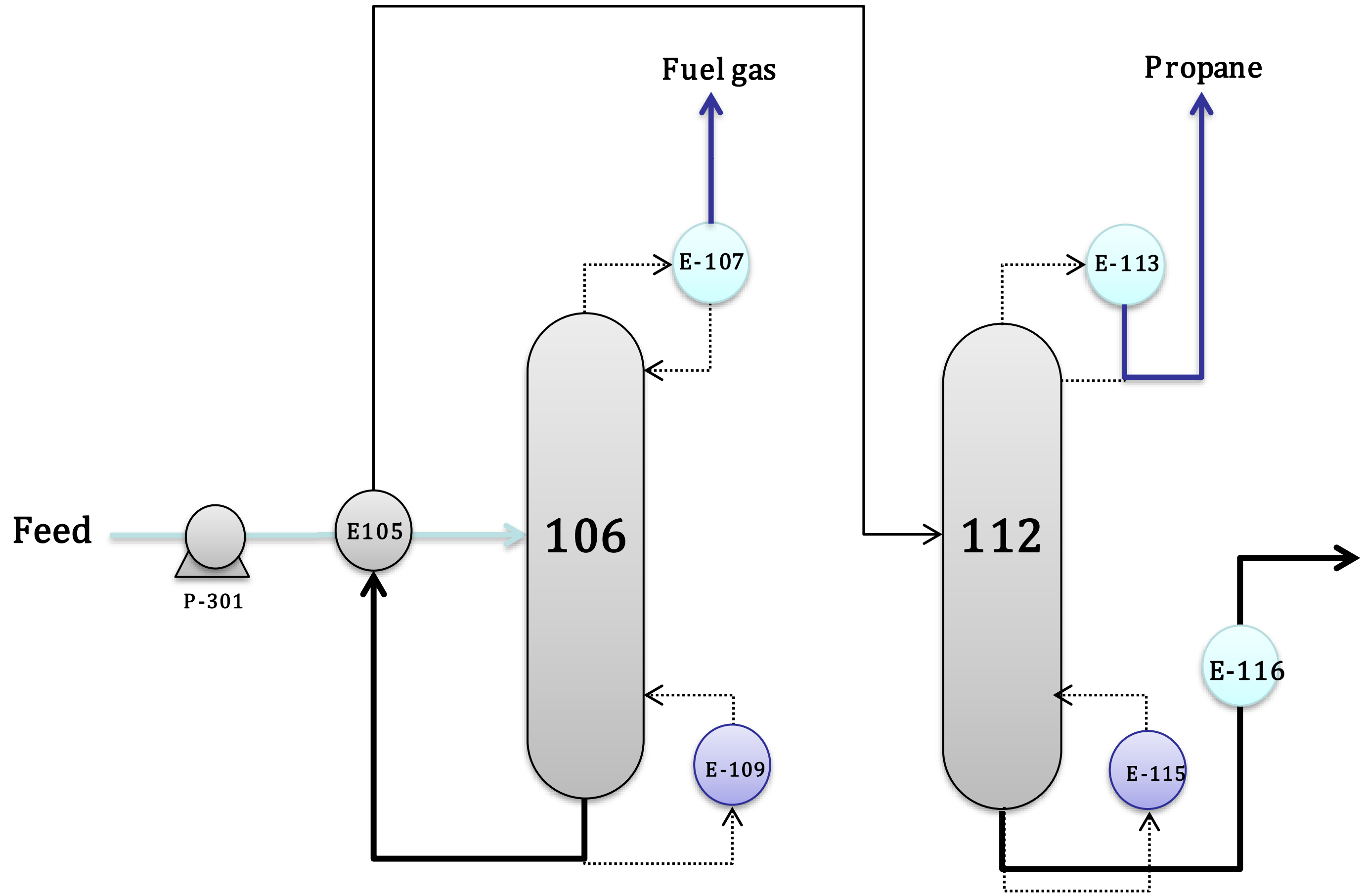
Betáplálás	kg/h	11701
	Cfok	15
	barg	28
Belépő nyomás	barg	32
Szivattyú hatásfok		0,7
106 belép hőmérséklet	Cfok	58

MOL GROUP

SIMULATION EXCERCISE

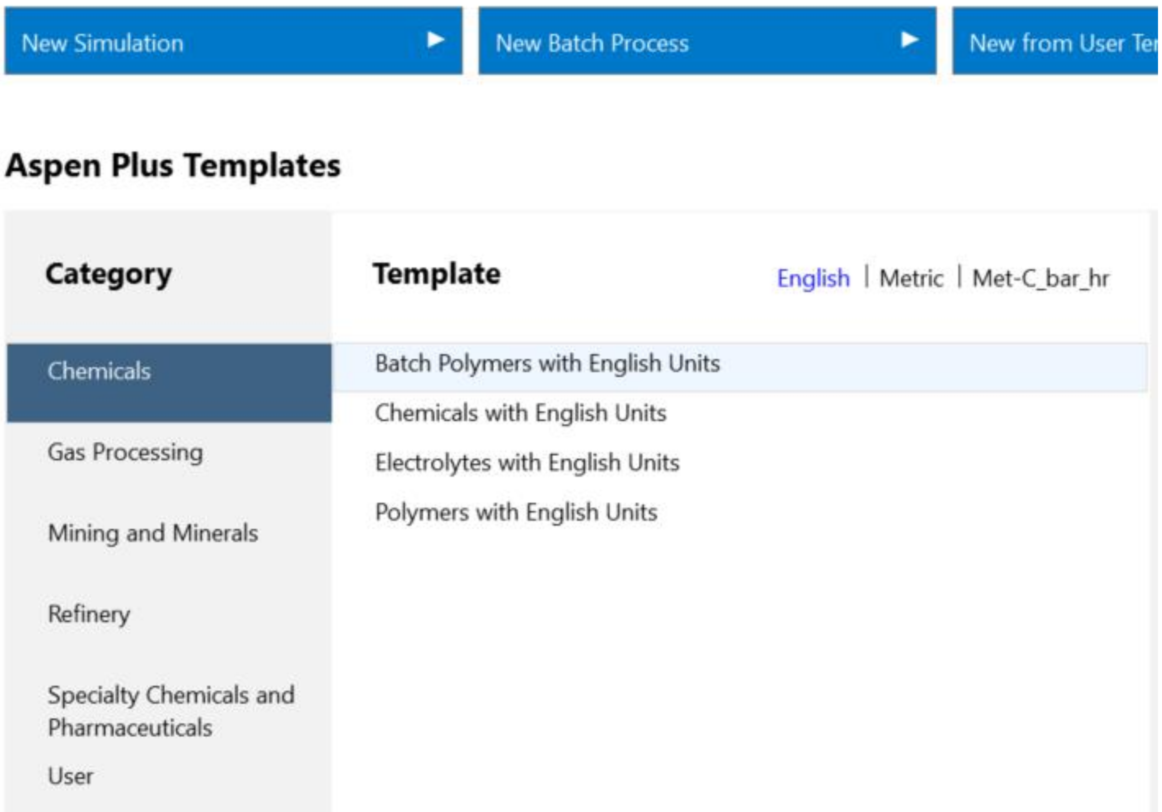
EXCERCISE

Modeling of deethenizer (Column 106) and depropanizer column (Column 112) of the Danube Refinery's Gas Fractionation Unit



GETTING START WITH ASPEN PLUS

- Open Aspen Plus V10
- Start:
  - **New simulation**
  - Aspen Plus template files (categorized by different applications)



UNIT SETS

- Three default engineering unit sets:
  - SI
  - EuroSI (bar,kcal
  - Field(English)

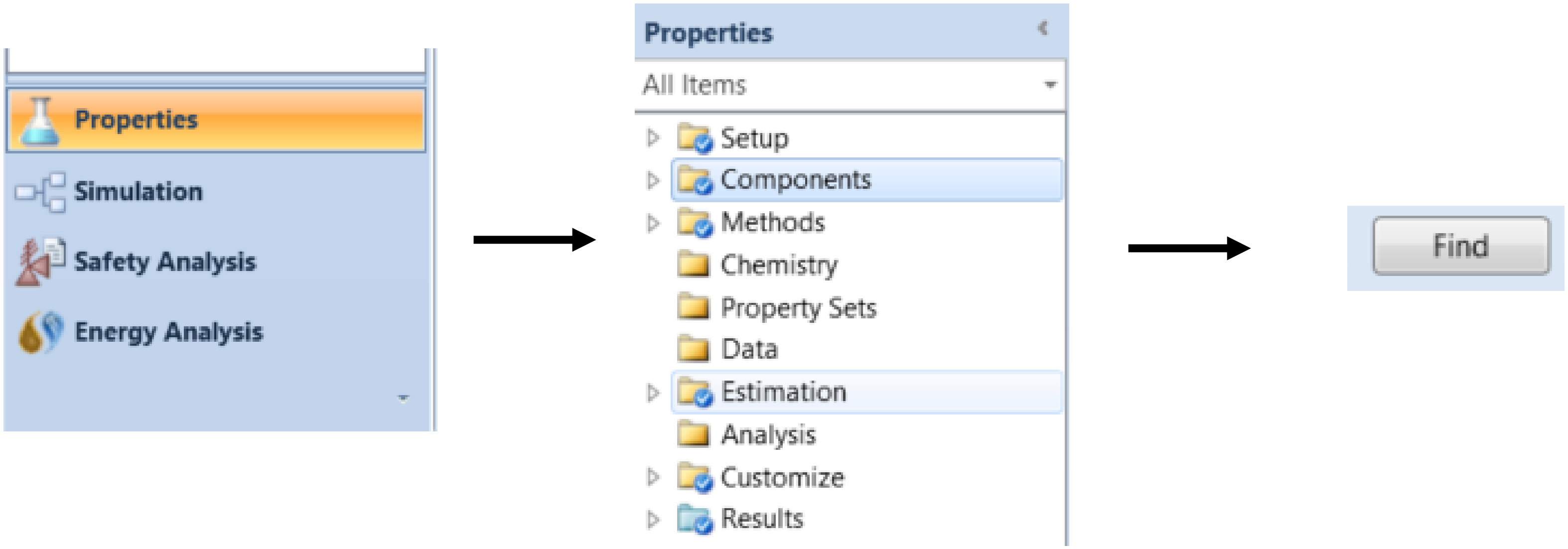
- Mostly used units:
  - mass: kg/h or t/h
  - temperature: C
  - pressure: **barg**
  - volume: m3/h

- Volume: Std m3/h (15 C ,1 bar) or actual m3/h (on actual T and p)

Component selection

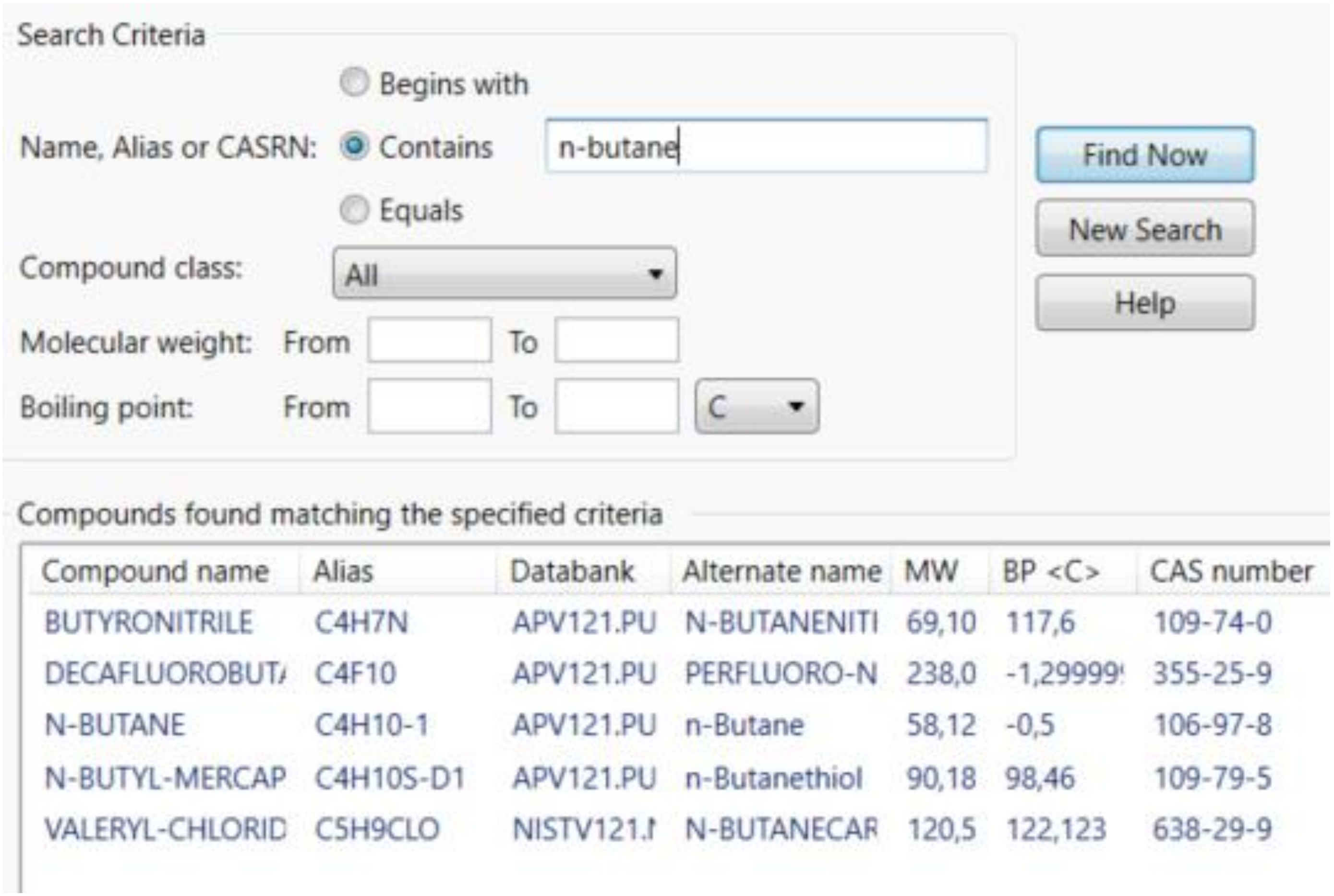
Component selection:

