Aspen Plus®
Getting Started!

Chemical Engineering Guy

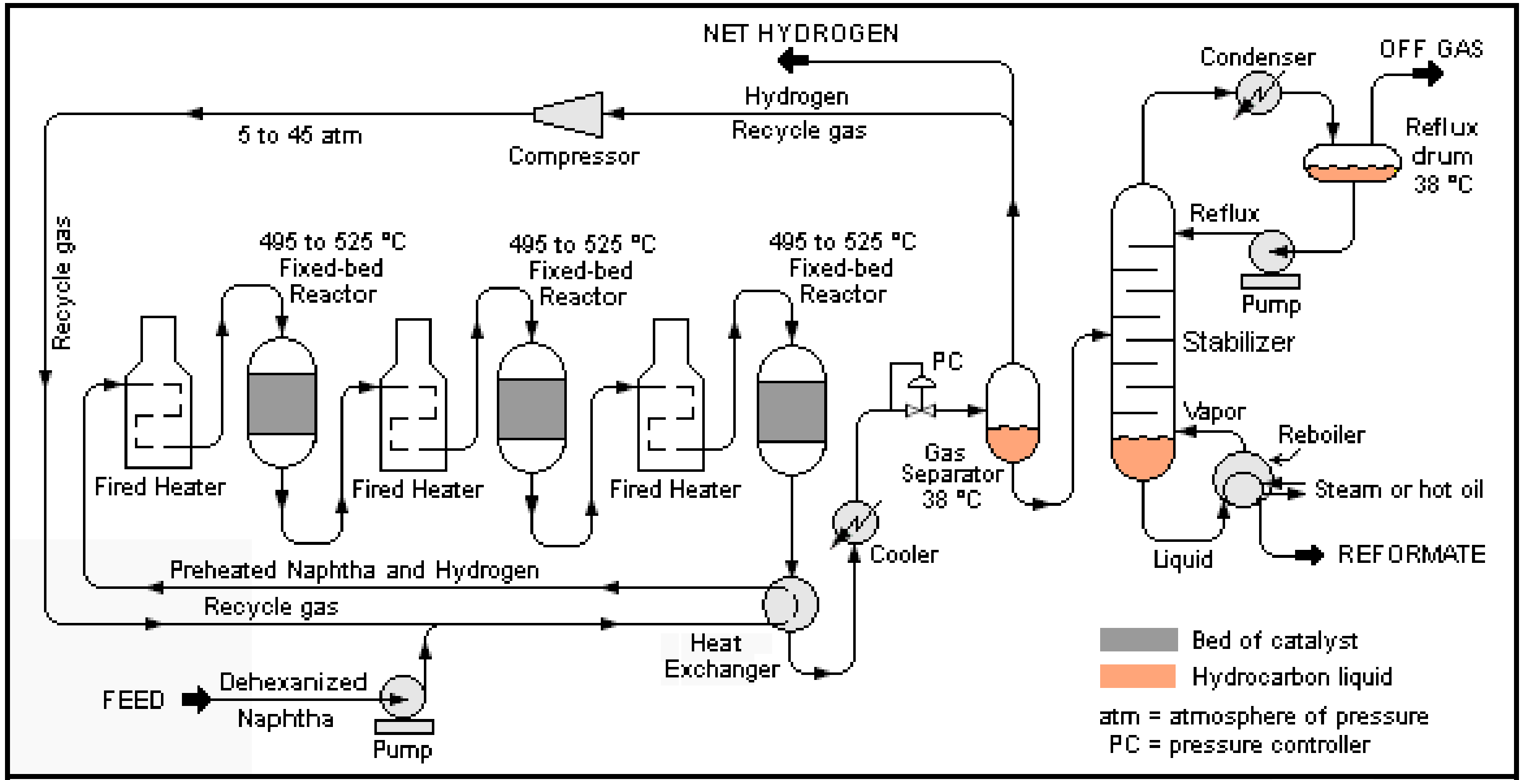
www.ChemicalEngineeringGuy.com

Chemical
Engineering Guy

Solve this!

Change:

- All T of Reactors
- Feed Composition
- No. of Plates in Distl. Col
- T of Heat Ex
- Gas Sep. T
- Compressor P
- Utility Costs



Process flow diagram of a semi-regenerative catalytic reforming unit in an oil refinery

And this….

Why Process Modeling/Simulation?

- Makes us easier/faster work
- Multiple and Simultaneous Simulations
- Different Real-Life Scenarios
  - Change on raw/feed materials scenario
- Pricing and Costs calculation
  - Raw Materials
  - Plant Cost
  - Utilities
- How it would behave under different conditions
  - High/Low Pressure
  - Humidity Changes
  - Temperature change (cool/warm days/seasons)

Which companies model?

- Mainly:
  - Petrochemical
  - Pharmaceutical
  - Fine chemicals

- Other commodities such as:
  - Sulfuric acids
  - Chlorine/Caustic industry
  - Solvents
  - Coatings
  - Many more…

Other Advantages…

- Excelent for your curriculum as an engineer
- Perfect for analytical/numerical minds
- Good for debuging and fixing “what if” scenarios

CONTENT INDEX

1. Introduction
2. Our Chemical Process!
3. Setting up the Physical Property Environment
4. Simulation Environment I – The Flowsheet
5. Simulation Environment II – Unit Operations
6. Running, Results & Analysis
7. Case Studies (A,B,C,D)
8. Conclusion

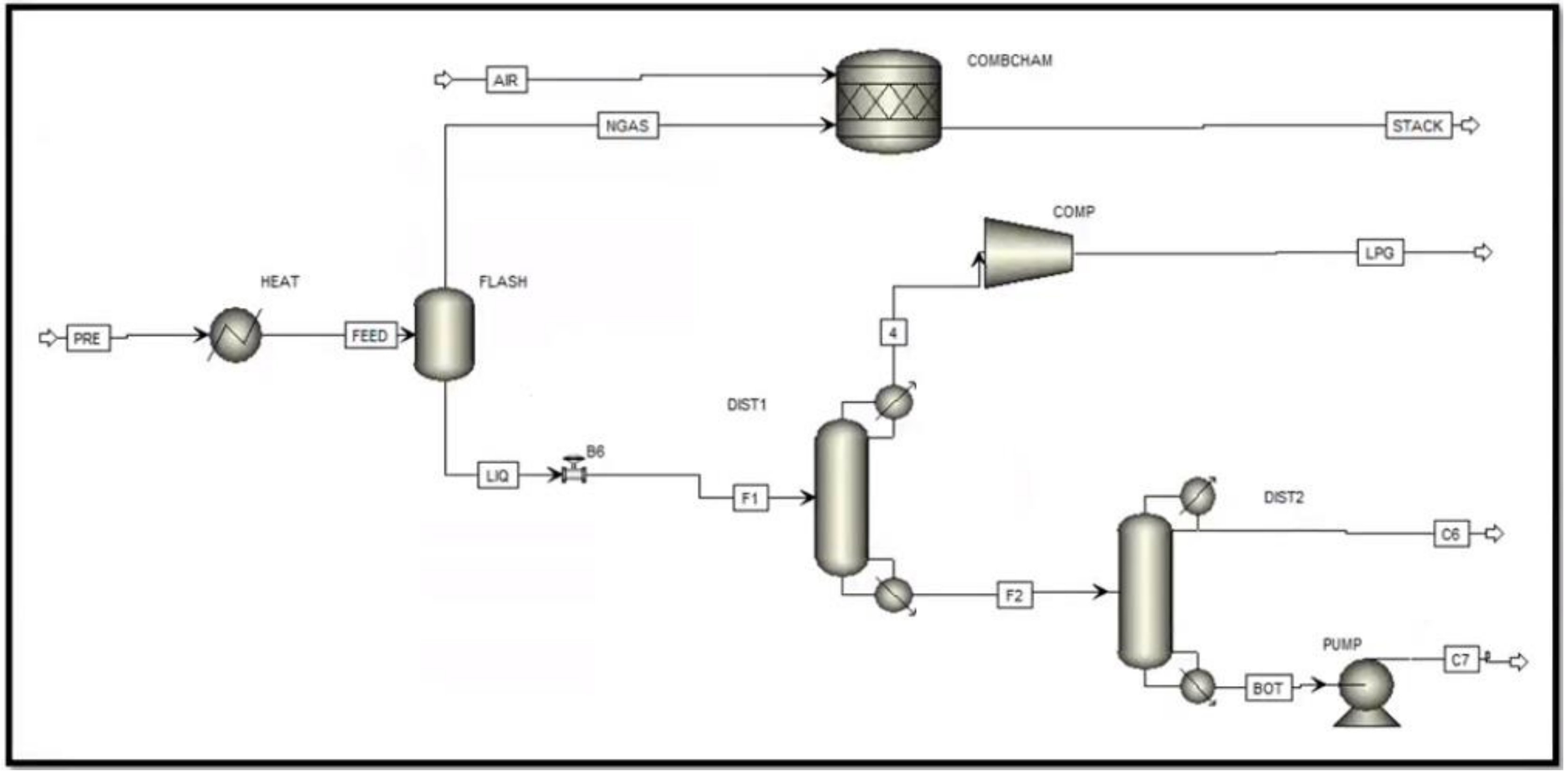
Course Objectives

- **Introductory Knowledge of Processes Modeling**
  - Setting the adequate Physical Properties
  - General Flowsheet Concepts
  - Basic Flowsheet "manipulation"
  - Common Unit Operations
  - Minimum Requirements to set up & run a Simulation
  - Analyze several changes in process conditions
  - Create an interest in Process Modeling

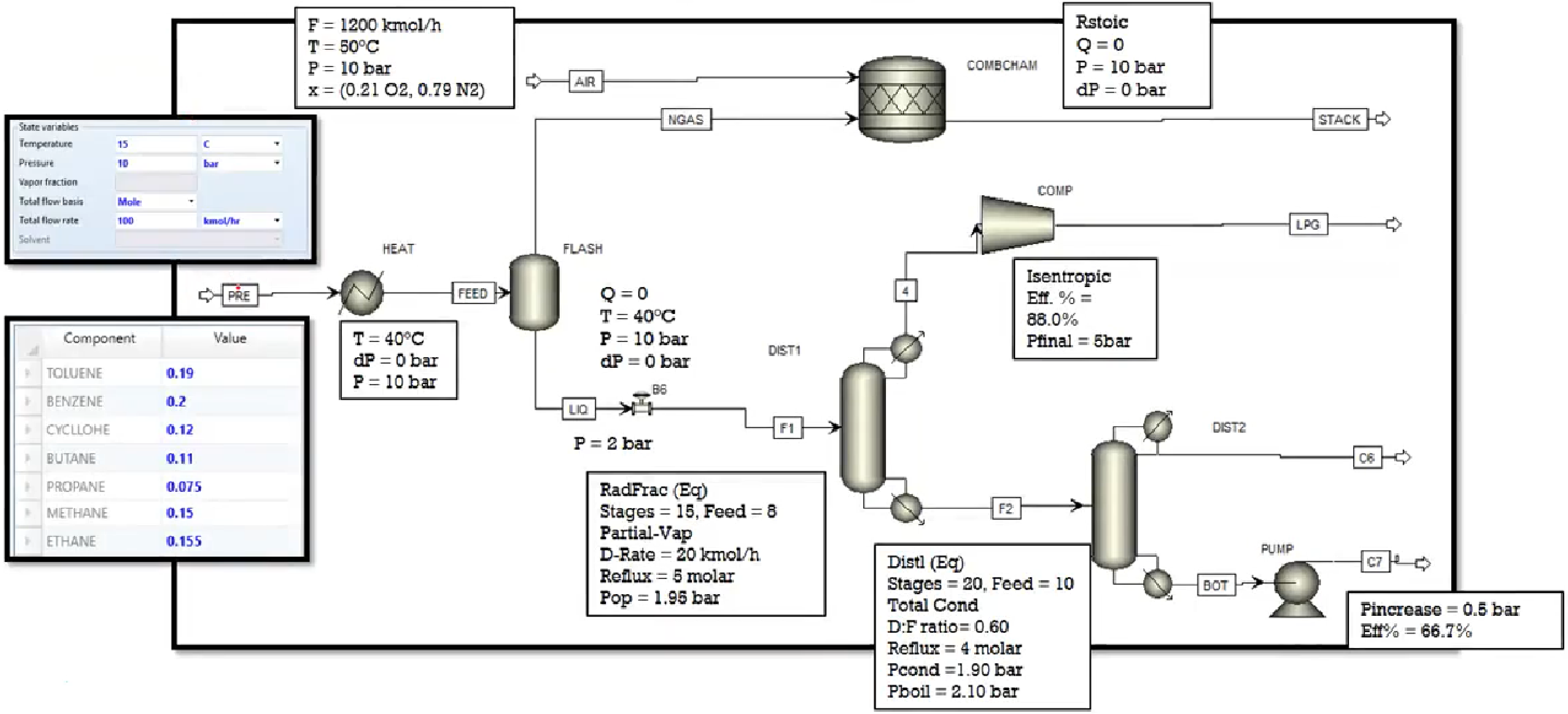
Contact

- Please contact me if required (doubts, questions, comments, suggestions)
  - Contact@ChemicalEngineeringGuy.com
- More courses…

2. Our Chemical Process!



2. Our Chemical Process!



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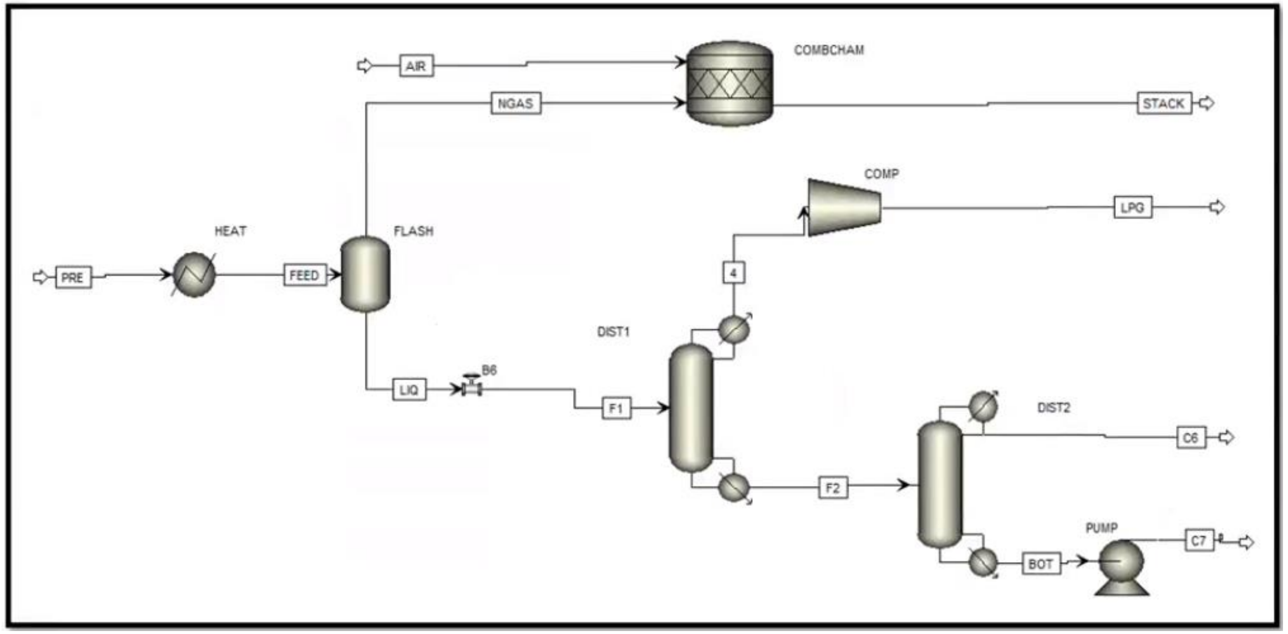
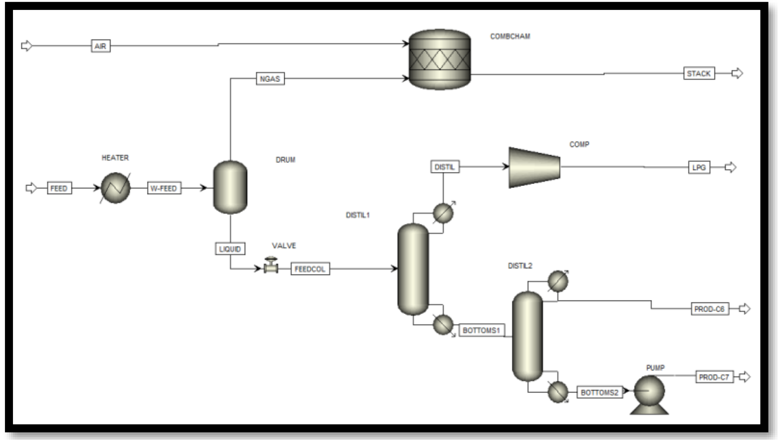
Conditions

- **Unit Operations**
  - Heat Exchange
    - Heat Exchanger
  - Reaction Kinetics
    - Combustion Chamber / Reactor
  - Momentum
    - Pump
    - Compressor
  - Separation Process
    - Flash Drum
    - Distillation Columns



Problem Statement



- A hydrocarbon feed rich in aromatics is to be separated via a series of separation processes.
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- Most of the hydrocarbons msut be recovered and the leftovers will be burnt in a combustion chamber.
- The combustion chamber will burn all hydrocarbons to form carbon dioxide. Assume 100% combustion. The air for combustion was previously adjusted to 50°C, 10bar. There is no pression loss in the combustion chamber.
- The liquified section must be de-pressurized in order to continue treatment. It drops to 2 bar via a valve.