- Properties → Components → Find



- **Pure component:**
  - Search by compound name/alternate name/formula
- **Assay/Blend definition:**
  - Generating pseudocomponents

Pure component selection



Pure component selection

Component list used in simulation

HIDROGEN
METAN
ETAN
ETILEN
PROPAN
PROPILEN
I_BUTAN
N_BUTAN
I_BUTEN
1_BUTEN
CIS_2_BUTEN
TR_2_BUTEN
I_PENTAN
N_PENTAN
N-HEXAN
SZENMONOXID
NITROGEN
H2S
VIZ

→

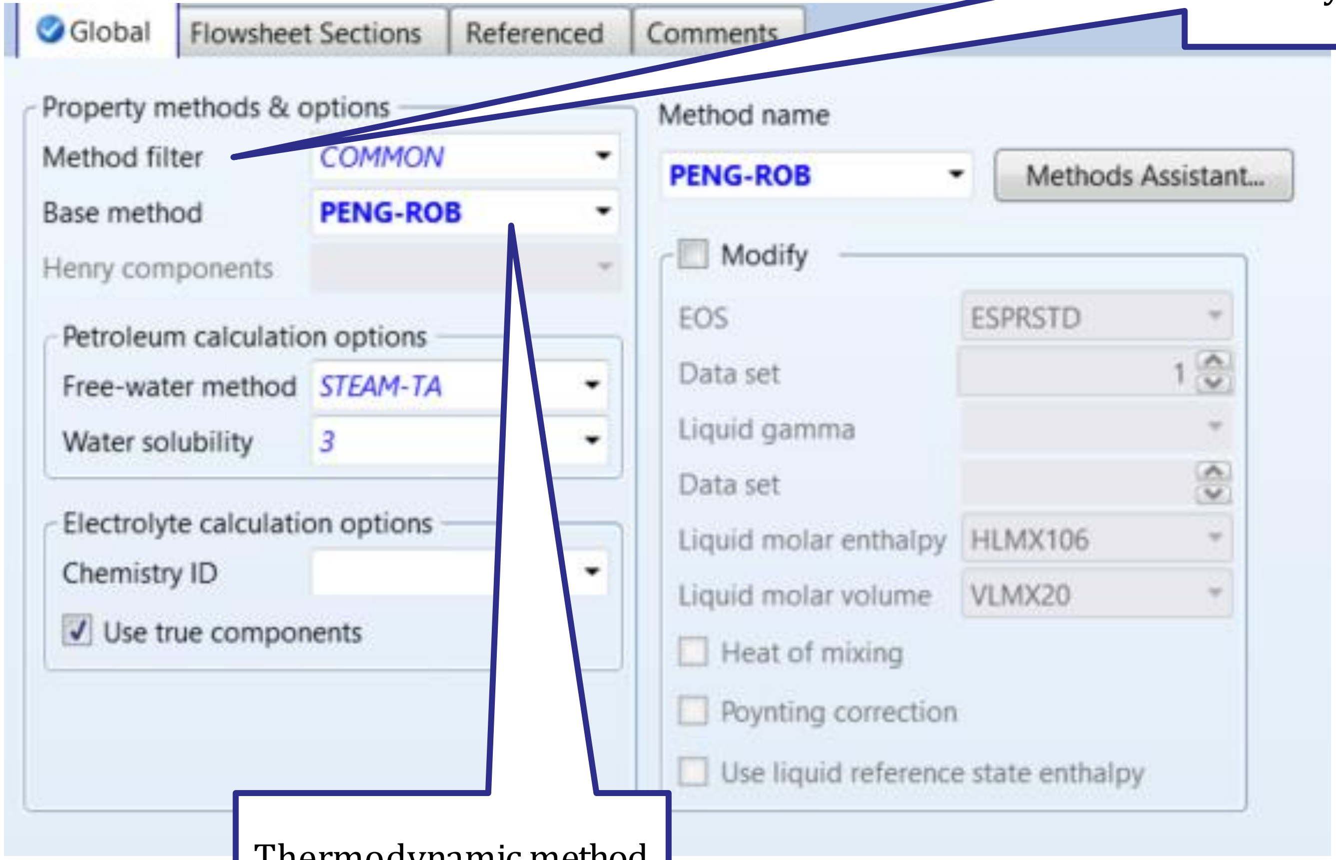
Component name	Alias
HYDROGEN	H2
METHANE	CH4
ETHANE	C2H6
ETHYLENE	C2H4
PROPANE	C3H8
PROPYLENE	C3H6-2
ISOBUTANE	C4H10-2
N-BUTANE	C4H10-1
ISOBUTYLENE	C4H8-5
1-BUTENE	C4H8-1
CIS-2-BUTENE	C4H8-2
TRANS-2-BUTENE	C4H8-3
2-METHYL-BUTANE	C5H12-2
N-PENTANE	C5H12-1
N-HEXANE	C6H14-1
CARBON-DIOXIDE	CO2
CARBON-MONOXIDE	CO
NITROGEN	N2
OXYGEN	O2
HYDROGEN-SULFIDE	H2S
WATER	H2O

THERMODYNAMIC METHODS

<u>Fluid package/thermodynamic method</u>

- to perform flash and physical property calculations

Method filter:
narrowing the methods by grouping



Thermodynamic method used in simulation environment

THERMODYNAMIC METHODS

Select thermodynamic method according to process or component type

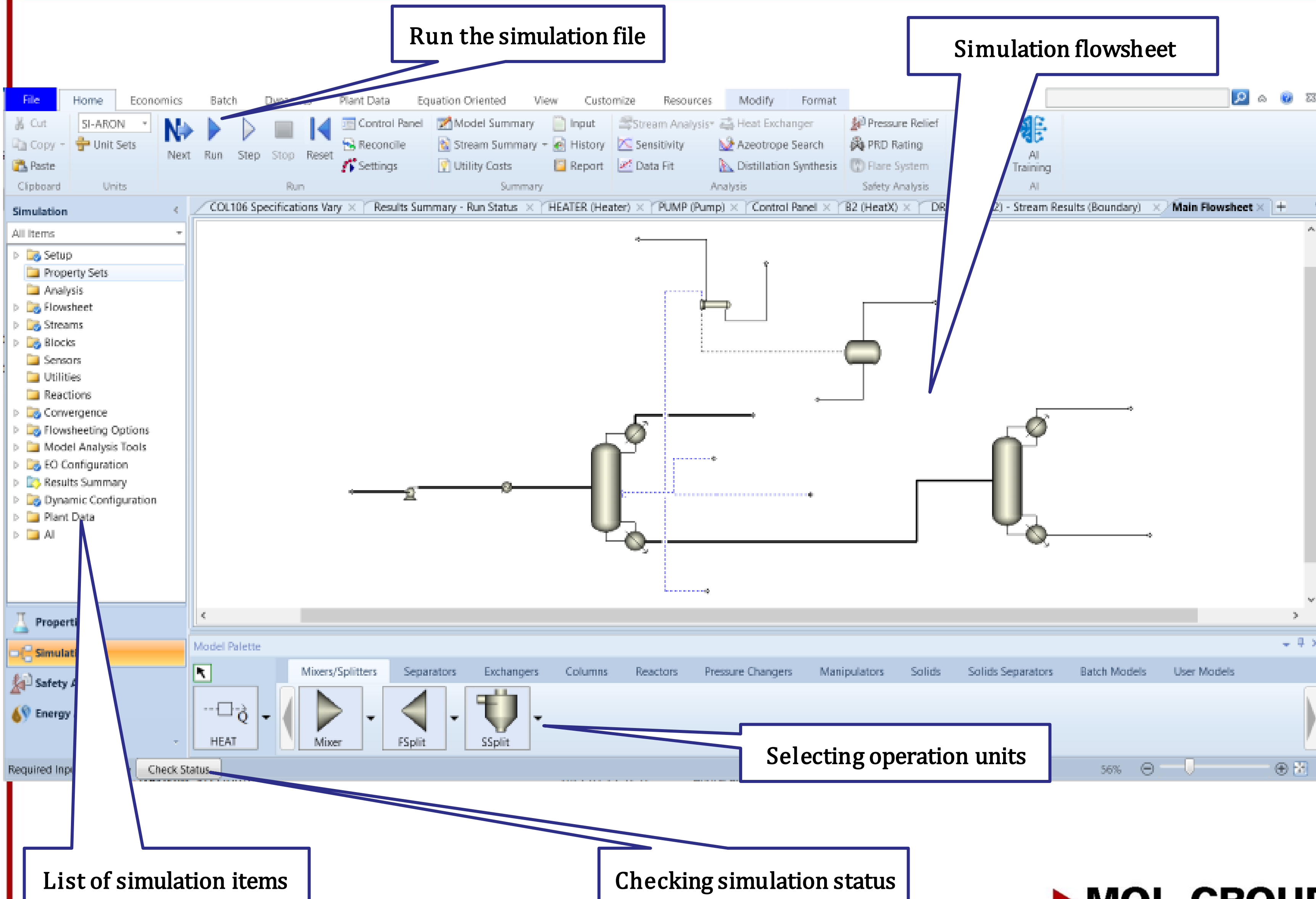
Specify component type:

Component system type	Thermodynamic methods
Chemical systems (low & high pressure)	Wong-Sandler, NRTL, Wilson, etc..
Hydrocarbon systems	Peng-Robinson, Chao-Seader, Grayson-Streed, etc..
Special (amine, sour water, electrolyte..)	Kent-Eisenberg, ELECNRTL, APISOUR, etc..
Refrigerants	REFRPOP

Specify process type:

Process type	Thermodynamic methods
Chemical	NRTL, Wilson, UNIQUAC
Refining	PR, Chao-Seader, Grayson-Streed, etc..
Gas processing	SRK, CPA, PR, etc..
Pharmaceuticals	RTL, UNIFAC, NRTL-SAC, COSMOSAC, etc..

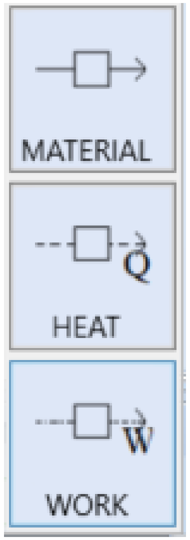
SIMULATION ENVIRONMENT



MOL GROUP

DEFINING PROCESS STREAMS

Process streams



- **Material stream:**
  - Temperature, pressure/vapor fraction & composition
- **Heat stream**
  - Duty, start & end temperature
- **Work stream**
  - Power & speed

MATERIAL STREAM COMPOSITION AND CONDITIONS

Specifications

Flash Type: Temperature | Pressure

State variables

Temperature	15	C
Pressure	28	barg
Vapor fraction	0	
Total flow basis	Mass	
Total flow rate	11701	kg/hr
Solvent		

Reference Temperature

Volume flow reference temperature: C

Component concentration reference temperature: C

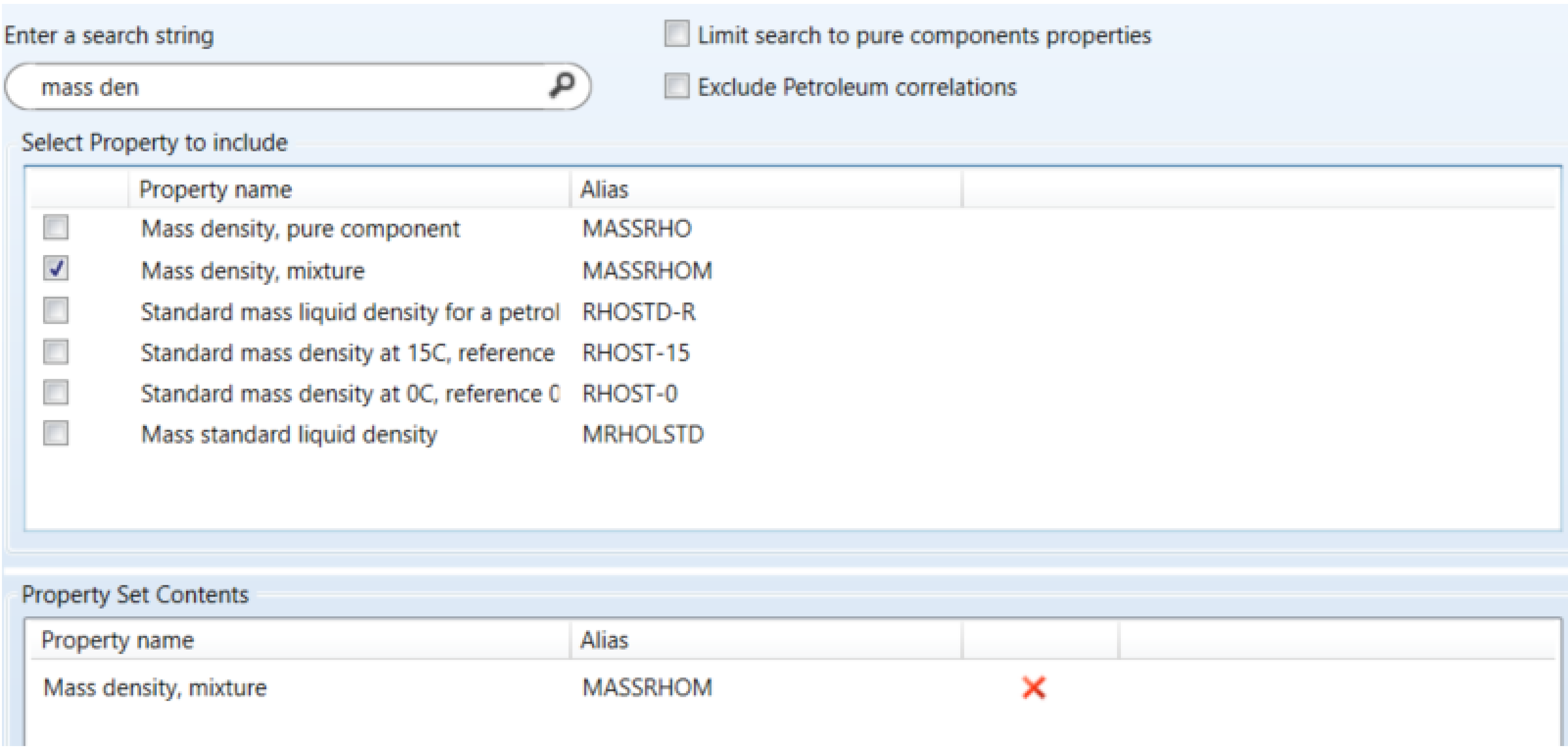
Composition: Mass-Frac

Component	Value
HYDRO-01	0,089
METHA-01	0,206
ETHAN-01	3,609
ETHYL-01	0,003
PROPA-01	35,862
PROPY-01	0,042
ISOBU-01	20,95
N-BUT-01	36,119
ISOBU-02	0,1
1-BUT-01	0,037
CIS-2-01	0,02
TRANS-01	0,038
2-MET-01	2,134
N-PEN-01	0,473
N-HEX-01	0,144
CARBO-01	0
CARBO-02	0,06
NITRO-01	0,109
OXYGE-01	0
HYDRO-02	0,003
WATER	

Feed stream	Value	UoM
Mass flowrate	11701	kg/h
Temperature	15	°C
Pressure	28	barg

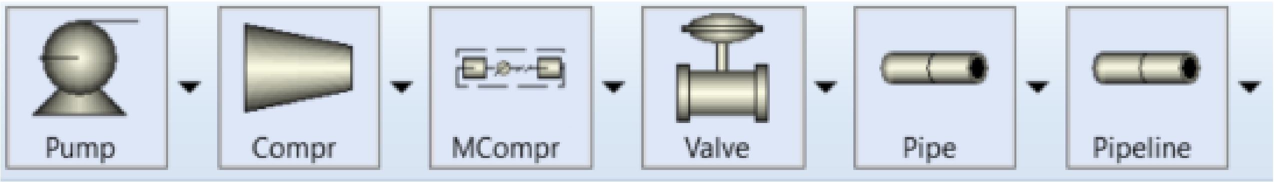
STREAM ANALYISIS

- Choosing mass density of mixture



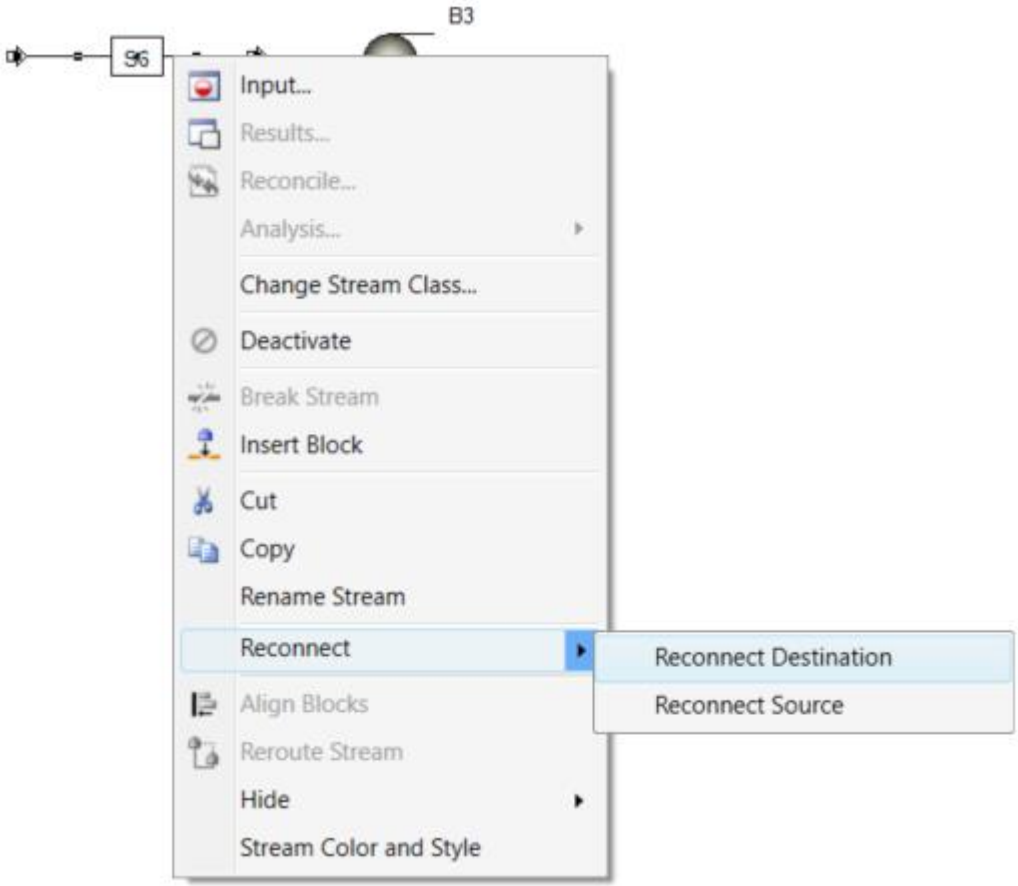
PRESSURE CHANGER UNIT OPERATIONS

- **Pressure changers:**
  - Pump
  - Compressor
  - Multistage compressor
  - Valves
  - Pipe (single segment)
  - Pipeline (multiple segments)



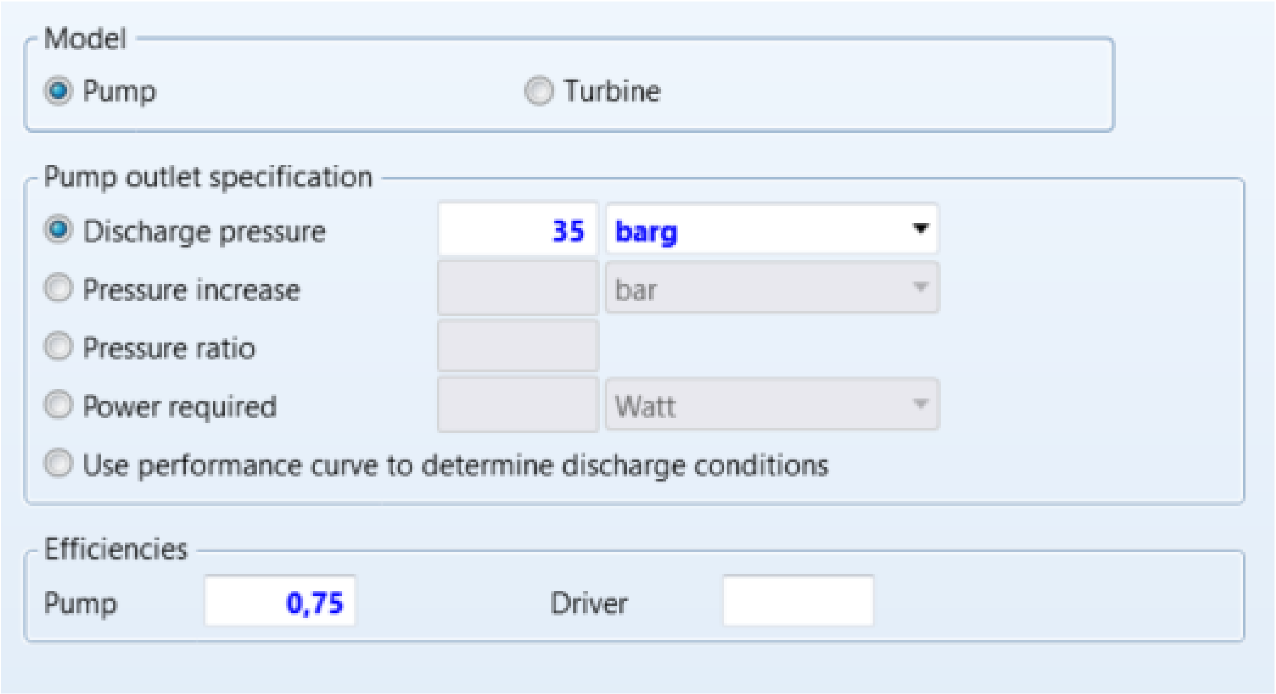
PUMP

- **Stream connection to pump**
  - Reconnect → Destination (for inlet streams) / source (for outlet streams)



PUMP

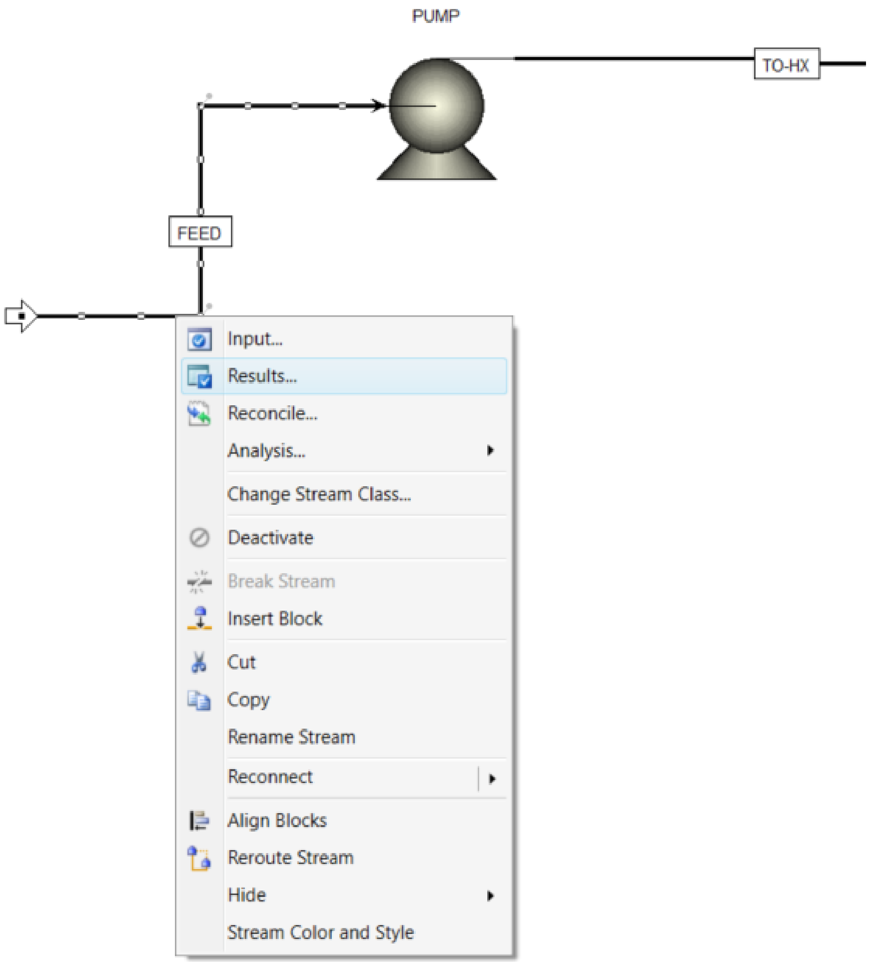
- Pump outlet specifications & efficiency



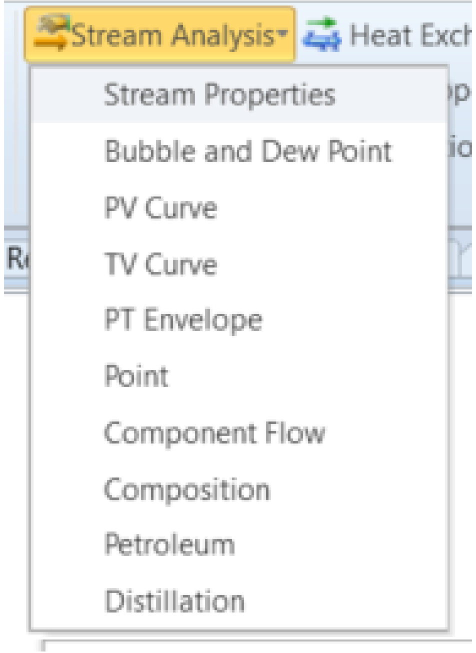
- Pump operation won't work if the inlet stream has vapor fraction