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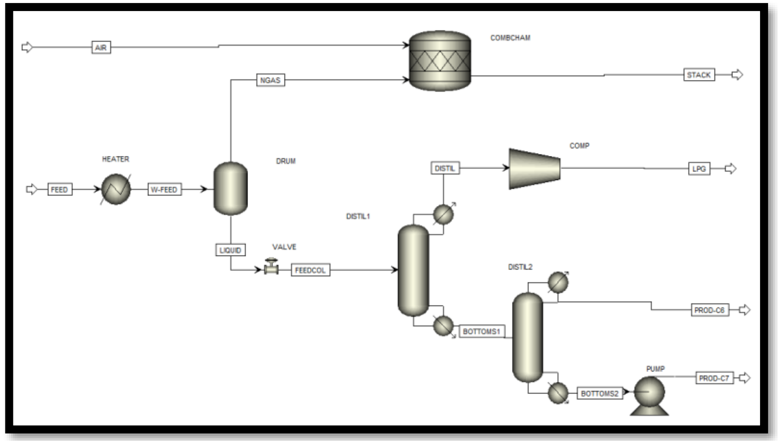

- This stream is then fed to a Distillation Column.
  - It currently has a total of 15 trays.
  - Feed tray must be between 7 and 8.
  - Recommended operation is partial vapor in order to avoid an extra stage. Reflux
  - Ratio is set to 5 (molar) and the approx.
  - Pressure drop is unknown, but can be assumed to be low or negligible.
  - At least 20% of the feed must be recovered for further treatment
- The Distillate is to be treated in a following process. It must be compressed to 5 bar. We use a compressor with approx. 88% efficiency. It can be modeled as an isentropic compression.

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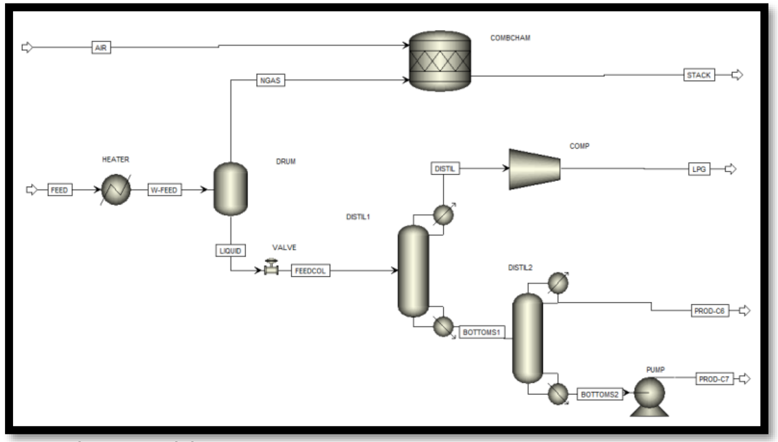

- The bottoms of this column are not pure enough. Further distillation is required.
- The following column requires a total of:
  - 20 trays feeding in 50% approx.
  - It uses a total condenser since the distillate is required as a liquid
  - Recommended Distillate recovery is 60%
  - Reflux is set to 4 molar
  - The pressure drop is unkown, but current process has:
    - Condenser working ate 1.90 bar
    - Reboiler working at 2.10 bar
- The distillate can be sent for storage
- The bottom must be further pressurized +0.5 bar in order to allow for pressure drop due to frictions. Efficiency of pump is 66.7%

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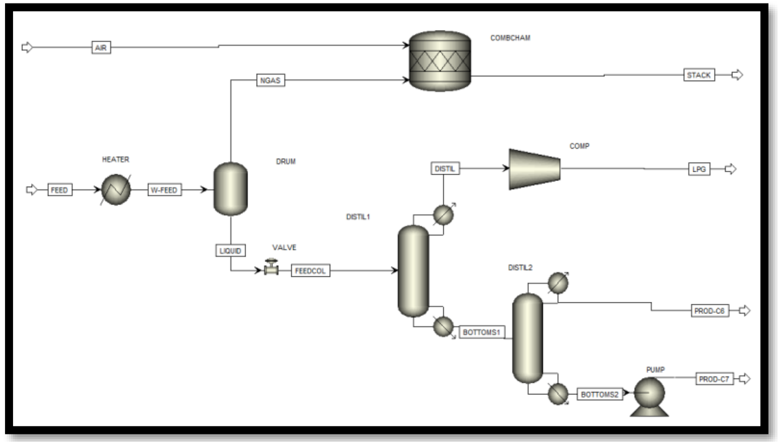

- Requirements:
  - Model the plant using Aspen Plus in Steady State
  - Verify Material/Energy Balances of the unit operations & processes
  - Verify purity and composition of streams
  - Verify conditions such as T, P and Flow rates.
  - For specific unit operations, verify their relevant results
    - Heater → Heat duty
    - Combustion Chamber → T-max, Heat released by reaction
    - Compressor/Pump → Required Work
    - For the Columns → Reboiler & Condenser Duties

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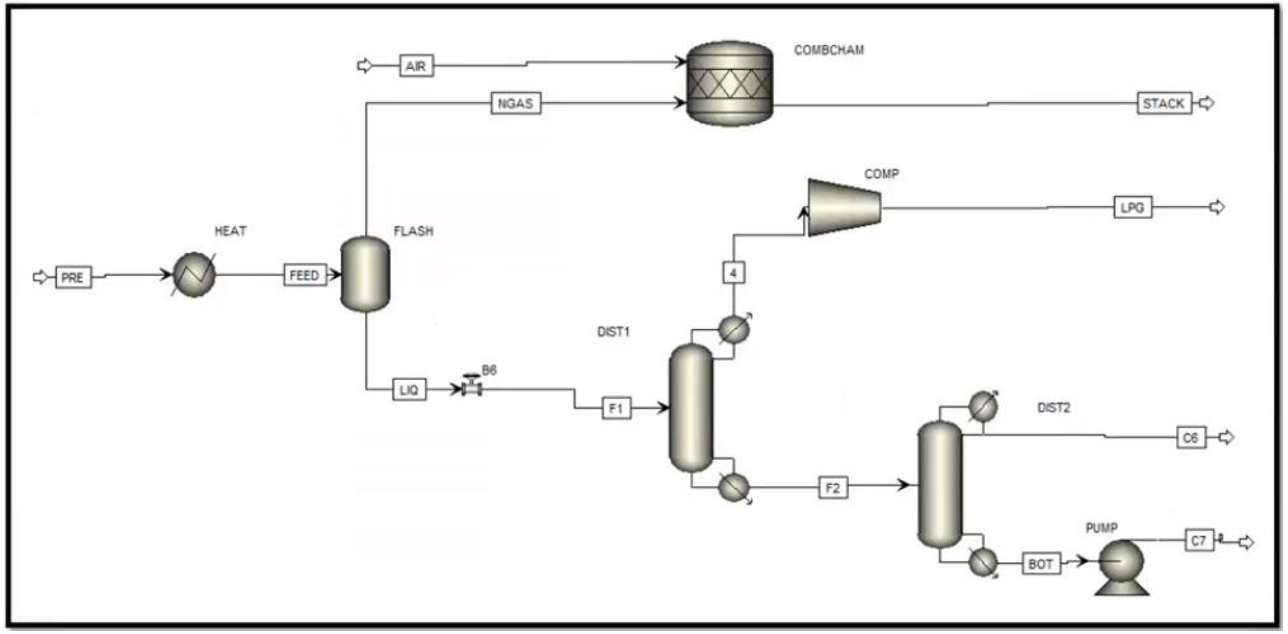
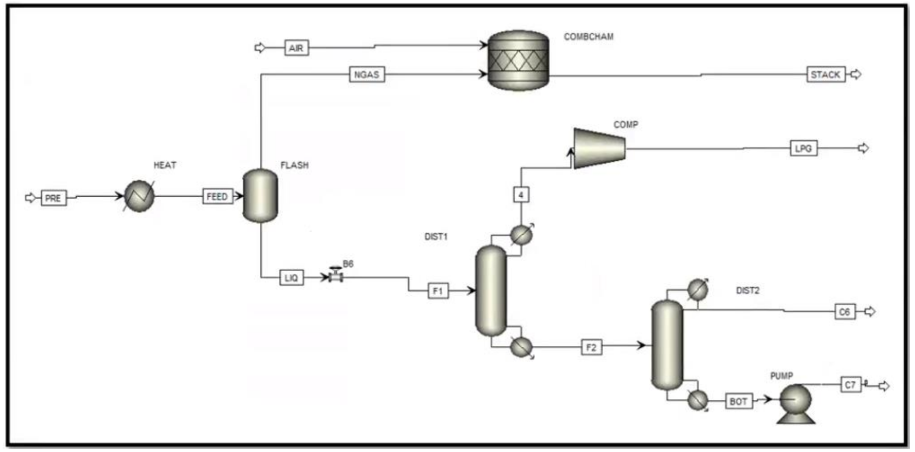


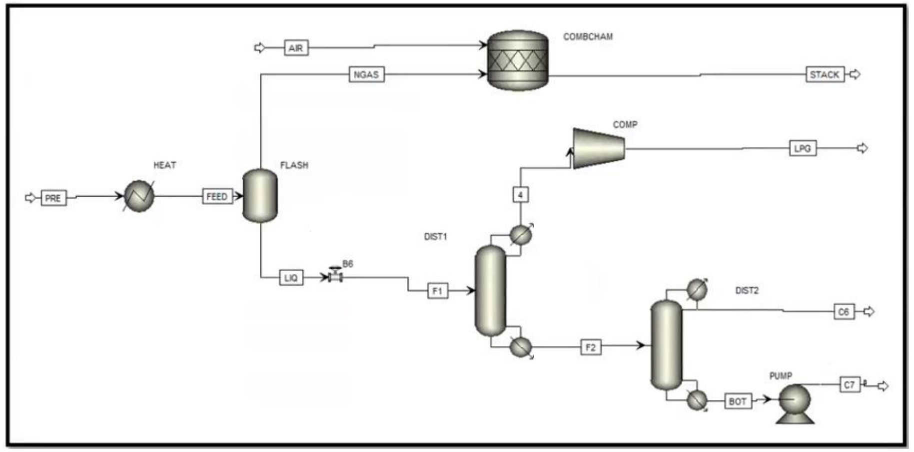
Examples

- Pipes



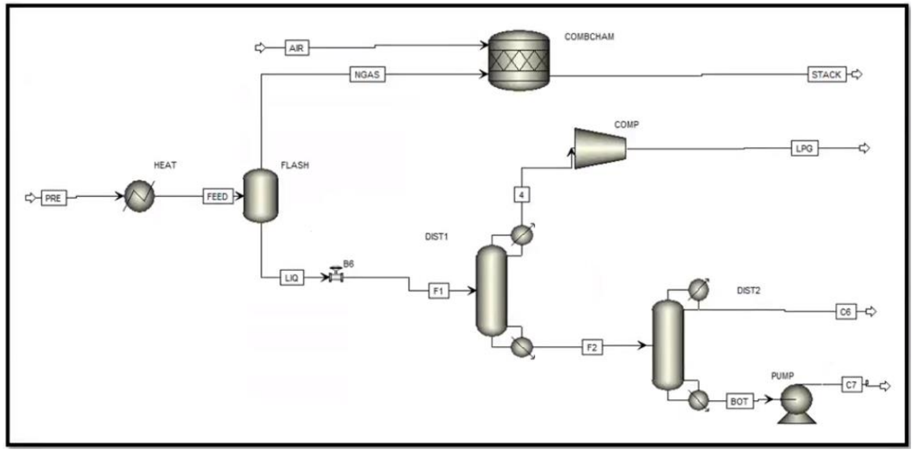
Examples

- Flash Tank:



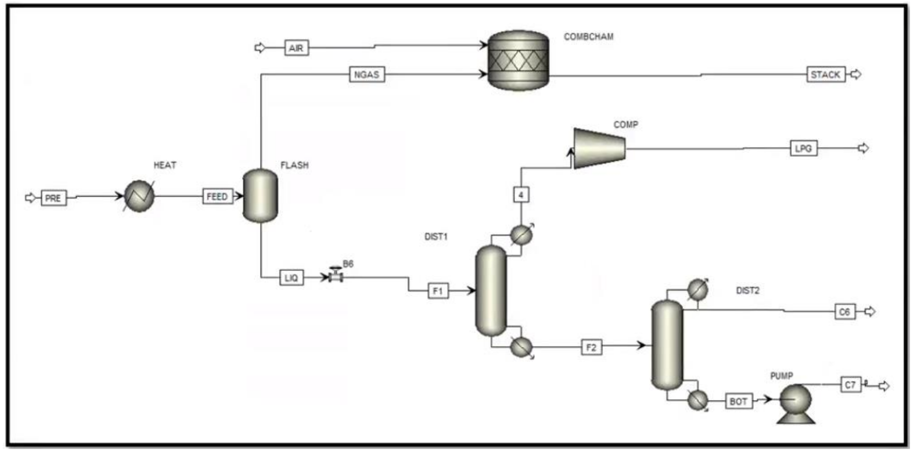
Examples

- Combustion Chamber / Reactor



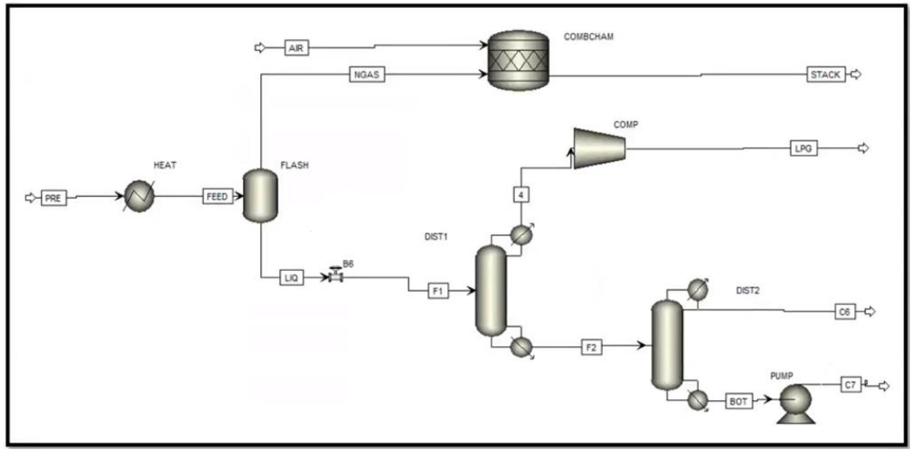
Examples

- Distillation Columns



Examples

- Compressor & Pump

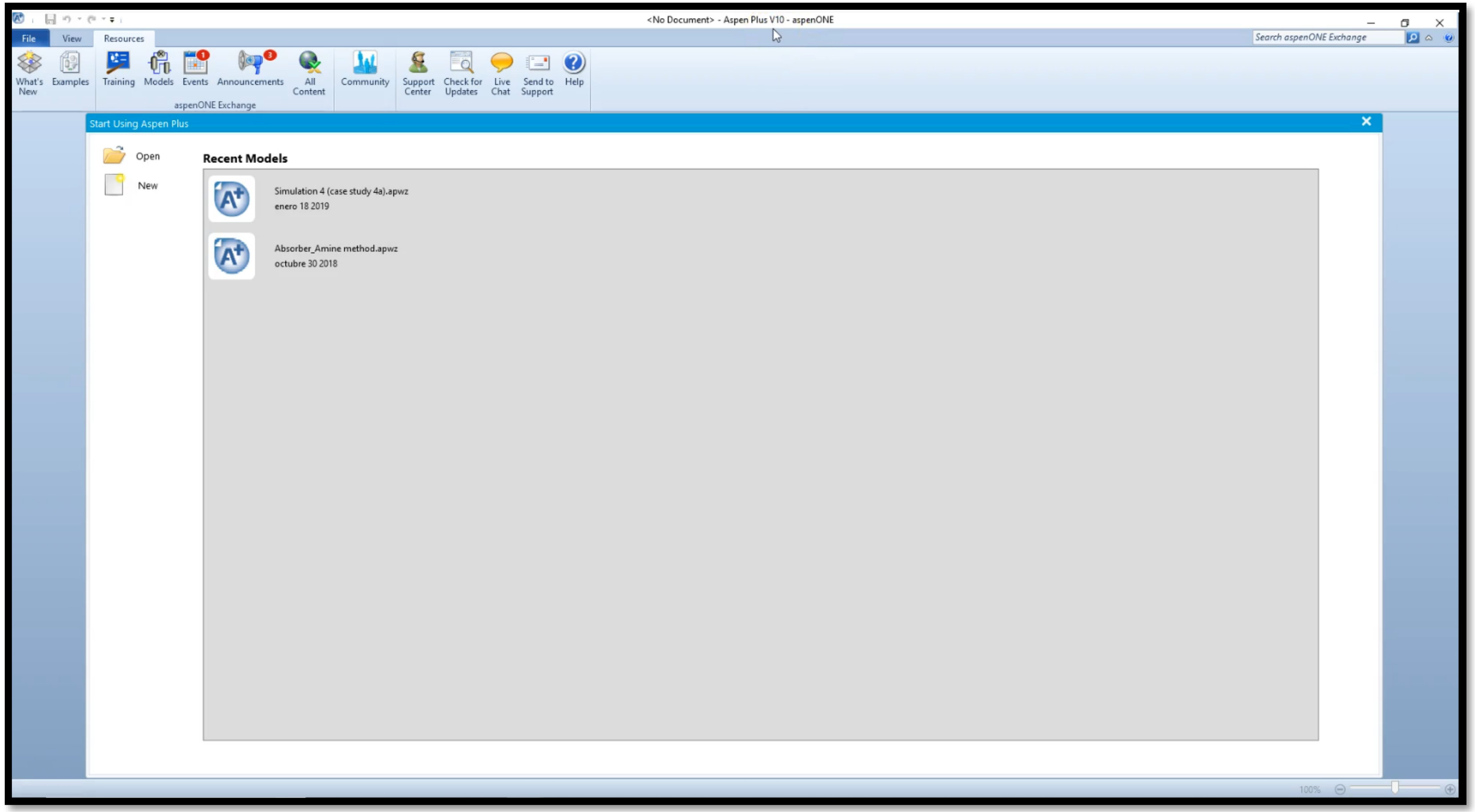


Resources

- PDF of Process diagram
- Spreadsheet with Unit Operations & Process conditions
- Spreadsheet with Component list & database

3. Physical Property Environment

- Landing Page



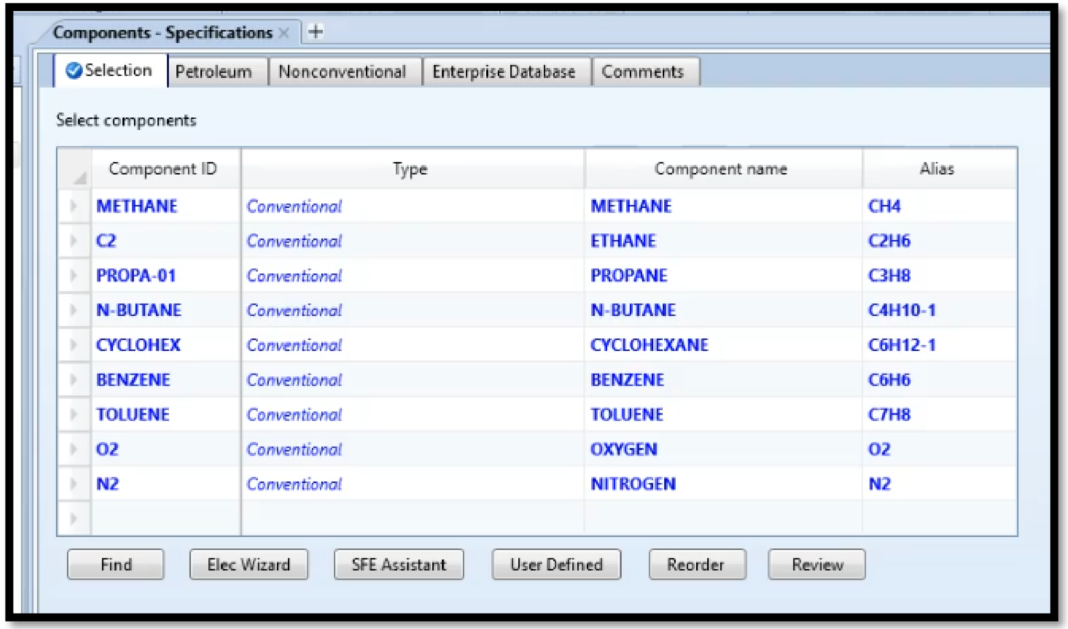
3. Physical Property Environment

- Min. Requirements:
  - Adding Components to the Component List
  - Selecting a Physical Property Method (Thermodynamic pack)

- If you want to further explore this environment →
  - **Aspen Plus - Physical Properties**
    - Different Types of Components
    - Methods (EOS, Activity, Mixed)
    - Modeling new/inexistent components
    - Physical & Chemical Property Analysis
    - Thermodynamic & Transport Properties

Adding Components

- Add the following compounds to the “Component List”
  - Methane
  - Ethane
  - Propane
  - N-Butane
  - Cyclohexane
  - Benzene
  - Toluene
  - Oxygen
  - Nitrogen

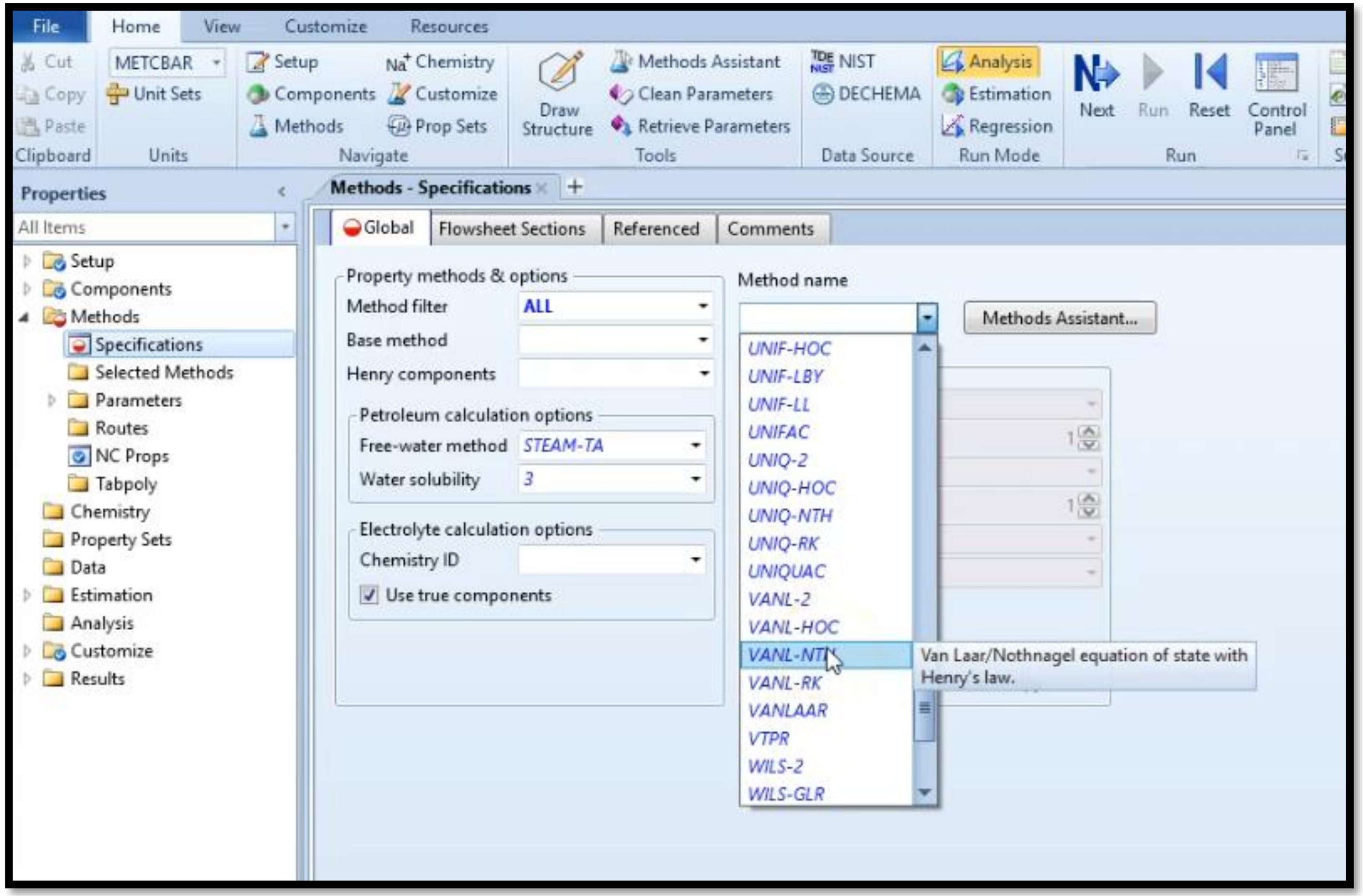


Component ID	Type	Component name	Alias
METHANE	Conventional	METHANE	CH4
C2	Conventional	ETHANE	C2H6
PROPA-01	Conventional	PROPANE	C3H8
N-BUTANE	Conventional	N-BUTANE	C4H10-1
CYCLOHEX	Conventional	CYCLOHEXANE	C6H12-1
BENZENE	Conventional	BENZENE	C6H6
TOLUENE	Conventional	TOLUENE	C7H8
O2	Conventional	OXYGEN	O2
N2	Conventional	NITROGEN	N2

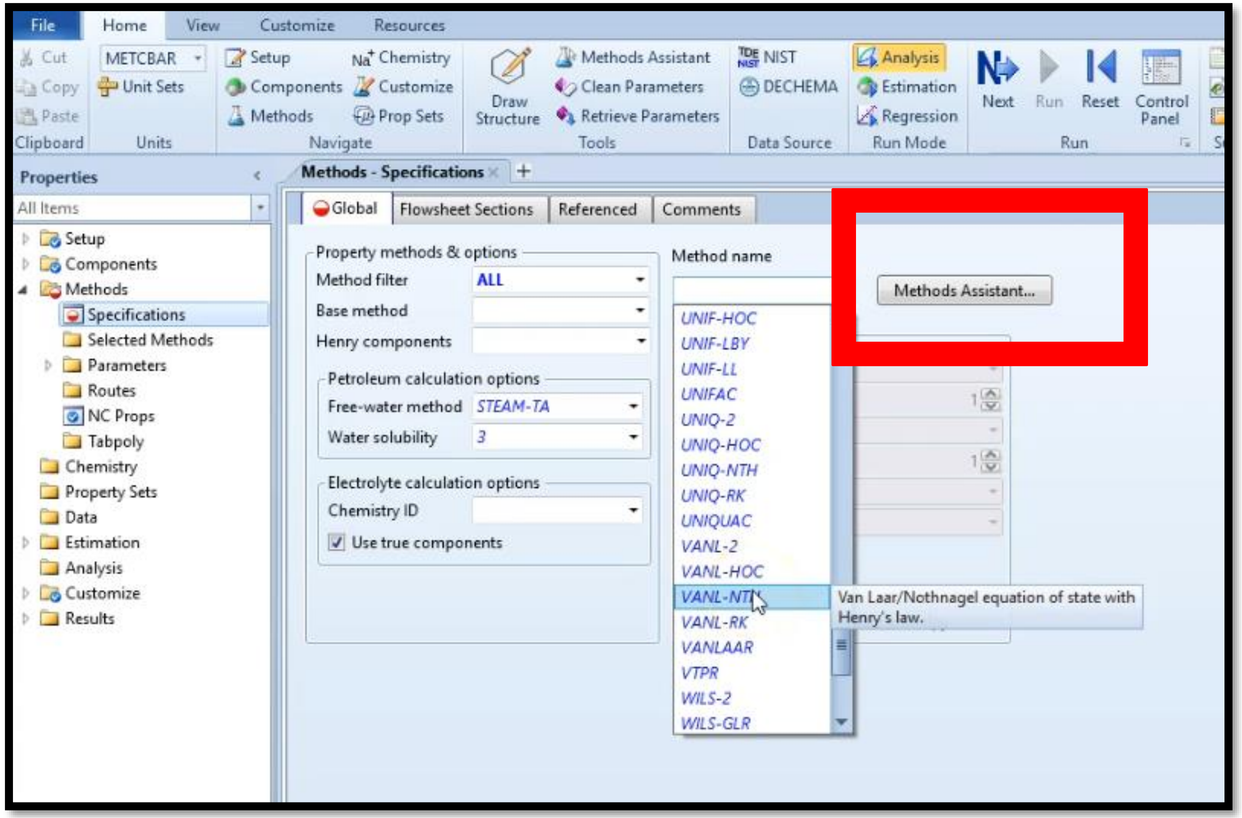
Choosing the Property Method

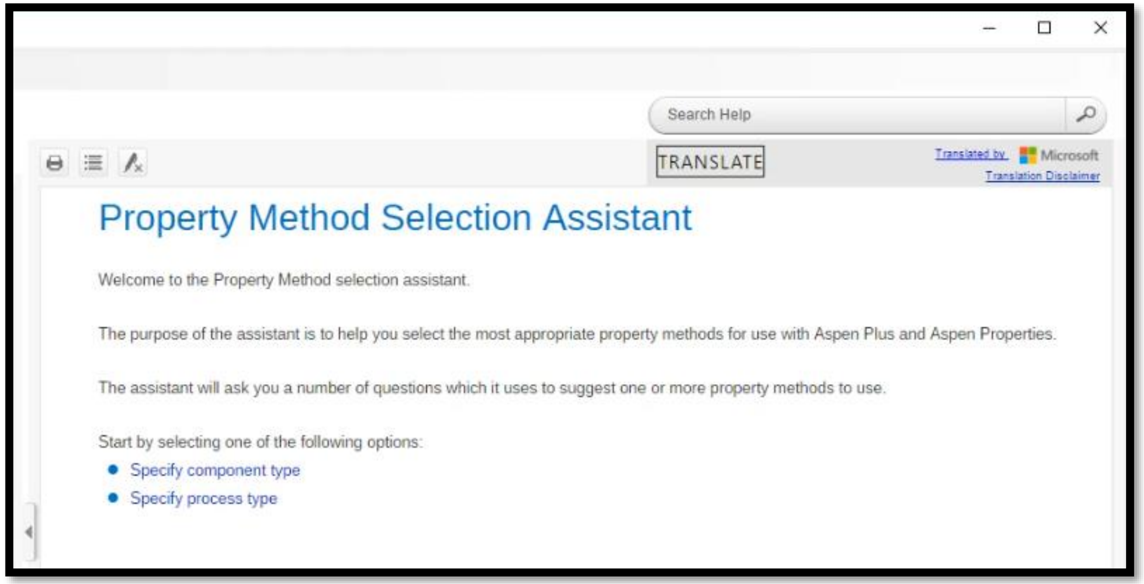
- Select Peng Robinson, as it is mostly non-polar system
  - Most models will be “set-up”
  - Pure substances Properties will be loaded
  - Binary Interactions are calculated
- Tip: Use the Method Assistant

Choosing the Property Method



Method Assistant…



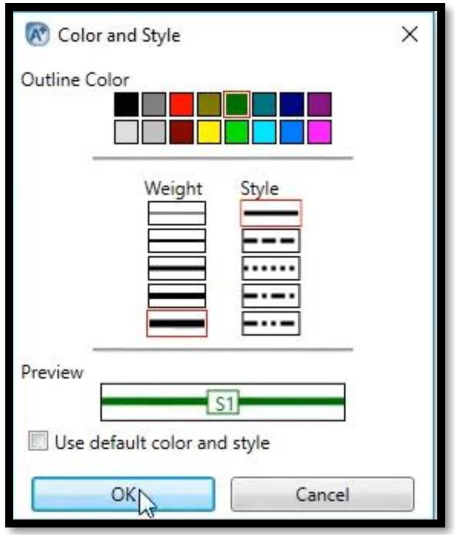


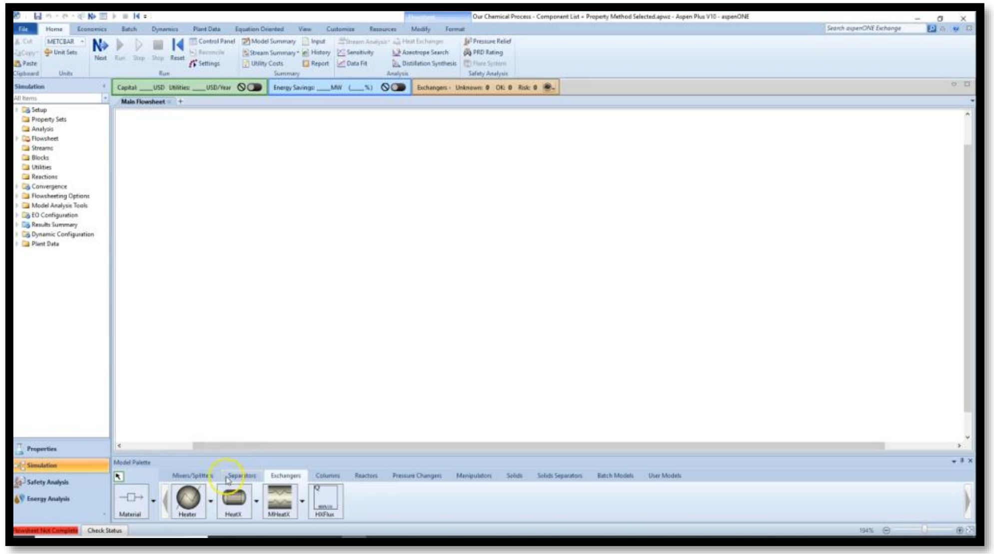
Simulation Environment I: The Flowsheet

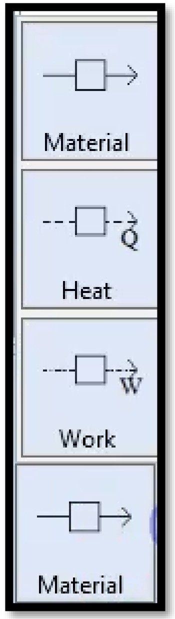
- Get to know what is a flowsheet and how to manipulate it.
- Menus, Tool, Areas, etc…
- Important:
  - General Setup
  - Blocks: Unit Operations, Others
  - Streams (Material, Heat, Work)
  - Analysis tools

Simulation Environment I: The Flowsheet

- Manipulation of the Flowsheet:
  - Adding Unit Operations
  - Adding Material and Energy streams
  - Moving
  - Labeling
  - Rotating
  - Deleting
  - Copy and Pasting







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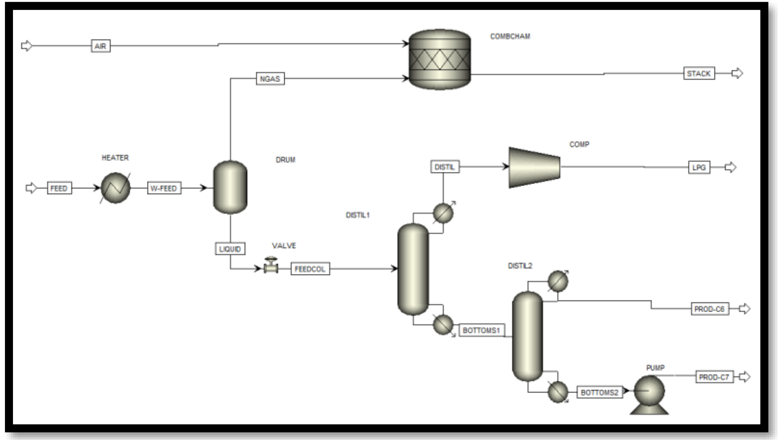
5. Simulation Environment II: Unit Operations

- Typical Unit Operations
- Adding UO
- Setting up
- Connecting streams
- Inlet/outlet



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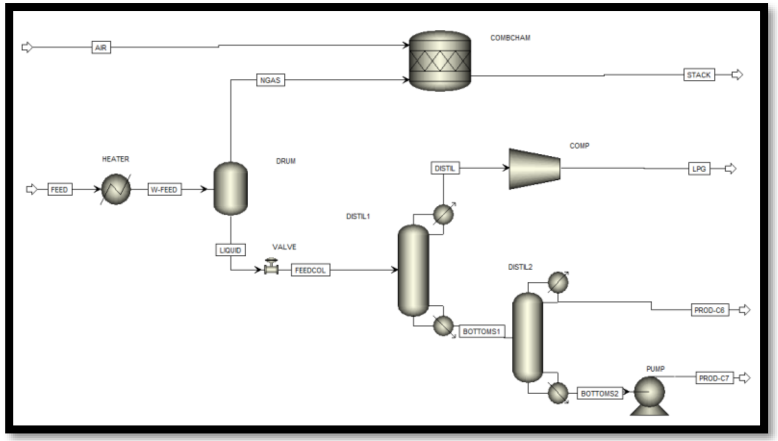

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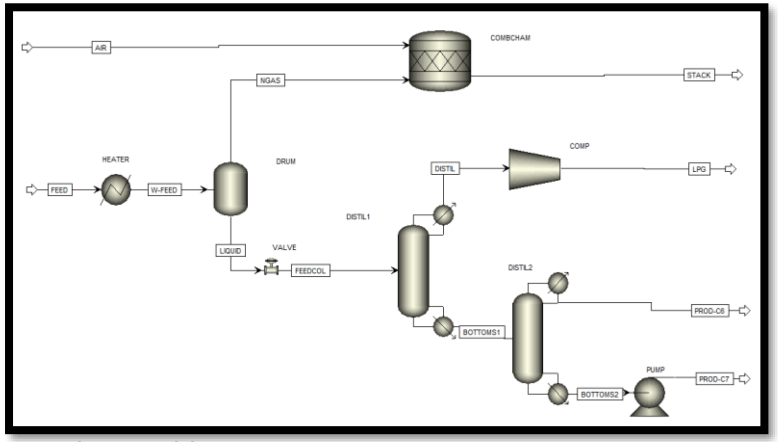

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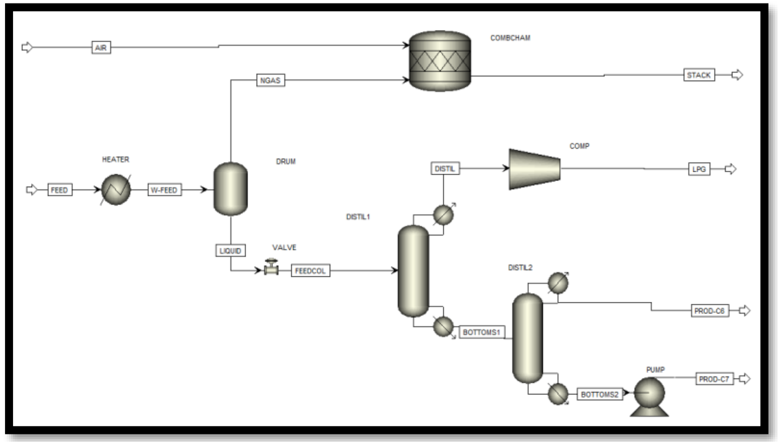

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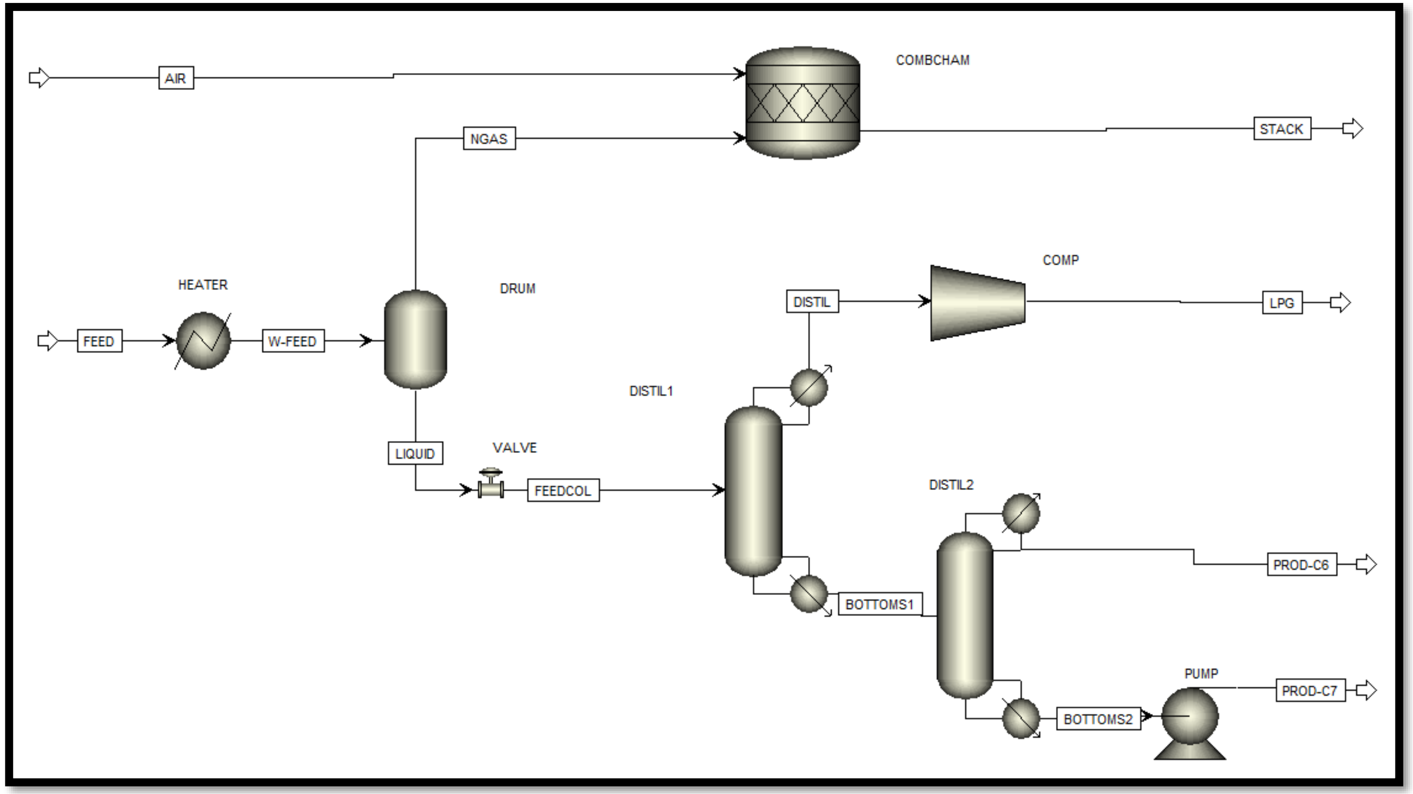
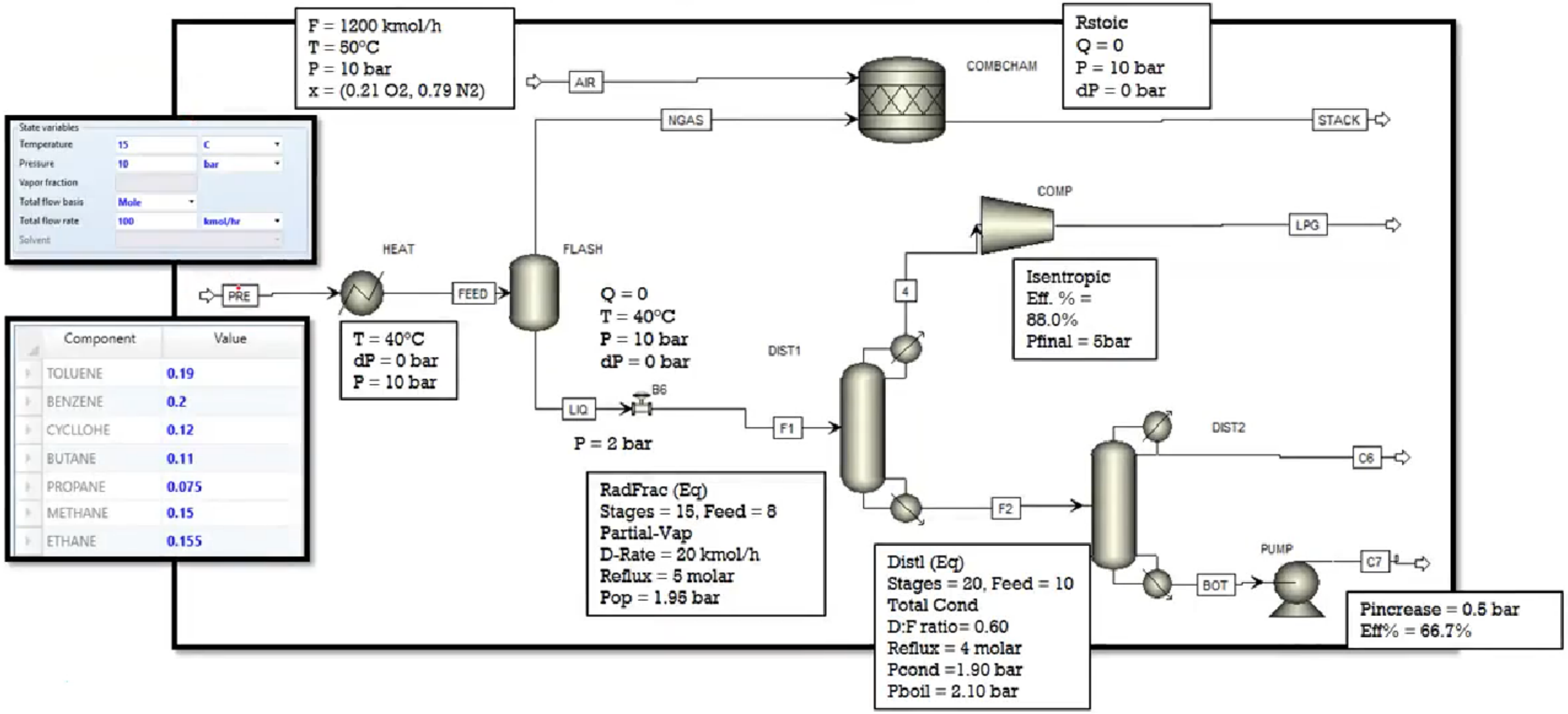