PUMP

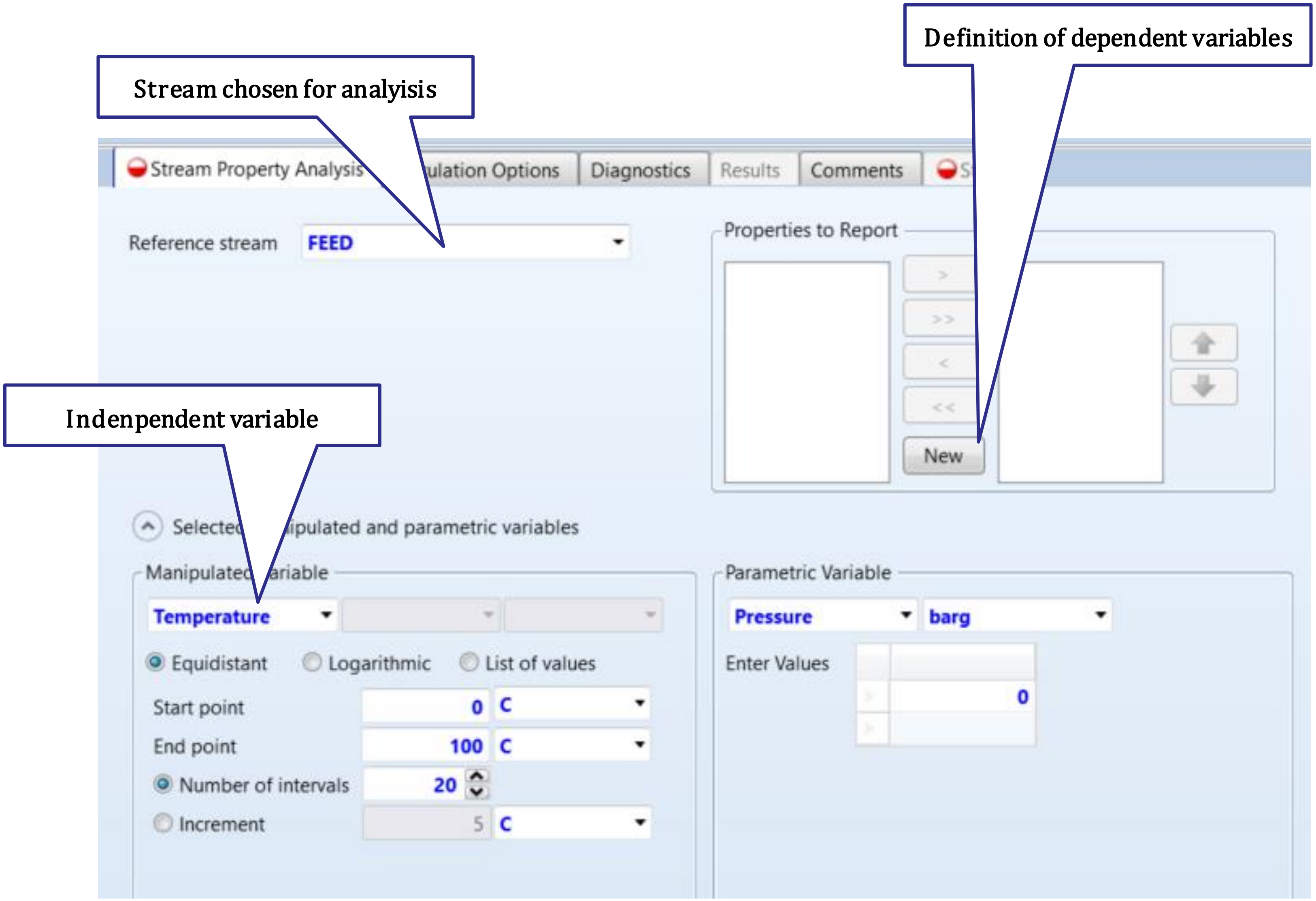
- Run the simulation and check the calculated values



STREAM ANALYSIS

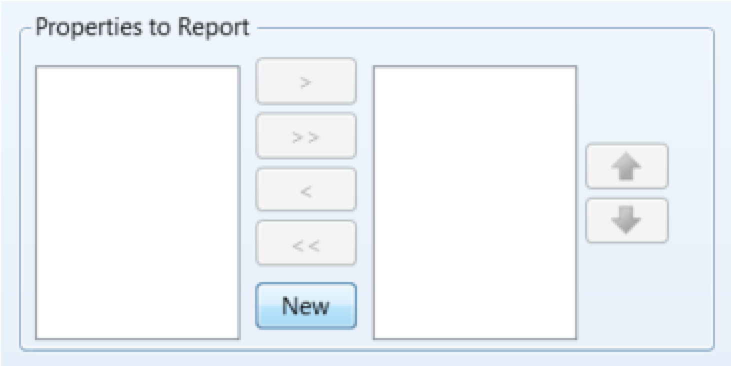


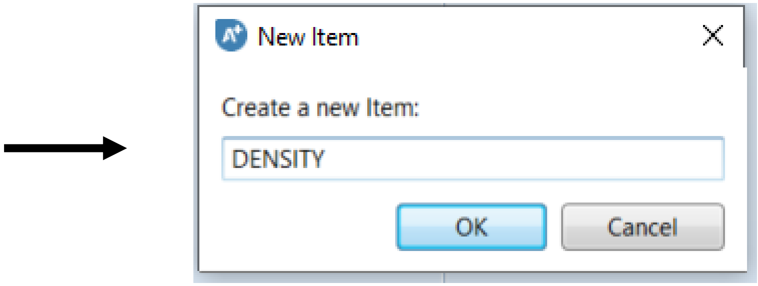
STREAM ANALYSIS



STREAM ANALYSIS

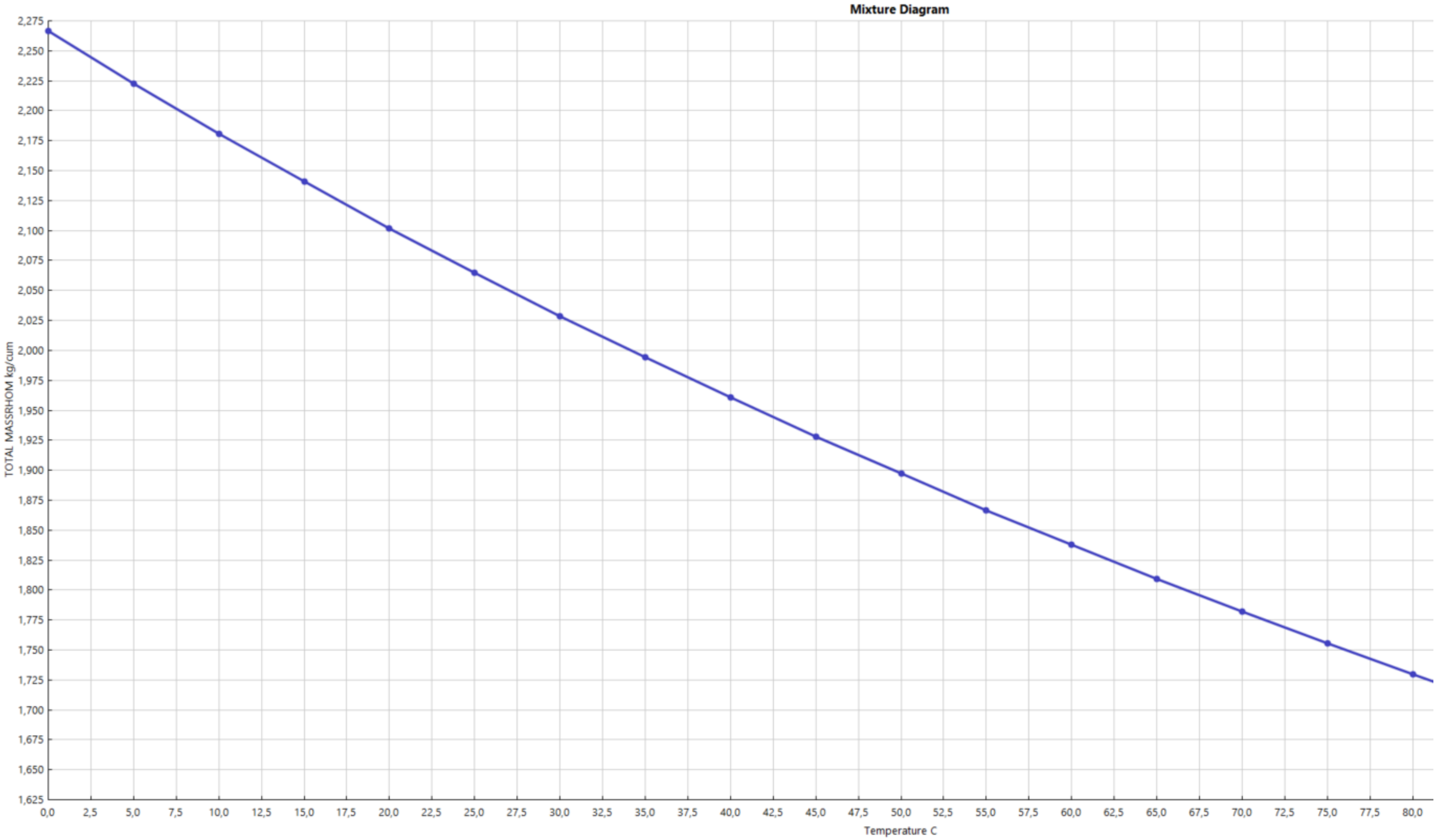
- Choosing properties to report





STREAM ANALYSIS

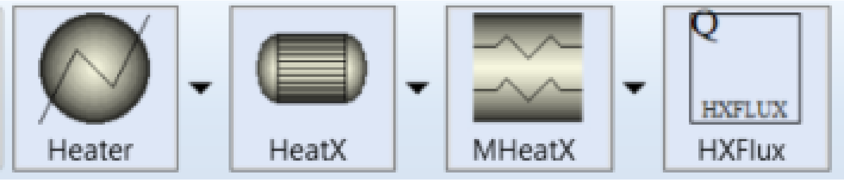
- After running analysis, results will be plotted



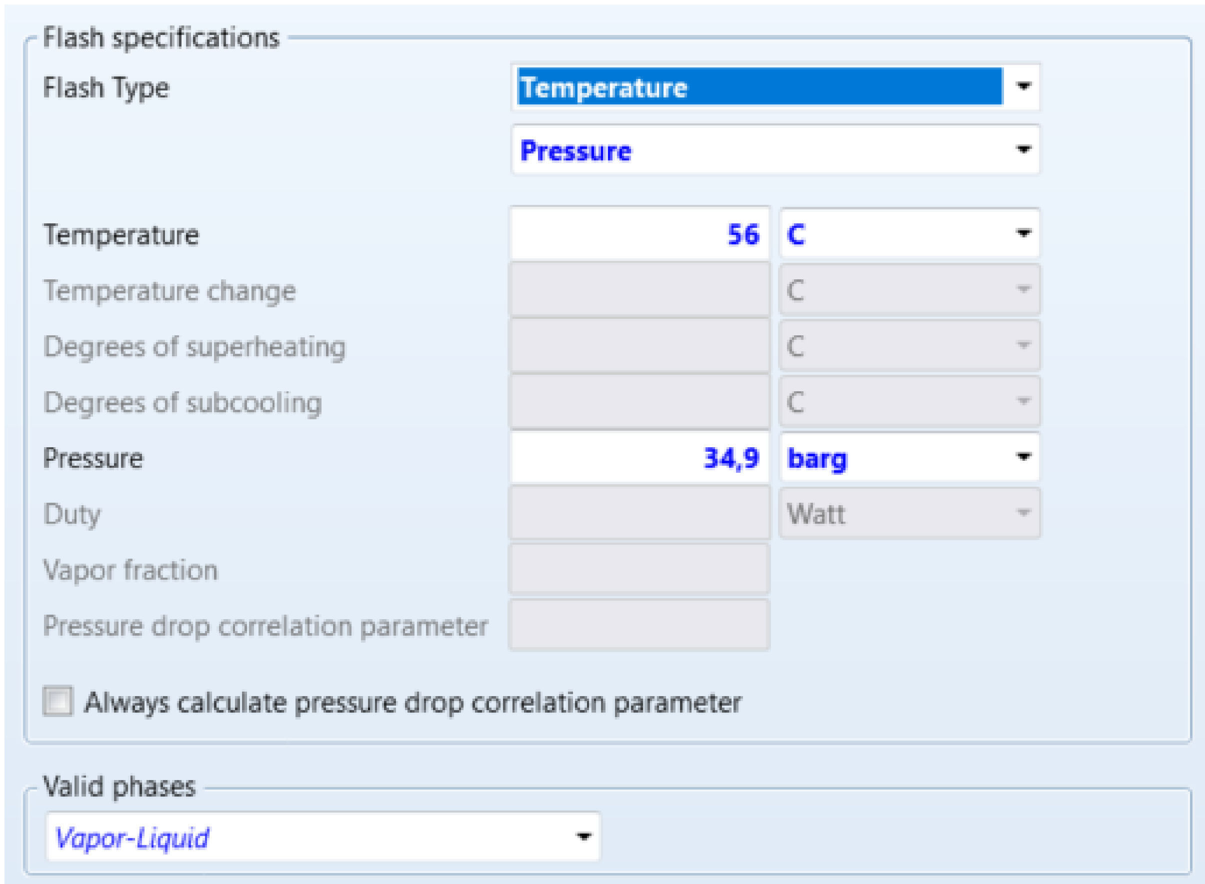
HEAT EXCHANGERS

Exchanger models

- Simple heater/cooler
  - Simple heat transfer calculation for one stream
  - Pressure and outlet temperature, ΔT, degrees of superheating/subcooling or heat duty need to be specified
- Detailed heat exchanger (HeatX)
  - Heat transfer calculations between 2 material streams
  - Different types:
    - Shortcut (simple calculations)
    - Shell & Tube (detailed geometry)
    - Kettle reboiler
    - Thermosyphon
    - Air Cooled
    - Plate
  - Different calculation modes
    - Design
    - Rating
    - Simulation
    - Maximum fouling



Simple heater specifications



Shell & tube heat exchanger sizing (EDR sizing console)