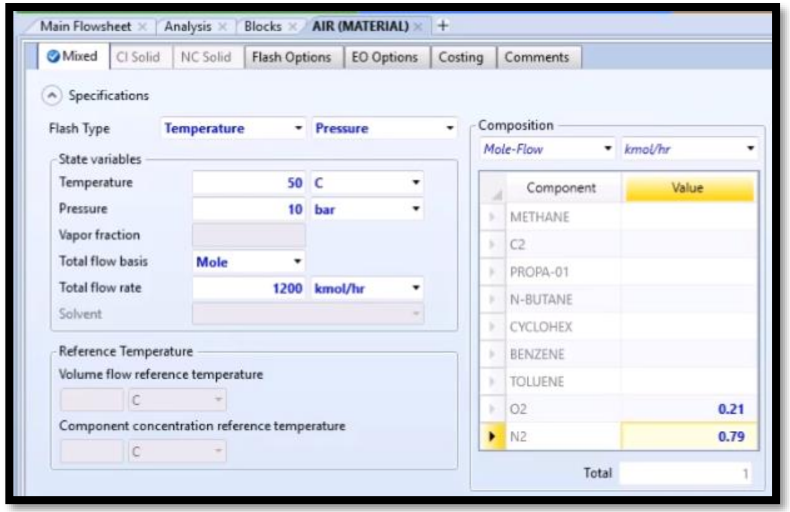
Lets try to build this:



Streams

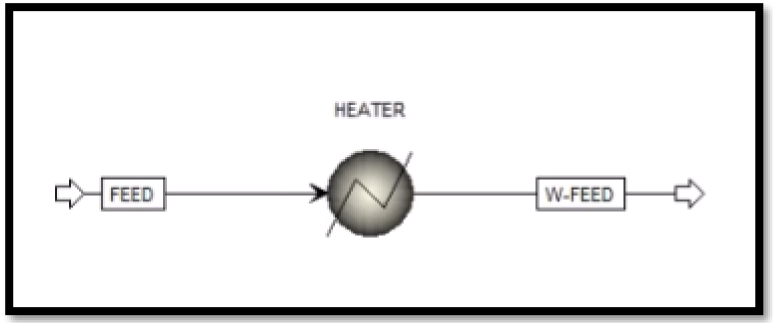
- **Feed**
  - F = 100 kmol/h
  - T = 15°C
  - P = 10 bar
  - Comp:
    - Toluene 0.190
    - Benzene 0.200
    - Cyclohex 0.120
    - Butane 0.110
    - Propane 0.075
    - Methane 0.150
    - Ethane 0.155

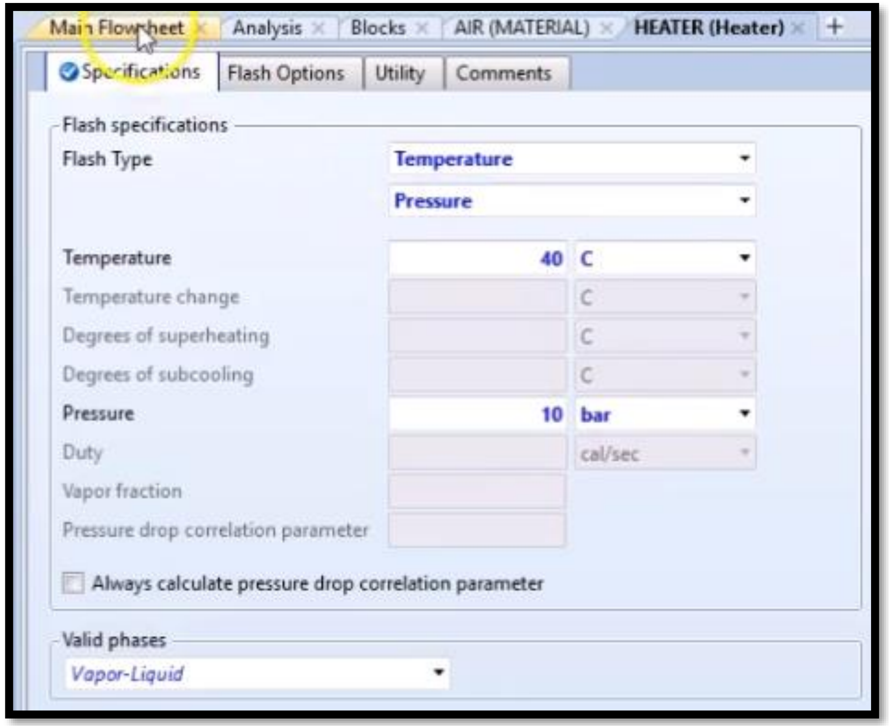
- **Air**
  - F = 1200 kmol/h
  - T = 50°C
  - P = 10 bar
  - Comp:
    - 0.79 N2
    - 0.21 O2



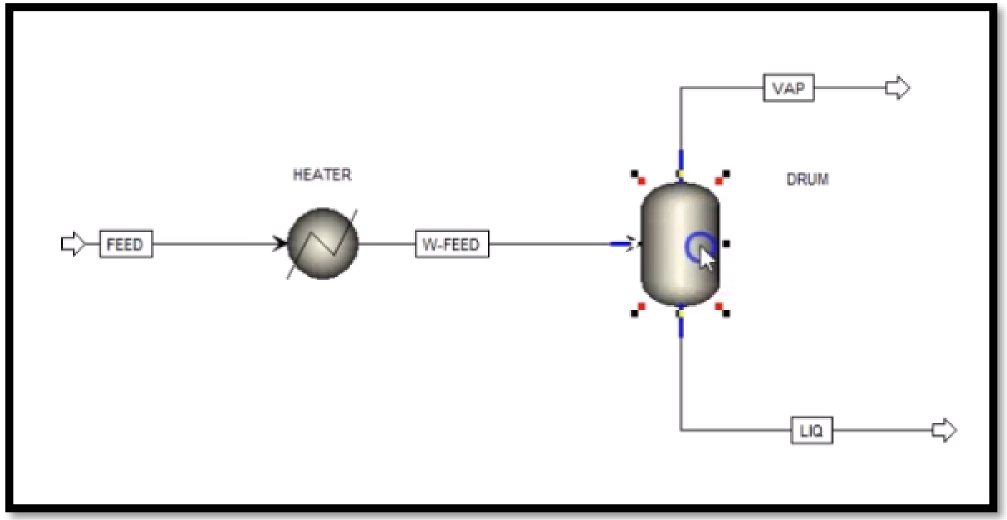
Blocks - Heat Exchanger

- Heater
  - T = 40°C
  - dP = 0 bar
  - P = 10 bar

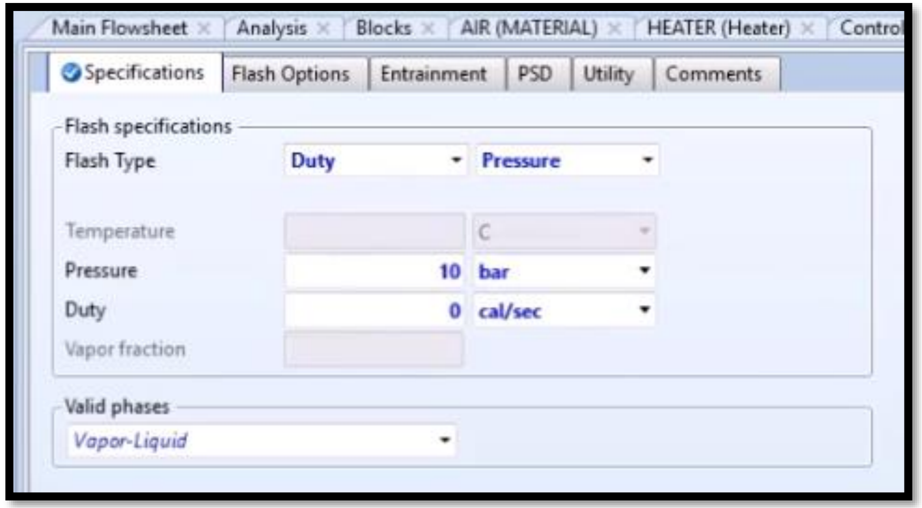




Blocks – Flash Drum

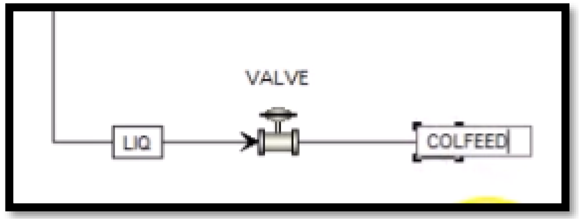


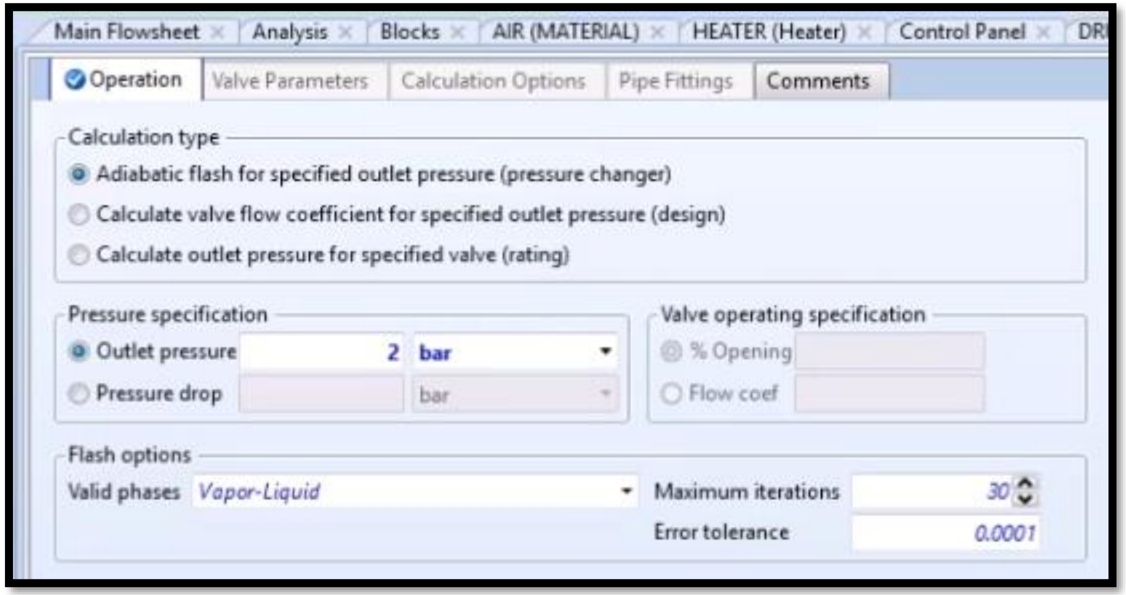
- Flash2
  - Q = 0
  - T = 40°C
  - P = 10 bar
  - dP = 0 bar



Blocks - Valve

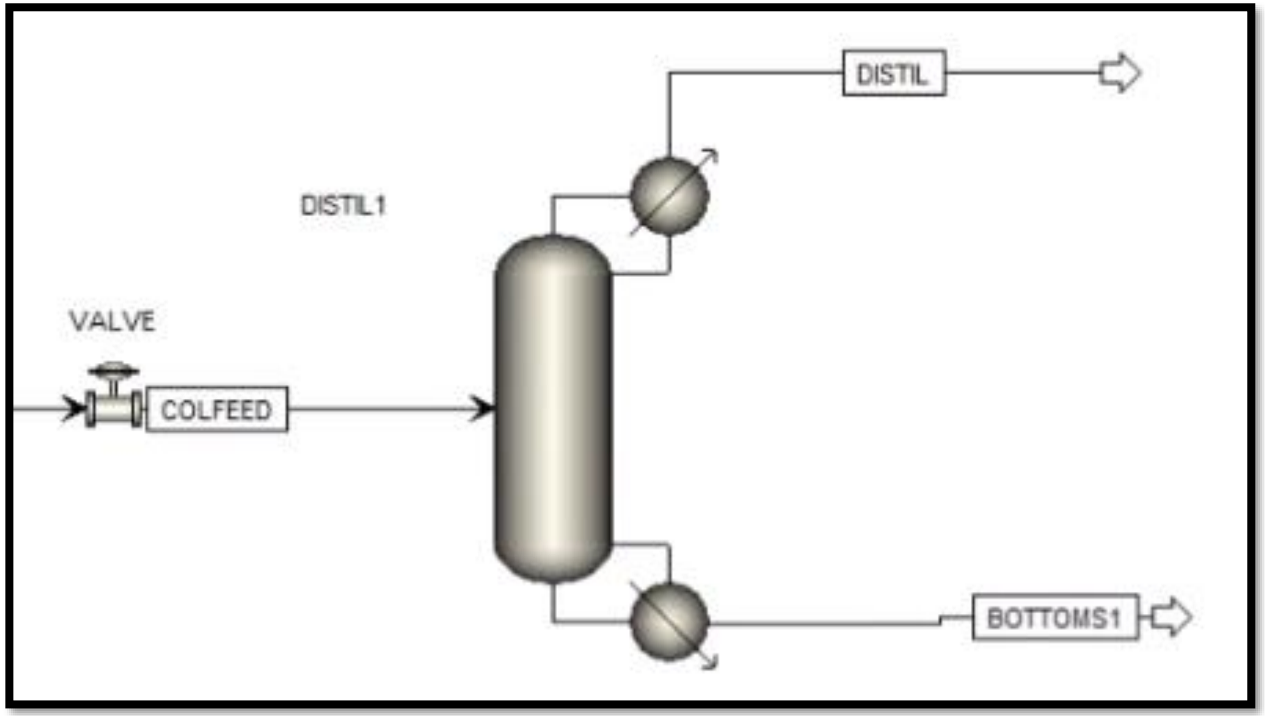
- Valve
  - P = 2 bar





Blocks – Distillation Column 1

- RadFrac
  - Stages = 15
  - Feed = 8
  - Cond = Partial
  - D-Rate = 20 kmol/h
  - Reflux = 5 molar
  - P-reboiler = 1.95 bar



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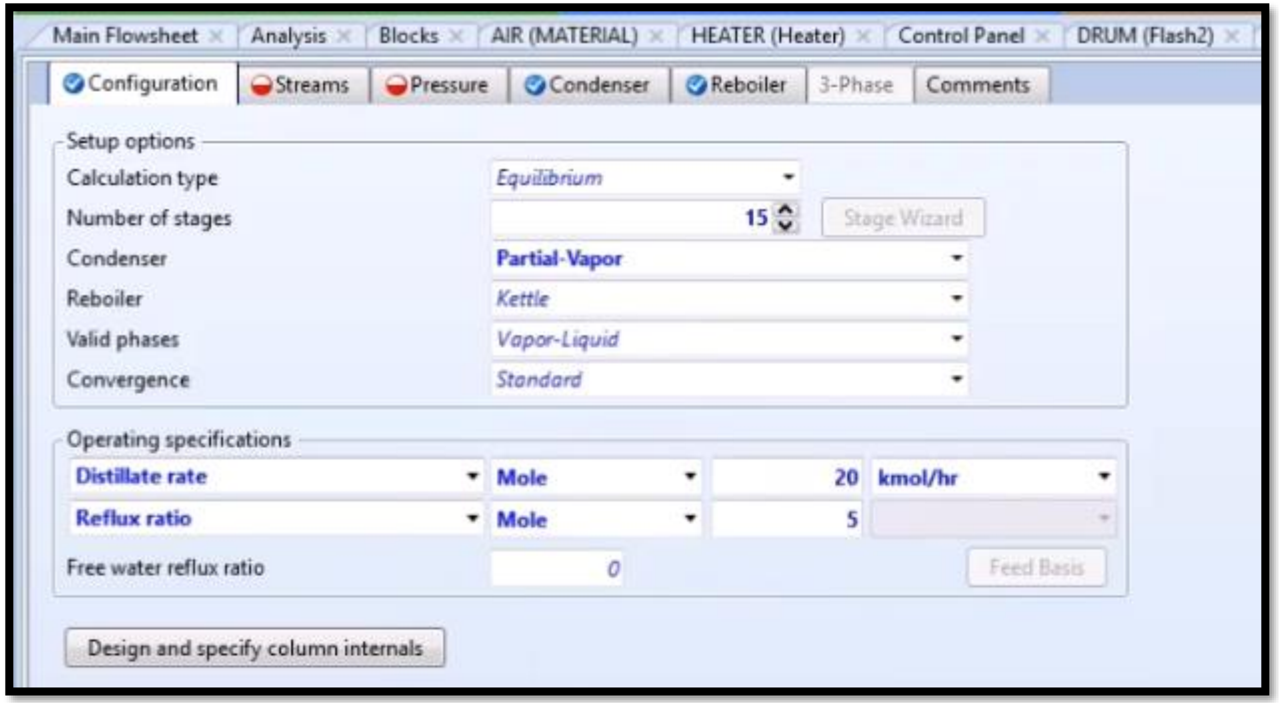

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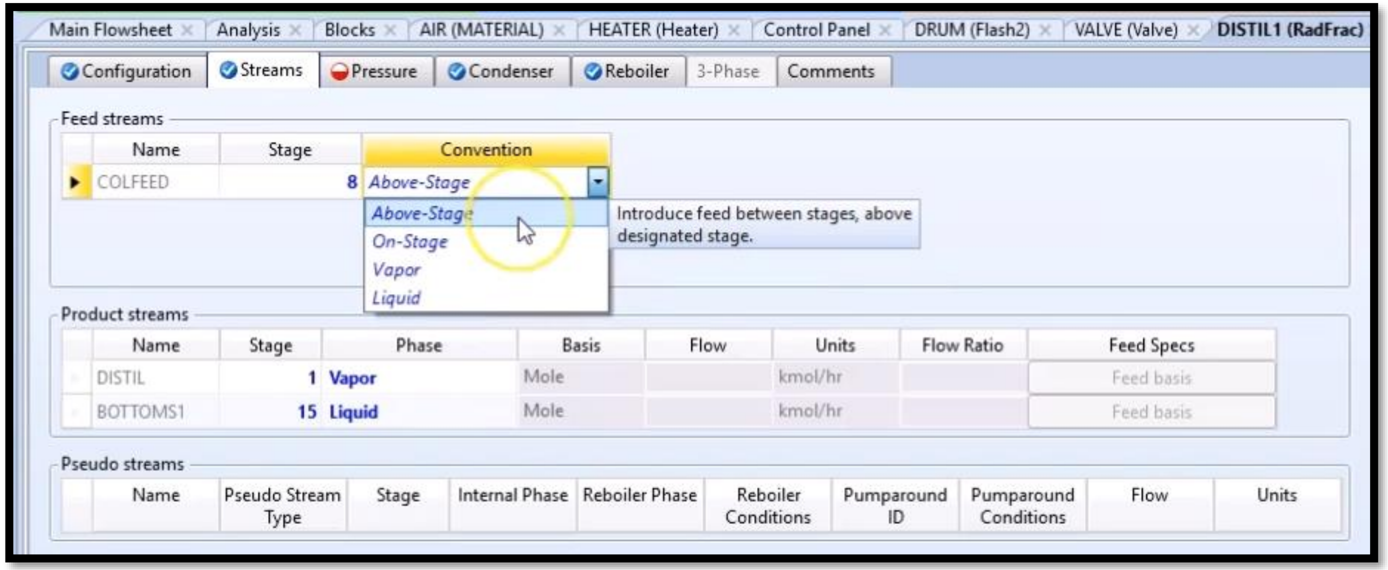

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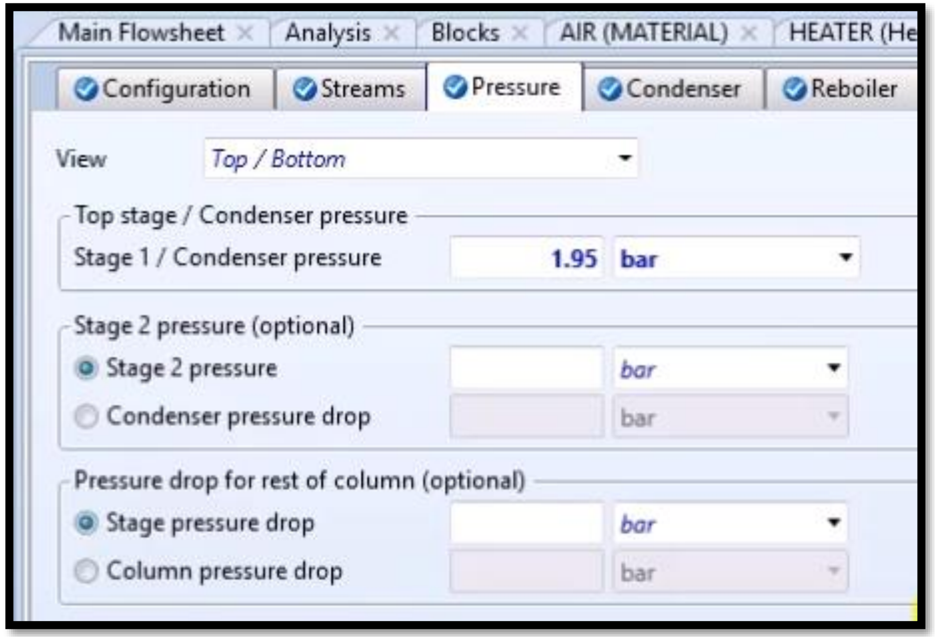

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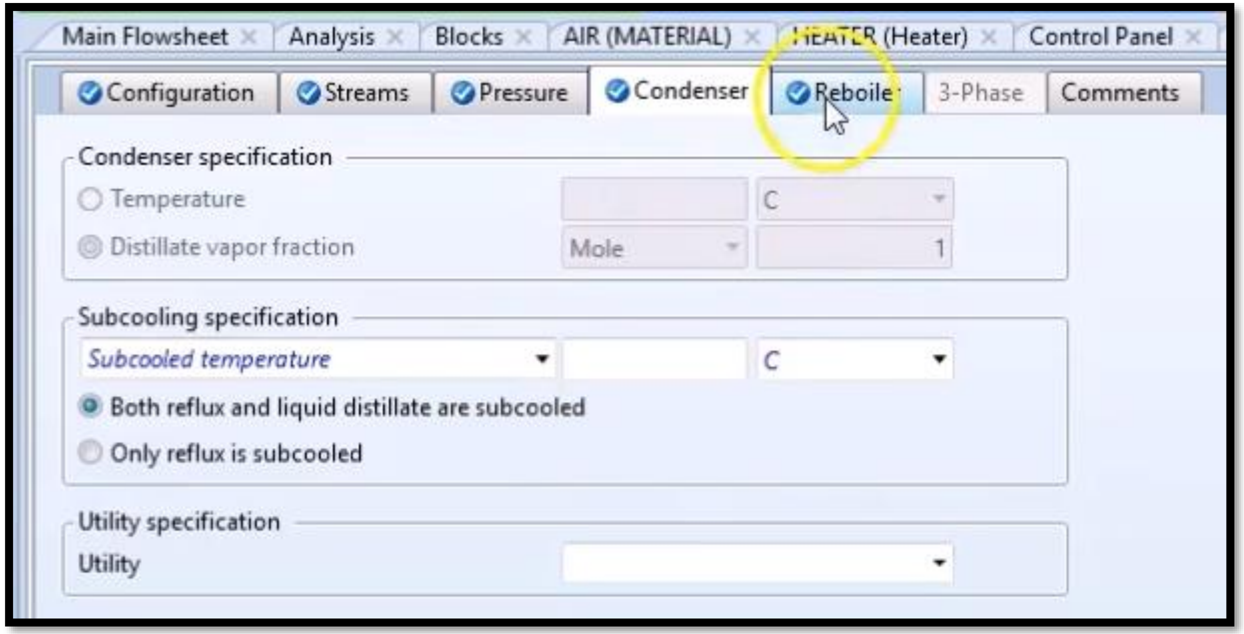

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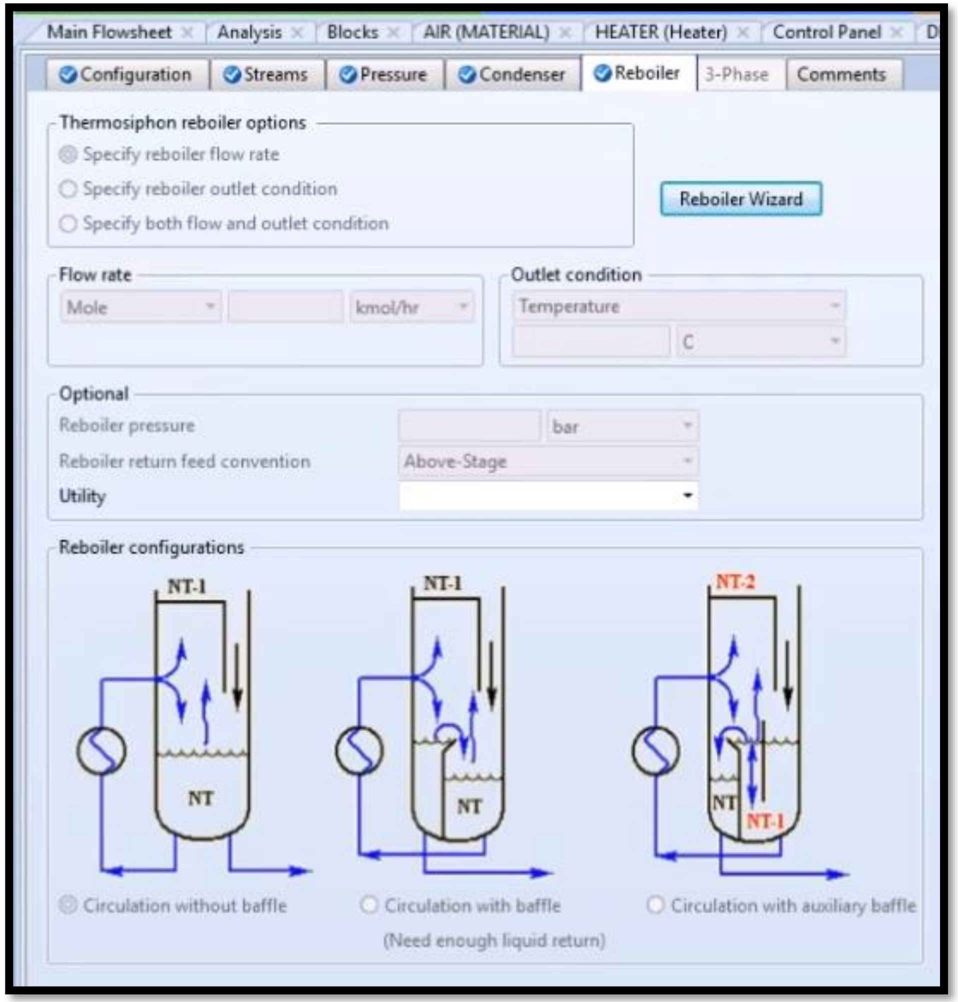
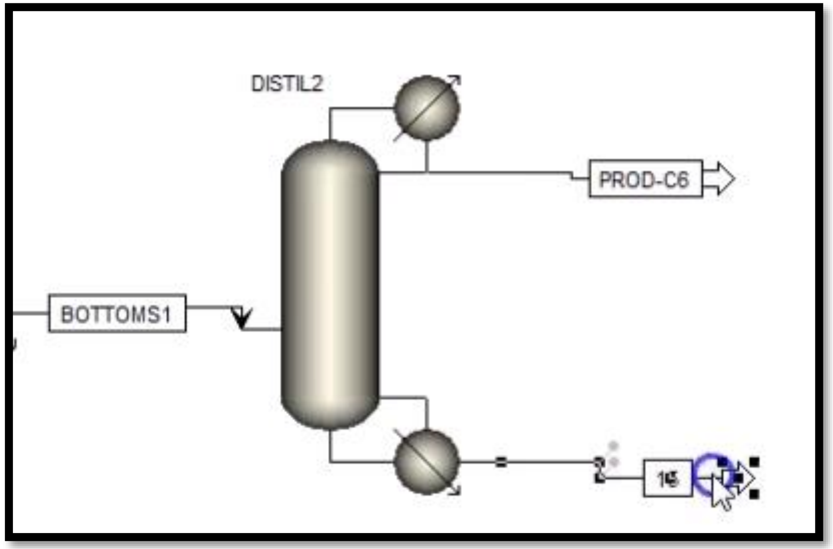
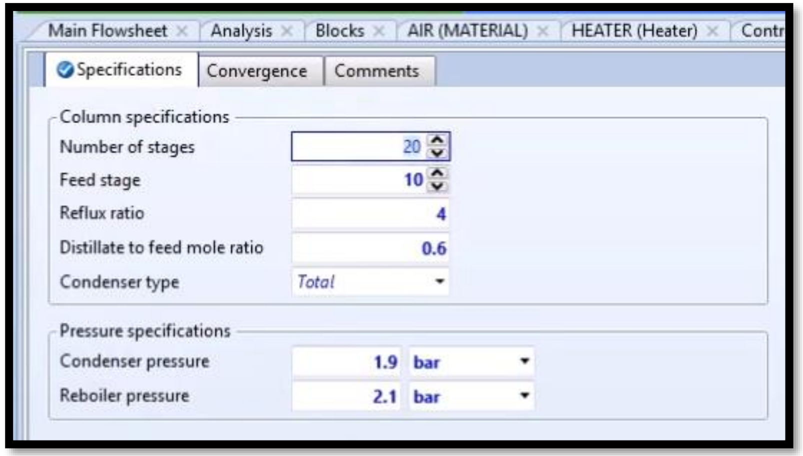