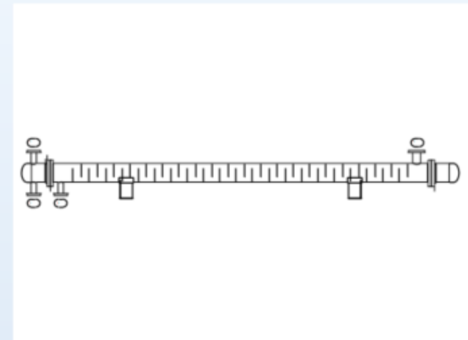
- Specifing detailed geometry

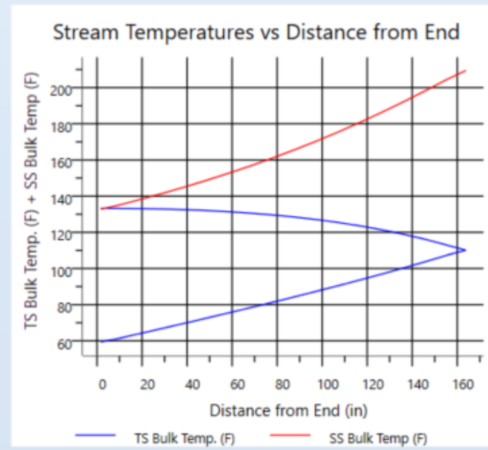
Calculation mode		Rating / Checking	Recent	Previous
Configuration				
TEMA Type		B - / E - / M -	BEM	
Tube layout option		New (optimum) layout		
Location of hot fluid		Shell side	Shell side	
Tube OD / Pitch	in	0,75 / 0,9375	0,75 / 0,9375	/
Tube pattern		30-Triangular	30	
Tubes are in baffle window		Yes	Yes	
Baffle type		Single segmental	Single segmental	
Baffle cut orientation		Horizontal	H	
Default exchanger material		Carbon Steel / 1	Carbon Steel	
Size				
Specify some sizes for Design		Set default	No	
Shell ID / OD	in	/	8,071 / 8,625	/
Tube length	in		165,3543	
Baffle spacing center-center (Bc)	in		3,5433	
Number of baffles			42	
Number of tubes / Tube passes		/	40 / 2	/
Shells in series		1	1	
Shells in parallel		1	1	

Overall Results

		Recent	Previous
Excess surface (%)		2	
Dp-ratio Shellside / Tubeside		0,6978 / 0,2932	/
Total cost (all shells)	Dollar(US)	15189	

Setting Plan / Tube Layout

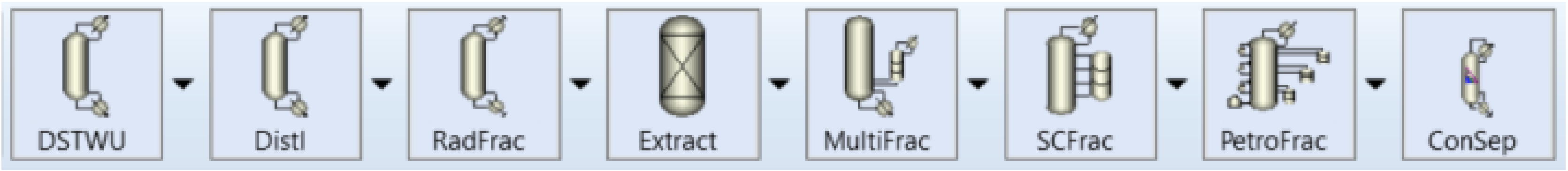




DISTILLATION COLUMNS

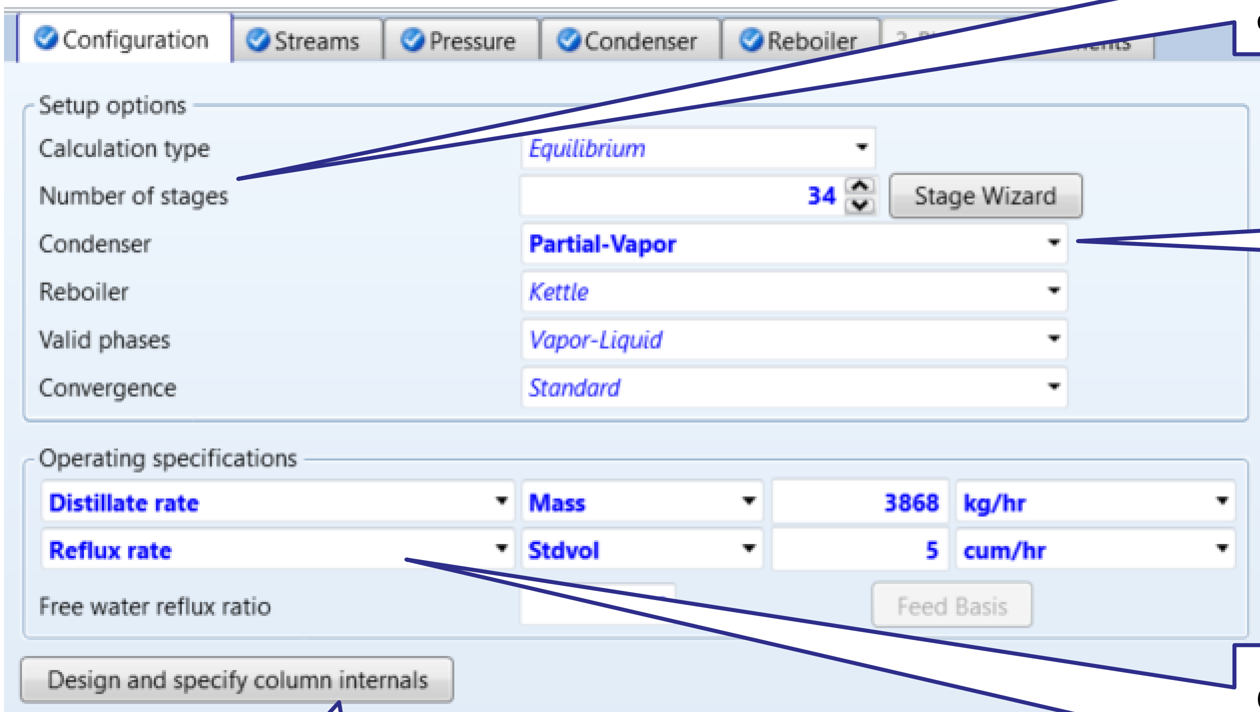
Different column types:

- DSTWU, Distl, SCFrac – shortcut columns with different calculation methods (Winn-Underwood-Gililand, Edmister…etc)
- **RadFrac** – rigorous 2 or 3 phase fractionation for single columns
- Extract – rigorous liquid-liquid extractor
- MultiFrac – rigorous fractionation for complex columns
- PetroFrac - rigorous fractionation for petroleum refining applications
- ConSep – feasibility and design calculations



RADFRAC COLUMN - CONFIGURATION

Distillation column 106 configuration



Number of stages: column tray number + 2 (condenser & reboiler are defined as trays)

Condenser type (total, partial or none)

Operating specifications (distillate rate, reflux ratio, boilup, etc) – can be overwritten by design specifications

Specifing column internals (trays or packing type, tray spacing, column diameter, tray geometry details)

RADFRAC COLUMN - STREAMS

Defining column 106 streams (streams need to be put down to the flowsheet and connected to the column before defining)

Configuration | Streams | Pressure | Condenser | Reboiler | 3-Phase | Comments

Feed streams

Name	Stage	Convention
TO-COL	14	*Above-Stage*

Product streams

Name	Stage	Phase	Basis	Flow	Units	Flow Ratio	Feed Specs
106VAP	1	**Vapor**	Mole		kmol/hr		Feed basis
106BTM	34	**Liquid**	Mole		kmol/hr		Feed basis

Pseudo streams

Name	Pseudo Stream Type	Stage	Internal Phase	Reboiler Phase	Reboiler Conditions	Pumparound ID	Pumparound Conditions	Flow	Units
106OH	*Internal*	2	**Vapor**		Outlet		Outlet		*kmol/hr*
106REB	*Internal*	33	*Liquid*		Outlet		Outlet		*kmol/hr*
106-REF	*Internal*	1	*Liquid*		Outlet		Outlet		*kmol/hr*
S1	*Internal*	5	*Liquid*		Outlet		Outlet		*kmol/hr*

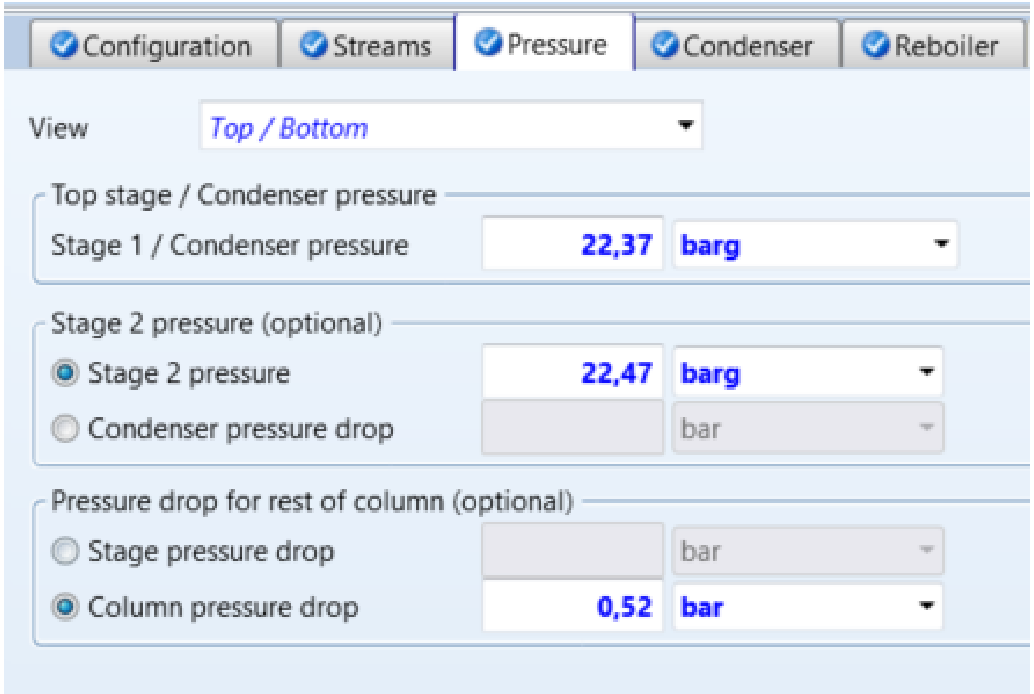
Specifing feed stage number and feed convention

Specifing product stream stages and phases

Pseudo streams – exported internal streams (reflux, overhead vapors, pumparounds etc)

RadFrac column - pressure

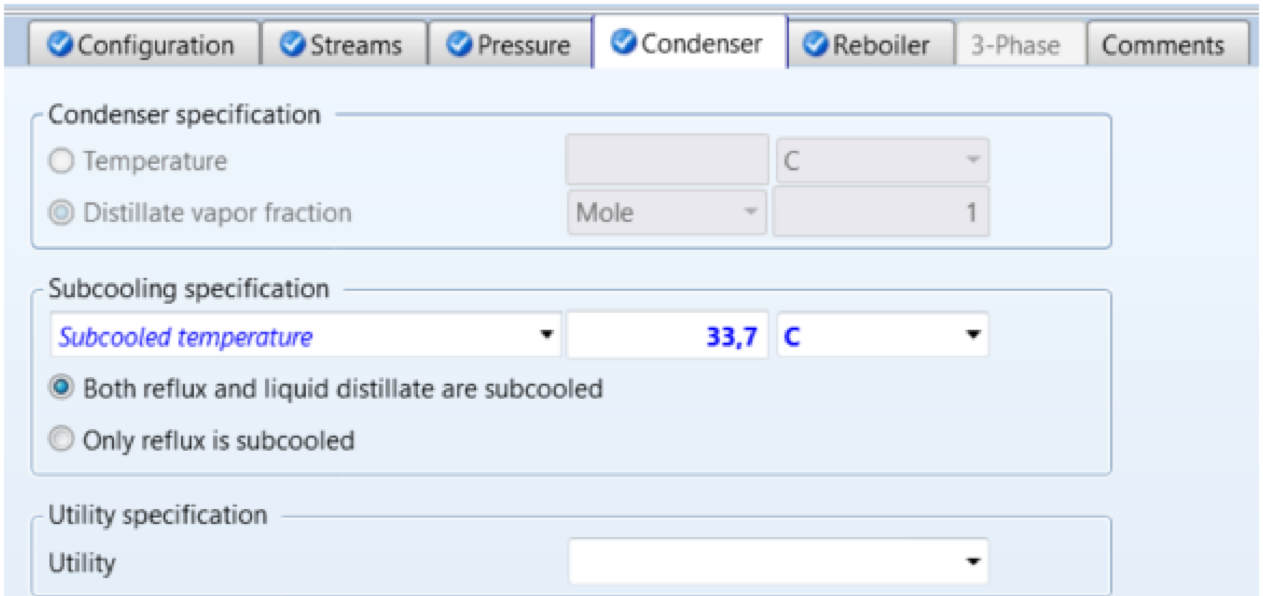
Defining column 106 pressure



- Top/bottom pressure & pressure drop
- Pressure profile
- Section pressure drop

RadFrac column – condenser

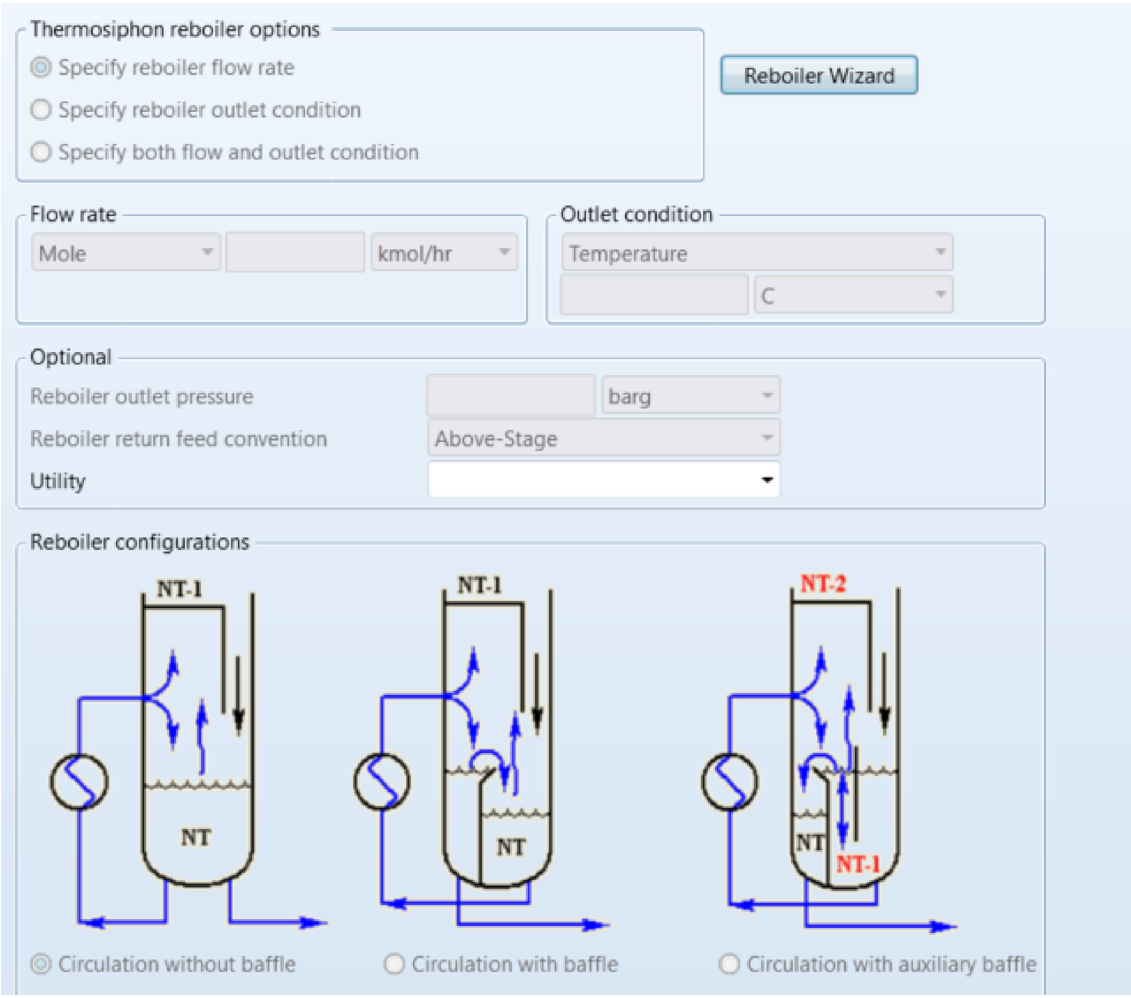
Specifing condenser parameters



- **In case of choosing Partial-Vapor condenser type in configuration tab, only subcooled temperature or degrees of subcooling can be specified**
- In case on Partial-Vapor-Liquid condenser, temperature or vapor fraction need to be defined along with subcooling parameters

RADFRAC COLUMN – CONDENSER

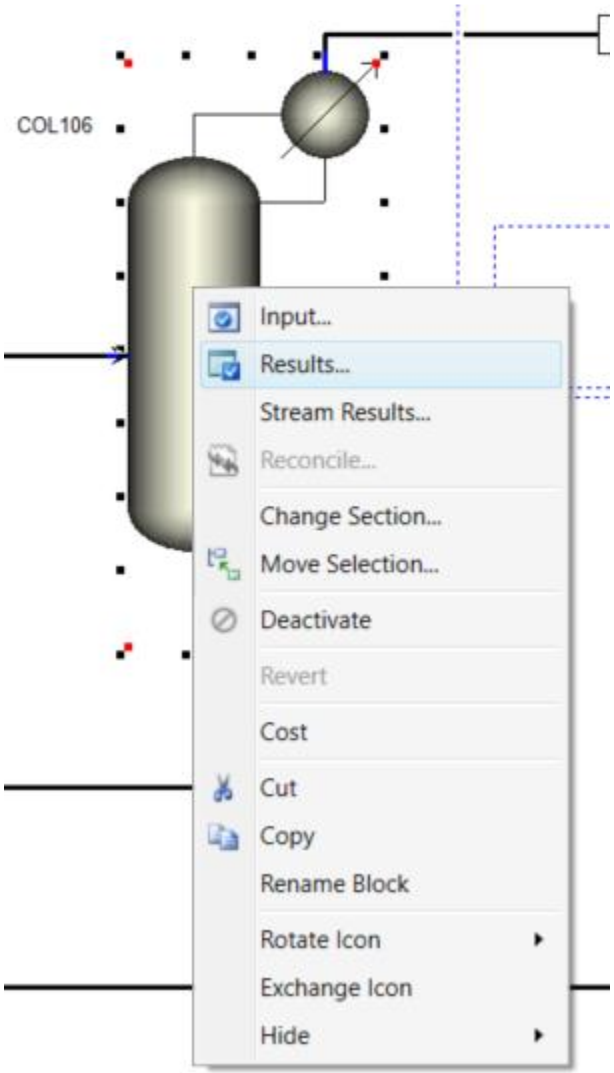
Specifing reboiler parameters



- **In case of choosing Kettle Rebolier, there's no parameter to be specified**
- In case of thermosiphon reboiler, flowrate and/or outlet condition can be defined

RADFRAC COLUMN – RESULTS

After defining column specification simulation can run → results



Basis: Mass

Condenser / Top stage performance

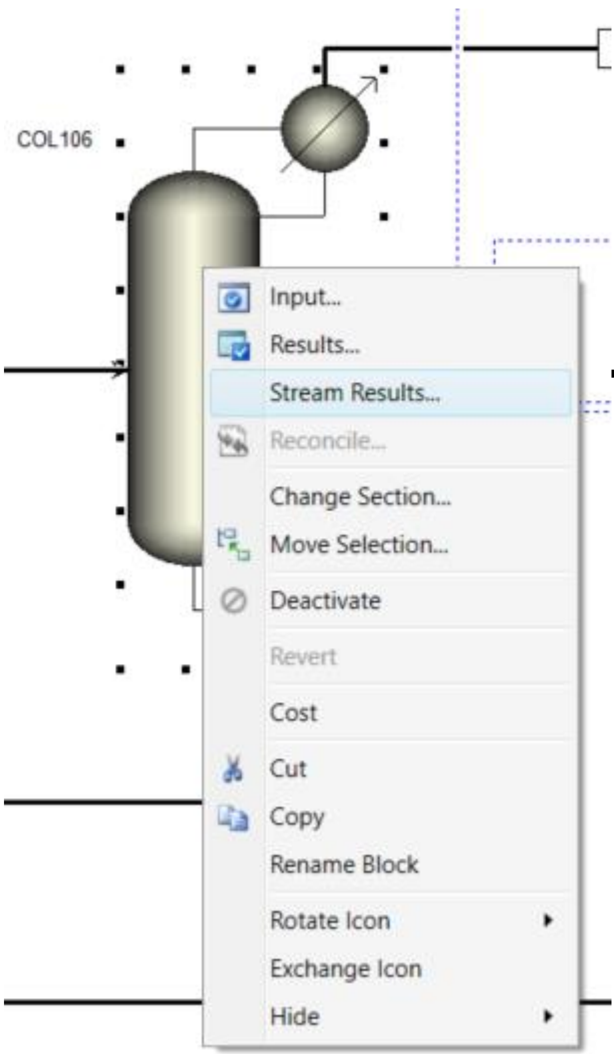
Name	Value	Units
Temperature	64,605	C
Subcooled temperature	33,7	C
Heat duty	-0,739834	GJ/hr
Subcooled duty	-0,241306	GJ/hr
Distillate rate	3868	kg/hr
Reflux rate	2591,25	kg/hr
Reflux ratio	0,66992	
Free water distillate rate		
Free water reflux ratio		
Distillate to feed ratio		

Reboiler / Bottom stage performance

Name	Value	Units
Temperature	103,823	C
Heat duty	3,31037	GJ/hr
Bottoms rate	7833	kg/hr
Boilup rate	14364	kg/hr
Boilup ratio	1,83378	
Bottoms to feed ratio		

RADFRAC COLUMN – STREAM RESULTS

Connected stream properties and compositions

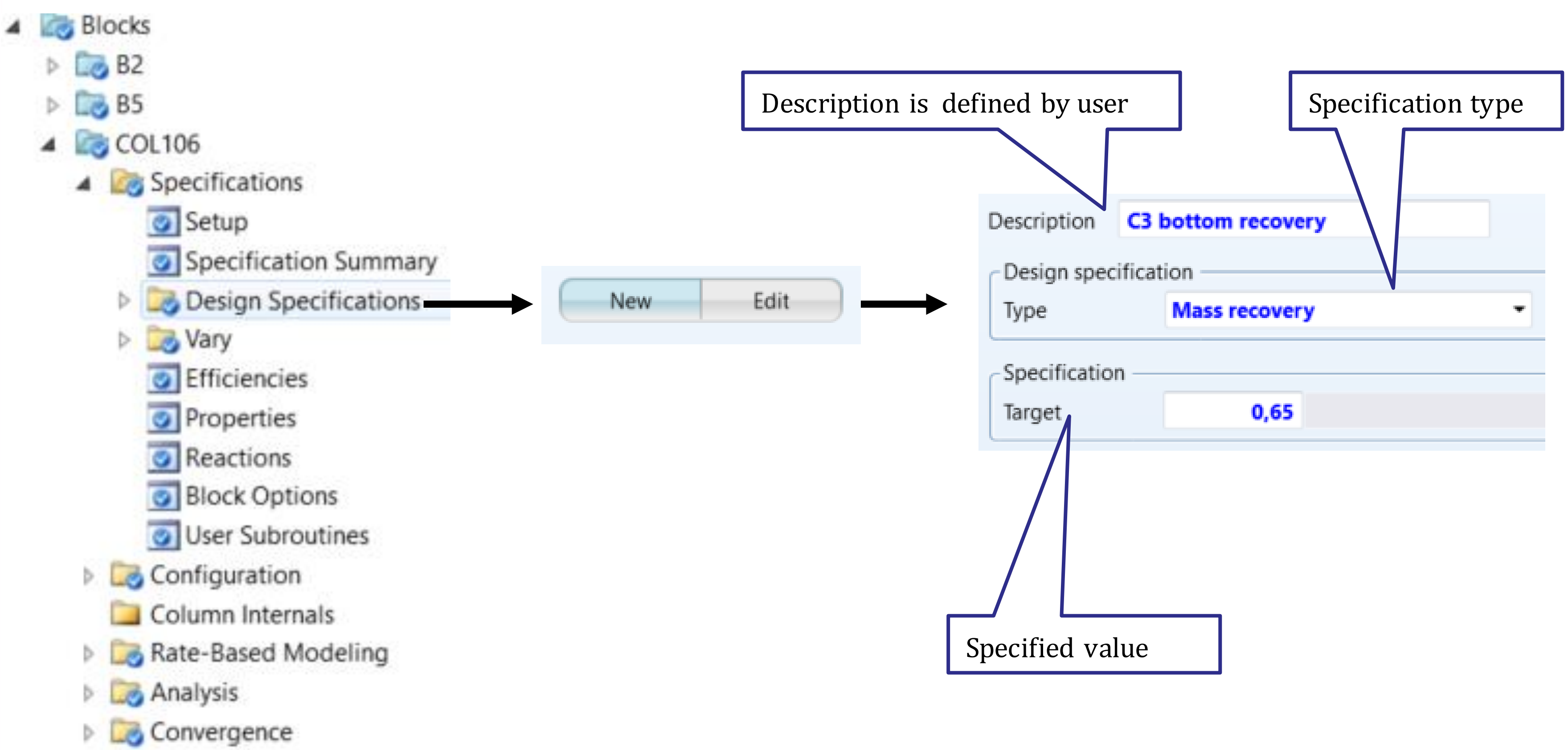


	Units	TO-COL	106-REF
Description			
From		B5	COL106
To		COL106	
Stream Class		CONVEN	CONVEN
Maximum Relative Error			
Cost Flow	$/sec		
− MIXED Substream			
Phase		Liquid Phase	Liquid Phase
Temperature	C	53,1641	33,7
Pressure	barg	35	22,37
Molar Vapor Fraction		0	0
Molar Liquid Fraction		1	1
Molar Solid Fraction		0	0
Mass Vapor Fraction		0	0
Mass Liquid Fraction		1	1
Mass Solid Fraction		0	0
Molar Enthalpy	J/kmol	-1,27326e+08	-1,2644e+08
Mass Enthalpy	J/kg	-2,57285e+06	-2,67562e+06
Molar Entropy	J/kmol-K	-359366	-353306
Mass Entropy	J/kg-K	-7261,63	-7476,35
Molar Density	kmol/cum	9,69643	10,5496
Mass Density	kg/cum	479,86	498,539
Enthalpy Flow	Watt	-8,36248e+06	-1,92589e+06
Average MW		49,4883	47,2564
+ Mole Flows	**kmol/hr**	**236,44**	**54,8338**
+ Mole Fractions			
+ Mass Flows	**kg/hr**	**11701**	**2591,25**
+ Mass Fractions			
Volume Flow	cum/hr	24,3842	5,19769