Blocks – Distillation Column 2

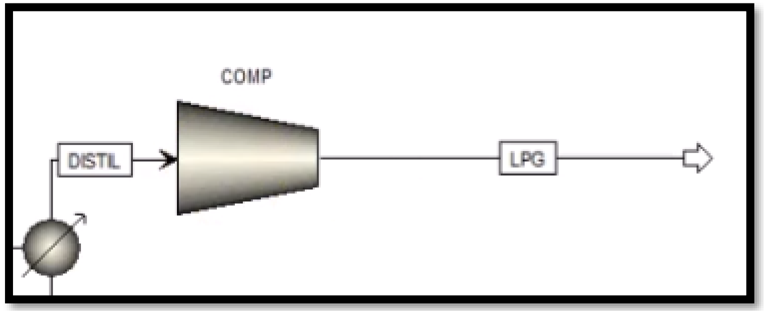
- Distil
  - Stages = 20
  - Feed = 10
  - Cond = Total
  - D:F Ratio = 0.60
  - Reflux = 4 molar
  - P-cond = 1.90 bar
  - P-reboiler = 2.10 bar

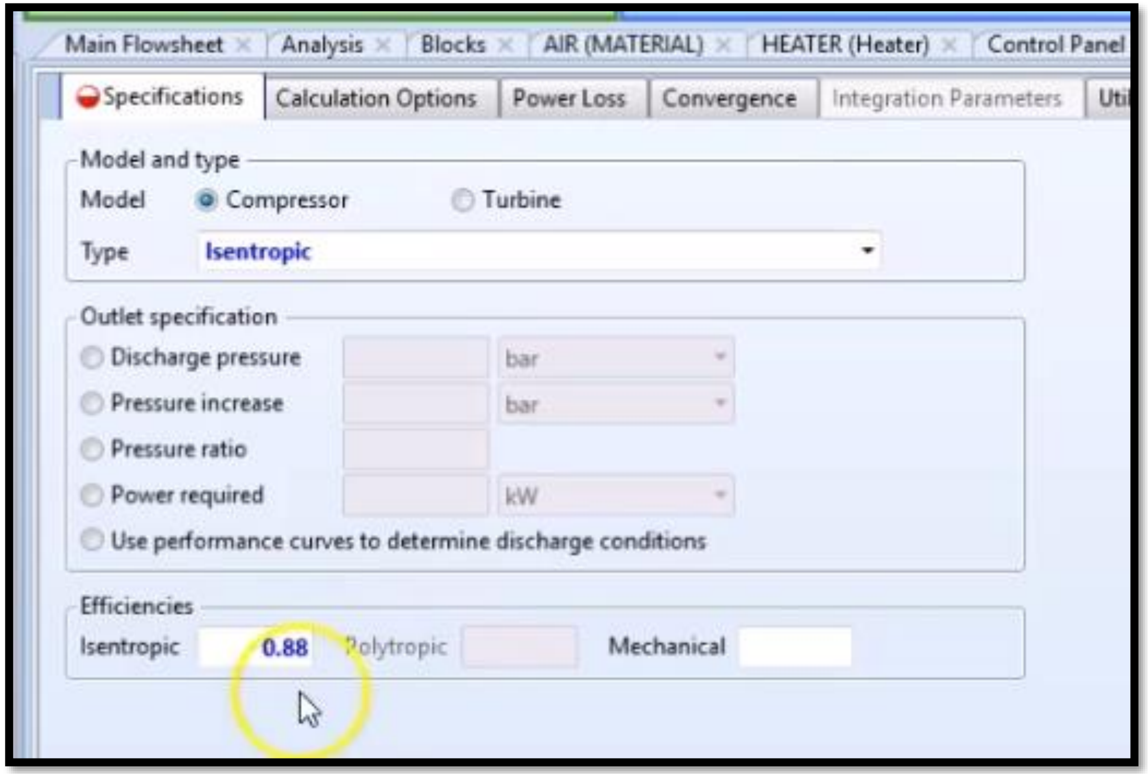




Blocks – Compressor

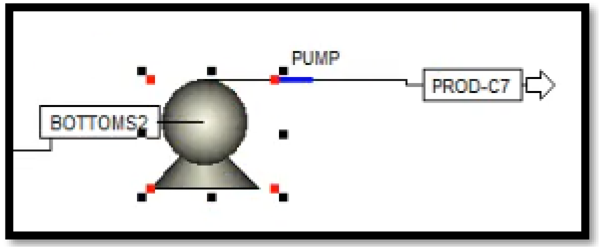
- Compr
  - Type = Isentropic
  - Eff = 88%
  - P-final = 5 bar

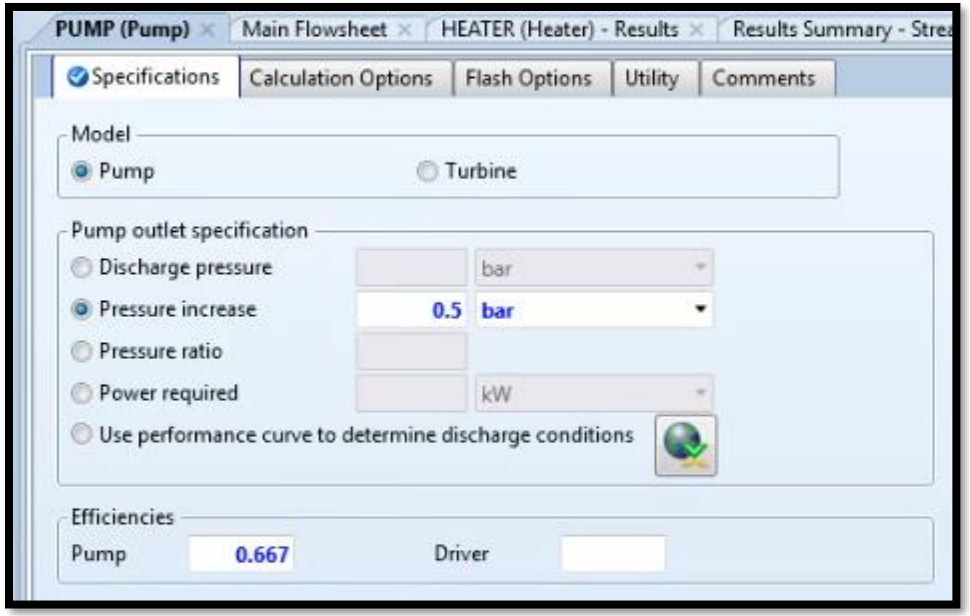




Blocks – Pump

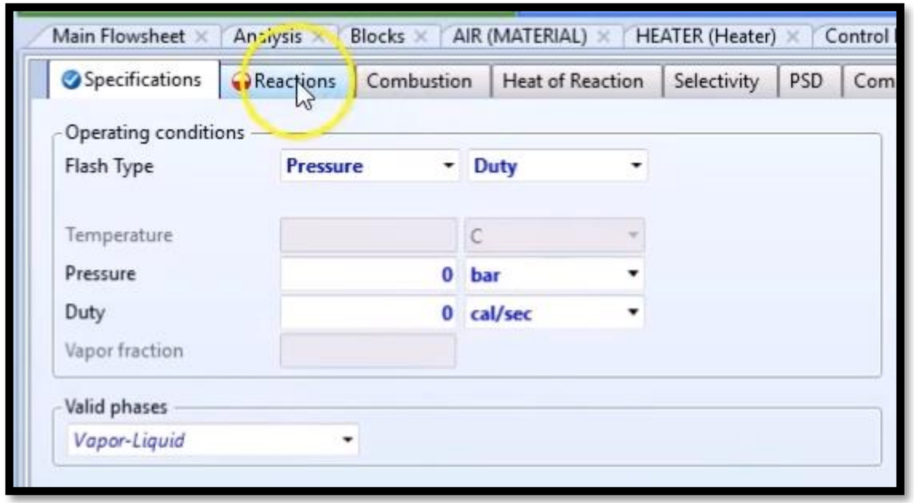
- Pump
  - Type = Isentropic
  - Eff = 66.7%
  - P-increse = 0.5 bar

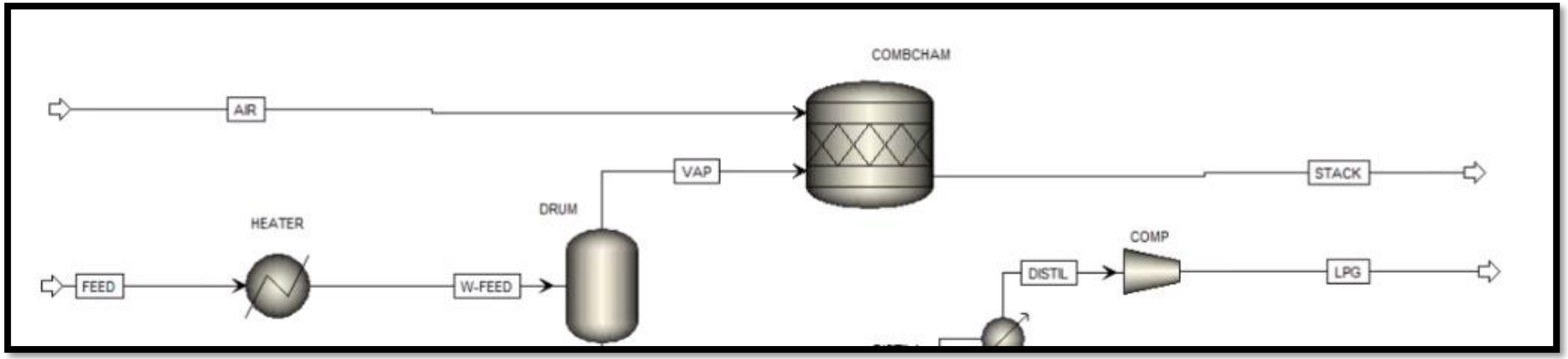




Blocks – Combustion Chamber

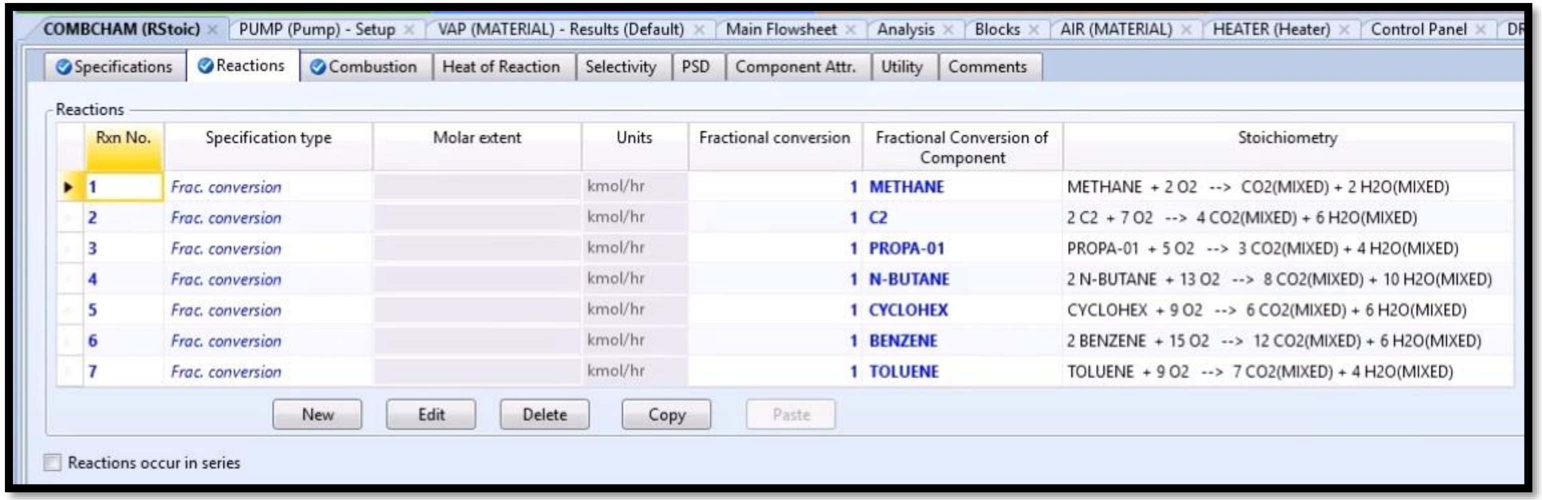
- RSTOIC
  - Type = Stoichiometry
  - Q = 0
  - P = 10 bar
  - dP = 0 bar





Blocks – Combustion Chamber

- RXN
  - $CH_4 + 2O_2 = CO_2 + 2H_2O$
  - $C_2H_6 + 7O_2 = 4CO_2 + 6H_2O$
  - $C_3H_8 + 5O_2 = 3CO_2 + 4H_2O$
  - $2C_4H_{10} + 13O_2 = 8CO_2 + 10H_2O$
  - $C_6H_{12} + 6O_2 = 3CO_2 + 6H_2O$
  - $2C_6H_6 + 15O_2 = 12CO_2 + 6H_2O$
  - $C_7H_8 + 9O_2 = 7CO_2 + 4H_2O$



Rxn No.	Specification type	Molar extent	Units	Fractional conversion	Fractional Conversion of Component	Stoichiometry
1	Frac. conversion		kmol/hr	1	METHANE	METHANE + 2 O2 --> CO2(MIXED) + 2 H2O(MIXED)
2	Frac. conversion		kmol/hr	1	C2	2 C2 + 7 O2 --> 4 CO2(MIXED) + 6 H2O(MIXED)
3	Frac. conversion		kmol/hr	1	PROPA-01	PROPA-01 + 5 O2 --> 3 CO2(MIXED) + 4 H2O(MIXED)
4	Frac. conversion		kmol/hr	1	N-BUTANE	2 N-BUTANE + 13 O2 --> 8 CO2(MIXED) + 10 H2O(MIXED)
5	Frac. conversion		kmol/hr	1	CYCLOHEX	CYCLOHEX + 9 O2 --> 6 CO2(MIXED) + 6 H2O(MIXED)
6	Frac. conversion		kmol/hr	1	BENZENE	2 BENZENE + 15 O2 --> 12 CO2(MIXED) + 6 H2O(MIXED)
7	Frac. conversion		kmol/hr	1	TOLUENE	TOLUENE + 9 O2 --> 7 CO2(MIXED) + 4 H2O(MIXED)