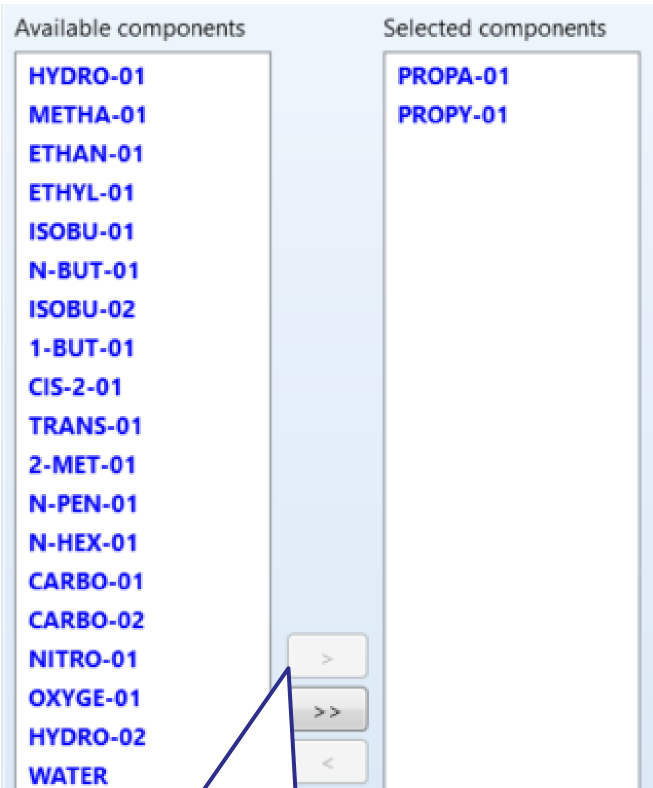
MOL GROUP

RadFrac column – design specifications

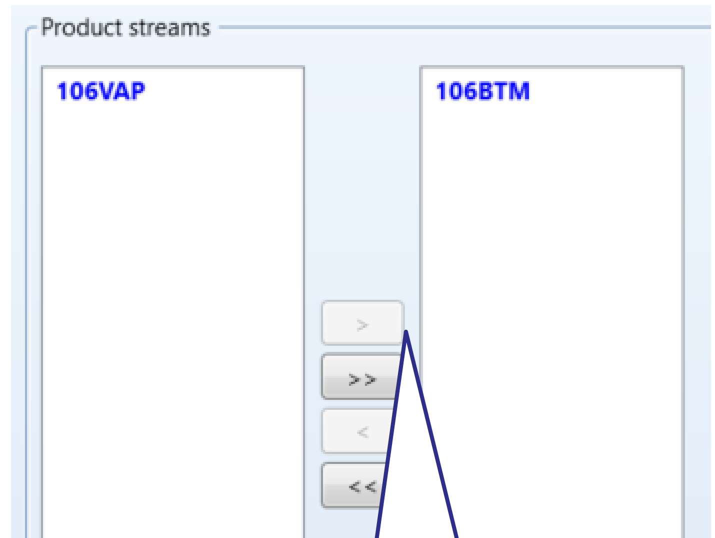
Distillation parameters (product qualities, component recoveries..etc) can be defined by design specifications (can be found on item list)



RADFRAC COLUMN – DESIGN SPECIFICATIONS



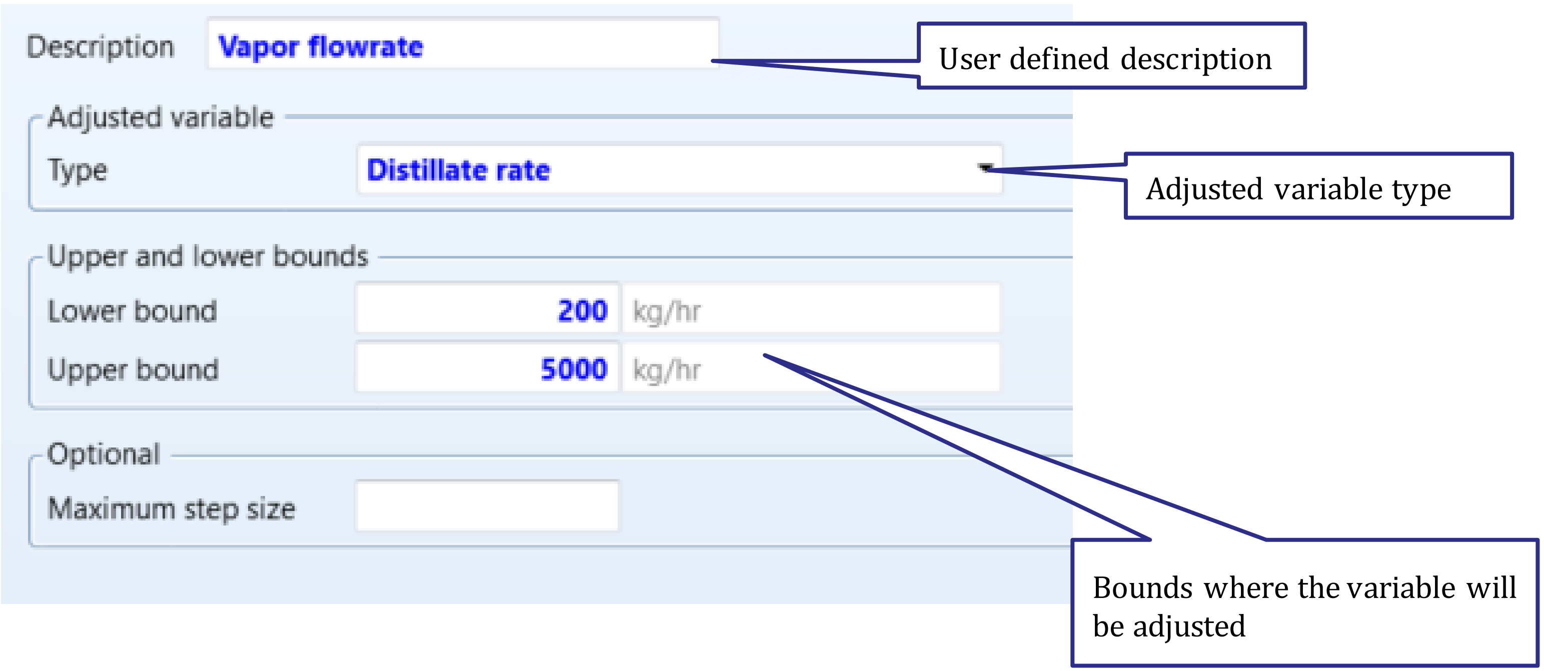
Choosing components for specifications



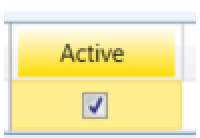
Choosing streams for specifications

RadFrac column – design specifications

Vary – selecting adjusted variables in order to meet the specified target values



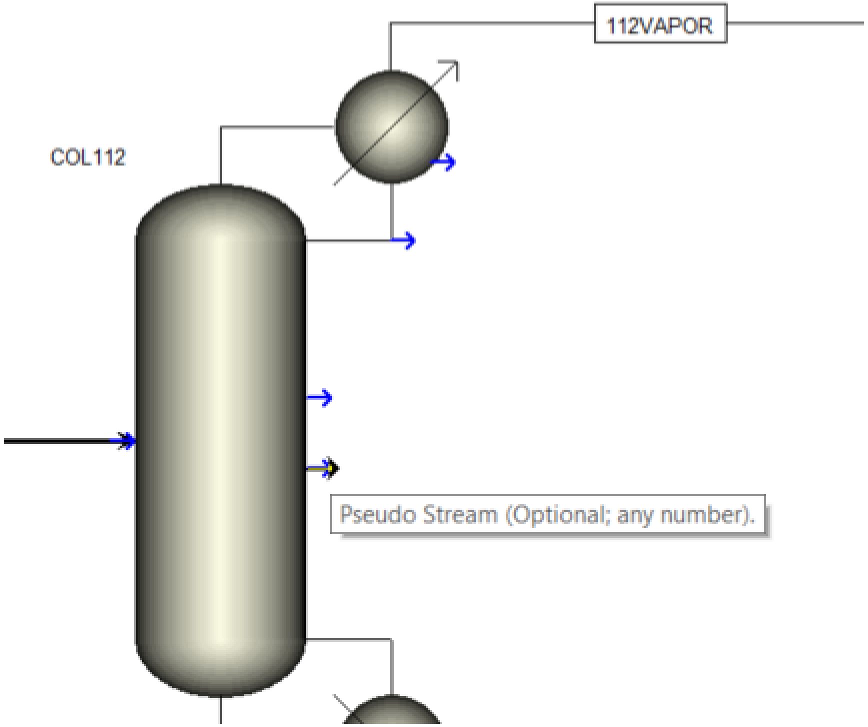
After definition, both design specification and vary have to be set active



RadFrac column – pseudo streams

Internal streams from column, which are not presented in mass balance but can be used for modeling excercises

Specification of pseudo streams: create a material stream in the simulation flowsheet by choosing the lower blue arrow on the column



RADFRAC COLUMN – PSEUDO STREAMS

Go to streams page inside the column block

Pseudo streams

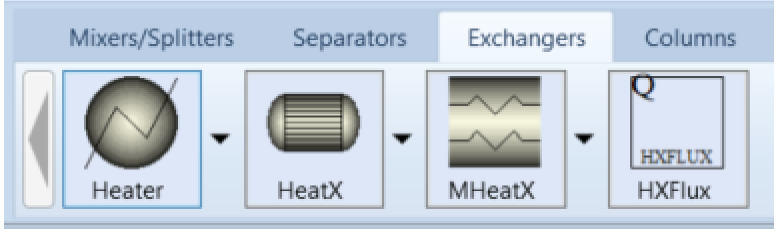
	Name	Pseudo Stream Type	Stage	Internal Phase	Reboiler Phase	Reboiler Conditions	Pumparound ID	Pumparound Conditions	Flow	Units
▶	S2	*Internal*	2	**Vapor**		Outlet		Outlet		*kmol/hr*

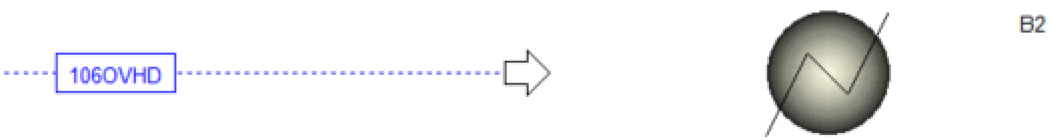
Liquid from Stage 2 (column's top stage) is specified, so after running simulation we have the column's overhead vapor as a pseudo stream

MODELING COLUMN'S OVERHEAD VAPOR SECTION

Buliding cooler heat exchanger and reflux drum in the column's overhead vapor section

Creating simple heat exchanger for overhead cooling

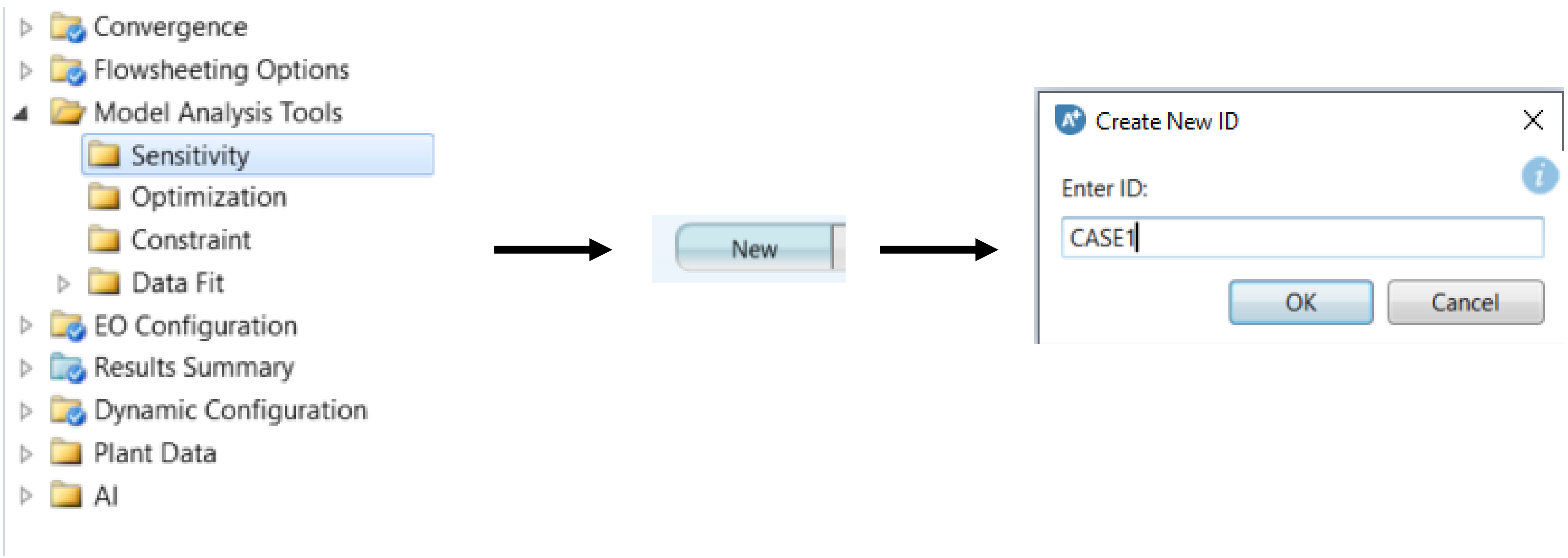




CASE STUDY

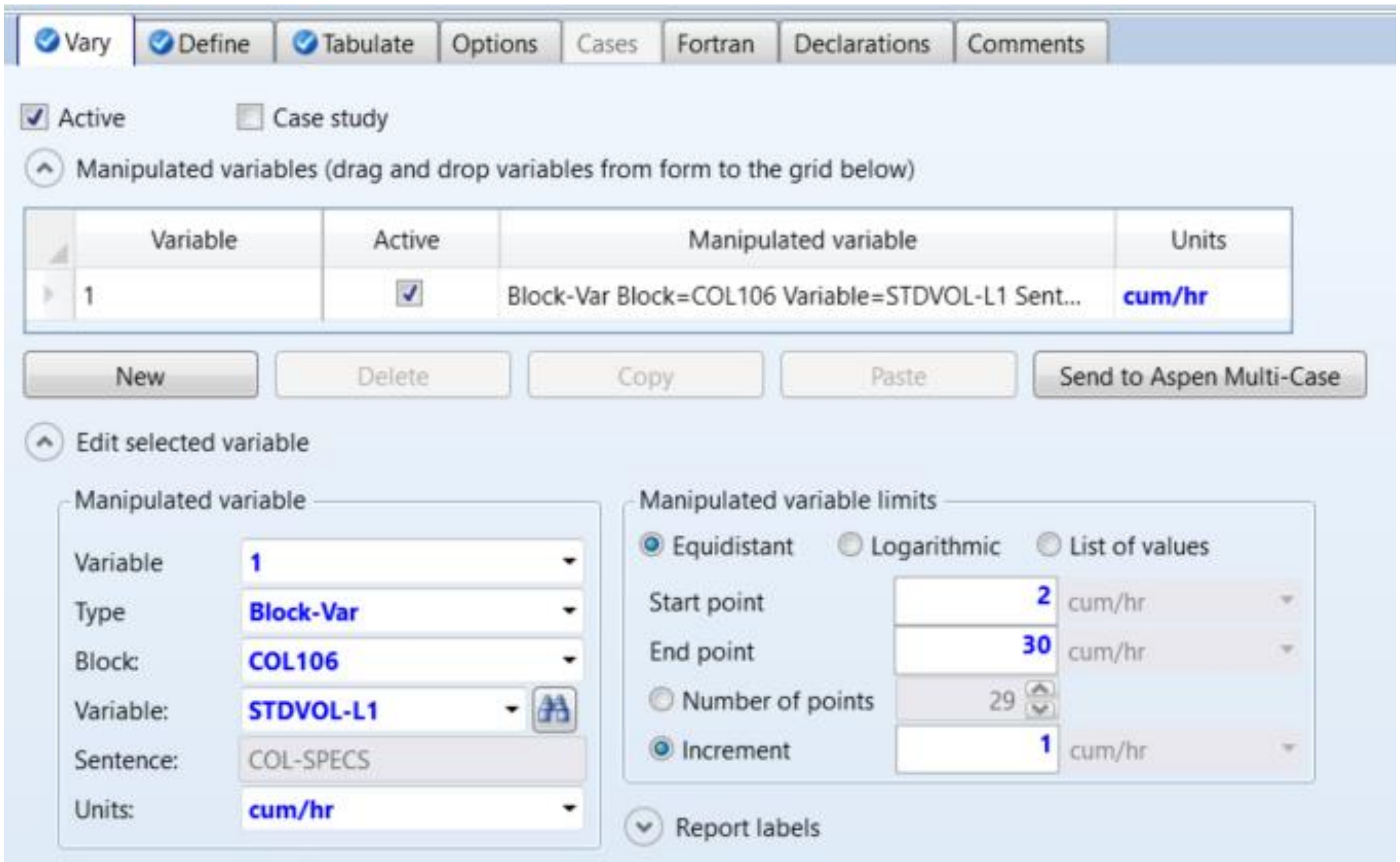
Dependent varible analysis as a function of an independent variable

Case study creation:



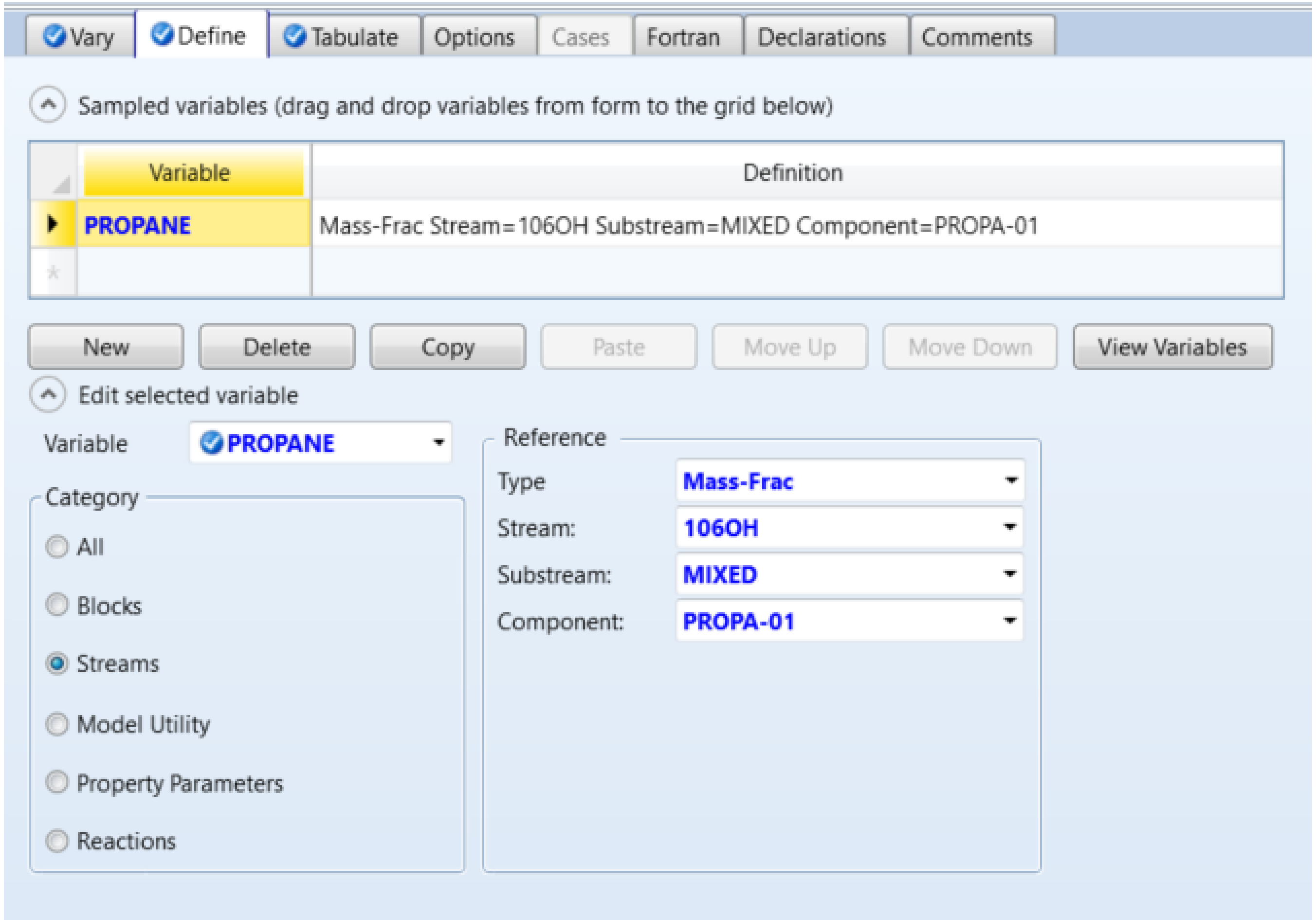
CASE STUDY

Definition of independent (manipulated variable) – reflux rate of Column 106



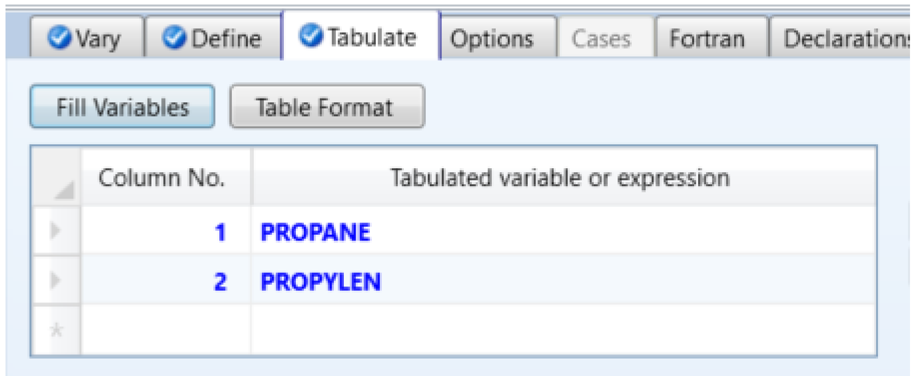
CASE STUDY

Definition of dependent variable– ethane mass fraction of Column 106 bottom



CASE STUDY

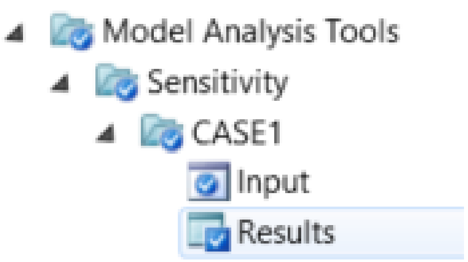
Tabulate – fill variables



Before running case study, make sure that RadFrac column's design specifications can be satisfied

CASE STUDY RESULTS

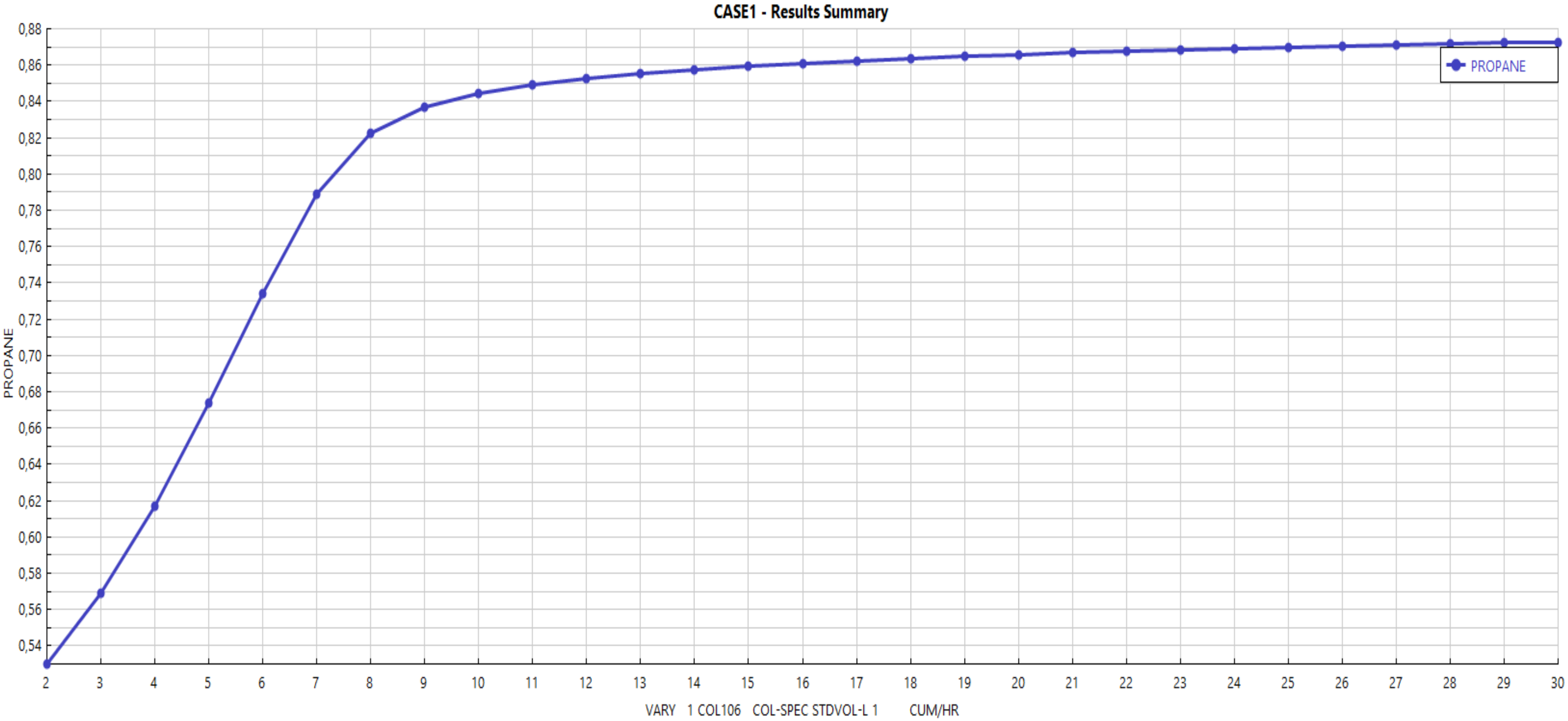
Checking case study results after running simulation



Row/Case	Status	Description	VARY 1 COL106 COL-SPEC STDVOL-L 1 CUM/HR	PROPANE
1	OK		2	0,530119
2	OK		3	0,56887
3	OK		4	0,617286
4	OK		5	0,673925
5	OK		6	0,734207
6	OK		7	0,788689
7	OK		8	0,822182
8	OK		9	0,836873
9	OK		10	0,844289
10	OK		11	0,848974
11	OK		12	0,852387
12	OK		13	0,855083
13	OK		14	0,857314
14	OK		15	0,859216
15	OK		16	0,860869
16	OK		17	0,862327
17	OK		18	0,863627
18	OK		19	0,864796

CASE STUDY RESULTS

Case study plots →



MOL GROUP