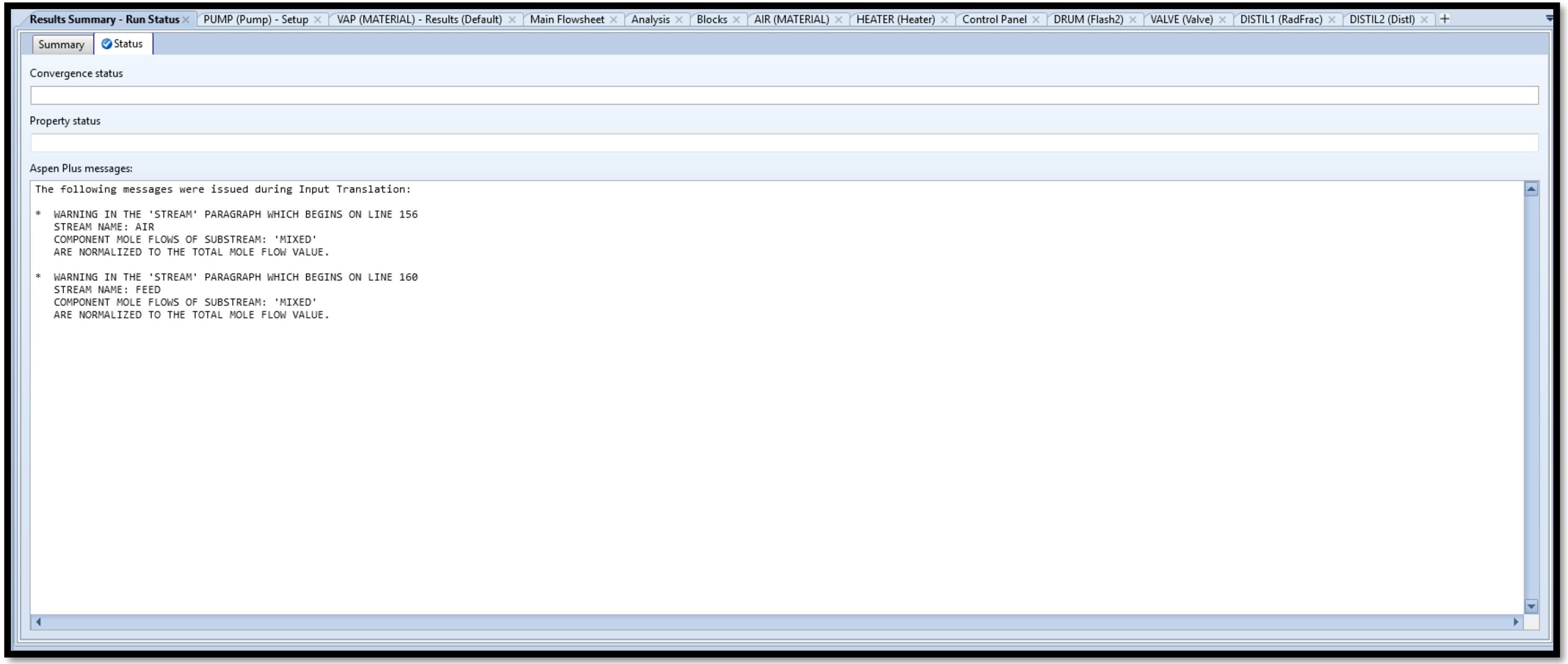
Save File!

Running, Results & Analysis

- Running the simulation
  - Errors & Debugging
- Getting Results
  - Stream Results
  - Block Results
- Analysis
  - What if Scenarios

Running the Simulation

- Error Messages



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Getting Stream Results

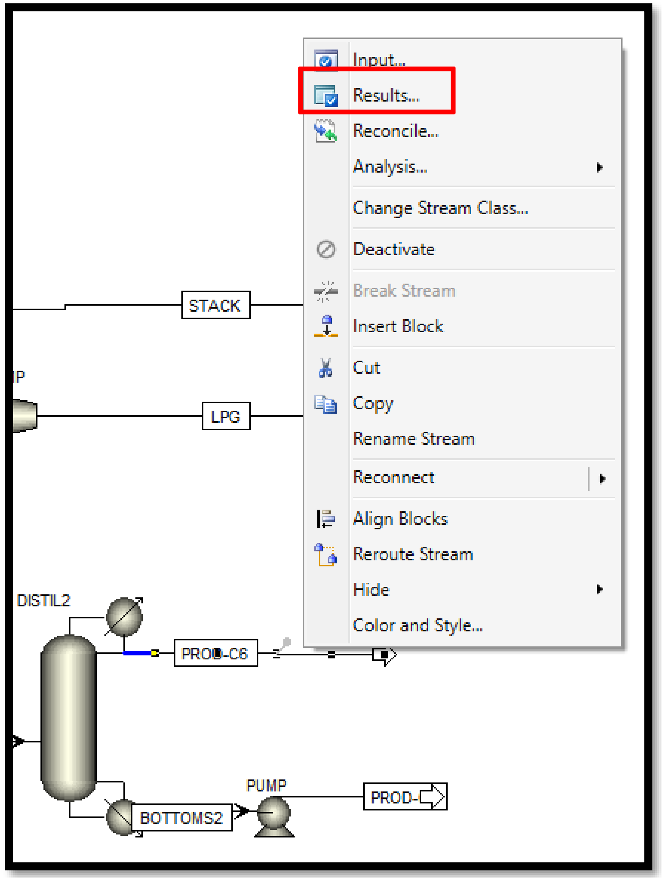
Results Summary - Streams (All) | DISTIL1 (RadFrac) - Results | PROD-C6 (MATERIAL) - Results (Default) | Results Summary - Run Status | PUMP (Pump) - Setup | VAP (MATERIAL) - Results (Default) | Main Flowsheet | Analysis | Blocks | AIR (MA… L) | …TER (Heater)

Material | Heat | Load | Work | Vol.% Curves | Wt. % Curves | Petroleum | Polymers | Solids

Sum: 10153.5

	Units	BOTTOMS1	BOTTOMS2	COLFEED	DISTIL	FEED	LIQ	LPG	PROD-C6	PROD-C7	STACK	VAP	W-FEED
Molar Density	mol/cc	0.00887379	0.00816443	0.000651575	8.15994e-05	0.0015948	0.0101947	0.000193645	0.00934497	0.00816398	9.22889e-05	0.000408329	0.00122446
Mass Density	gm/cc	0.753306	0.74826	0.0483167	0.00388533	0.0956828	0.755973	0.00922034	0.751204	0.748219	0.00263436	0.0113674	0.0734636
Enthalpy Flow	cal/sec	4918.25	37762.7	-188442	-135027	-378537	-188442	-131514	-30424	37774.7	-113942	-166711	-355152
Average MW		84.8911	91.6487	74.1537	47.6147	59.9968	74.1537	47.6147	80.3859	91.6487	28.5447	27.8388	59.9968
+ Mole Flows	**kmol/hr**	**49.4333**	**19.7733**	**69.4333**	**20**	**100**	**69.4333**	**20**	**29.66**	**19.7733**	**1242.66**	**30.5667**	**100**
− Mole Fractions													
METHANE		7.64126e-22	0	0.0142686	0.0495358	0.15	0.0142686	0.0495358	0	0	0	0.458318	0.15
C2		6.79459e-16	0	0.0662011	0.229828	0.155	0.0662011	0.229828	0	0	0	0.35671	0.155
PROPA-01		2.01073e-12	0	0.062759	0.217878	0.075	0.062759	0.217878	3.35121e-12	0	0	0.102806	0.075
N-BUTANE		1.24588e-08	0	0.130493	0.453029	0.11	0.130493	0.453029	2.07647e-08	0	0	0.063449	0.11
CYCLOHEX		0.233528	0.0234228	0.170325	0.0141078	0.12	0.170325	0.0141078	0.373598	0.0234228	0	0.00568554	0.12
BENZENE		0.383983	0.0217369	0.283637	0.0356162	0.2	0.283637	0.0356162	0.625481	0.0217369	0	0.0100147	0.2
TOLUENE		0.382489	0.95484	0.272316	5.45676e-06	0.19	0.272316	5.45676e-06	0.000921004	0.95484	0	0.00301676	0.19
O2		0	0	0	0	0	0	0	0	0	0.122971	0	0
N2		0	0	0	0	0	0	0	0	0	0.762878	0	0
CO2		0	0	0	0	0	0	0	0	0	0.0454879	0	0
H2O		0	0	0	0	0	0	0	0	0	0.0686636	0	0
+ Mass Flows	**kg/hr**	**4196.44**	**1812.2**	**5148.74**	**952.294**	**5999.68**	**5148.74**	**952.294**	**2384.25**	**1812.2**	**35471.4**	**850.941**	**5999.68**
+ Mass Fractions													
Volume Flow	l/min	92.8451	40.3647	1776.04	4085	1045.06	113.512	1721.36	52.8983	40.367	224415	1247.63	1361.15
+ Vapor Phase													
+ Liquid Phase													
<add properties>													

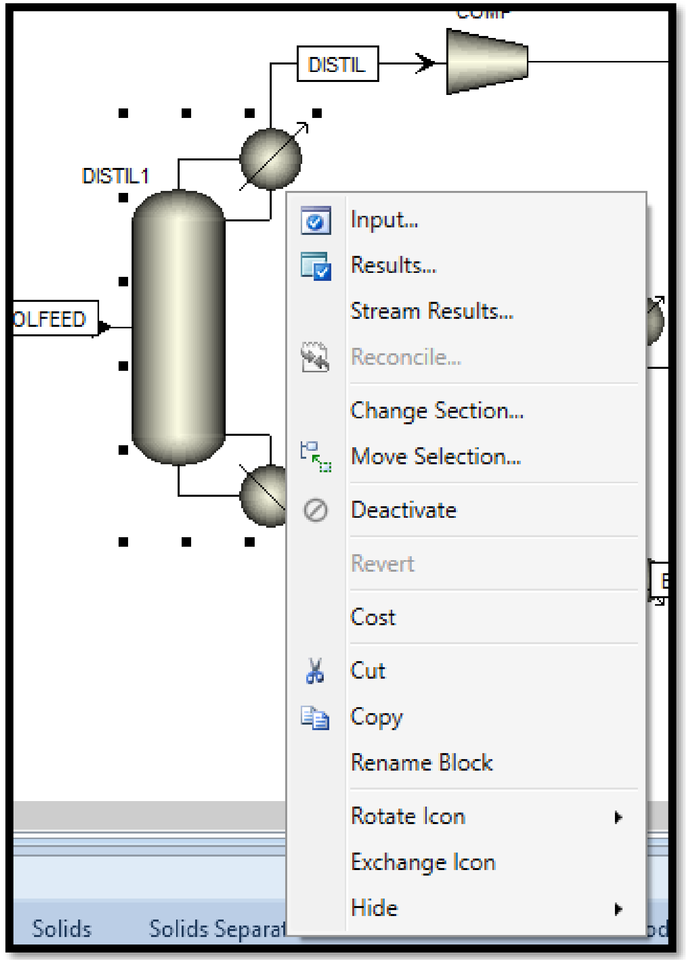
Getting Stream Results

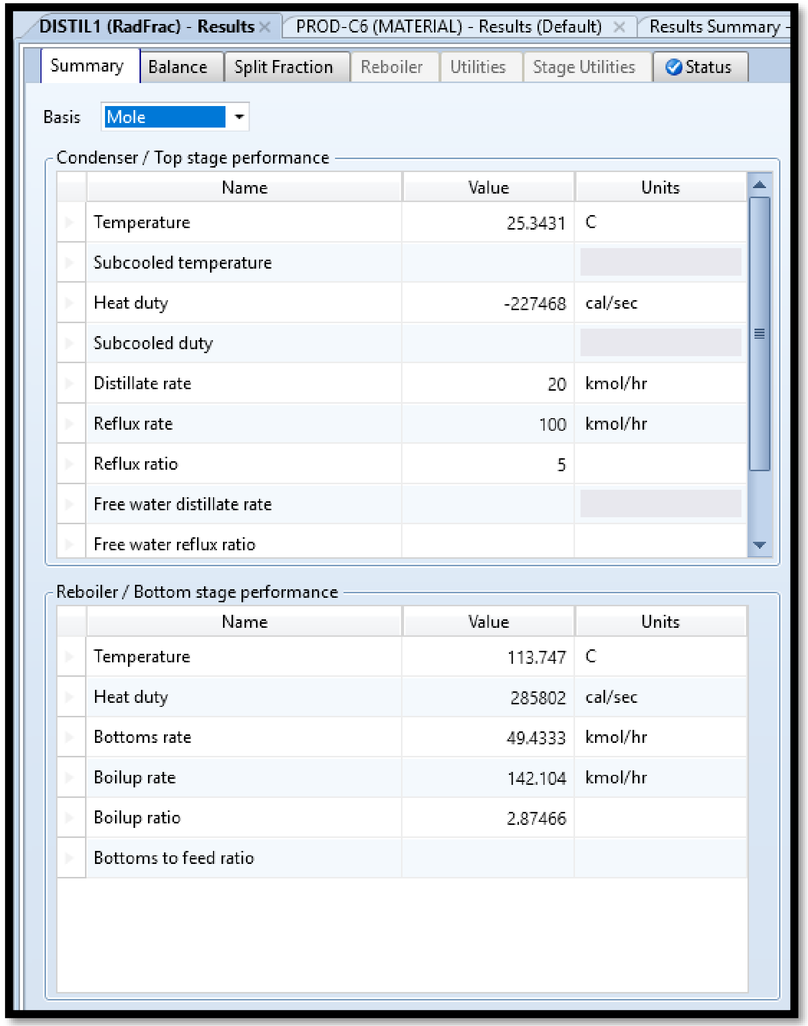


	Units	PROD-C6
− MIXED Substream		
Phase		Liquid Phase
Temperature	C	102.643
Pressure	bar	1.9
Molar Vapor Fraction		0
Molar Liquid Fraction		1
Molar Solid Fraction		0
Mass Vapor Fraction		0
Mass Liquid Fraction		1
Mass Solid Fraction		0
Molar Enthalpy	cal/mol	-3692.74
Mass Enthalpy	cal/gm	-45.9376
Molar Entropy	cal/mol-K	-82.6706
Mass Entropy	cal/gm-K	-1.02842
Molar Density	mol/cc	0.00934497
Mass Density	gm/cc	0.751204
Enthalpy Flow	cal/sec	-30424
Average MW		80.3859
− Mole Flows	**kmol/hr**	**29.66**
METHANE	kmol/hr	0
C2	kmol/hr	0
PROPA-01	kmol/hr	9.93969e-11
N-BUTANE	kmol/hr	6.1588e-07
CYCLOHEX	kmol/hr	11.0809

	Units	PROD-C6
− Mole Flows	**kmol/hr**	**29.66**
METHANE	kmol/hr	0
C2	kmol/hr	0
PROPA-01	kmol/hr	9.93969e-11
N-BUTANE	kmol/hr	6.1588e-07
CYCLOHEX	kmol/hr	11.0809
BENZENE	kmol/hr	18.5517
TOLUENE	kmol/hr	0.0273169
O2	kmol/hr	0
N2	kmol/hr	0
CO2	kmol/hr	0
H2O	kmol/hr	0
− Mole Fractions		
METHANE		0
C2		0
PROPA-01		3.35121e-12
N-BUTANE		2.07647e-08
CYCLOHEX		0.373598
BENZENE		0.625481
TOLUENE		0.000921004
O2		0
N2		0
CO2		0
H2O		0

Getting Block Results





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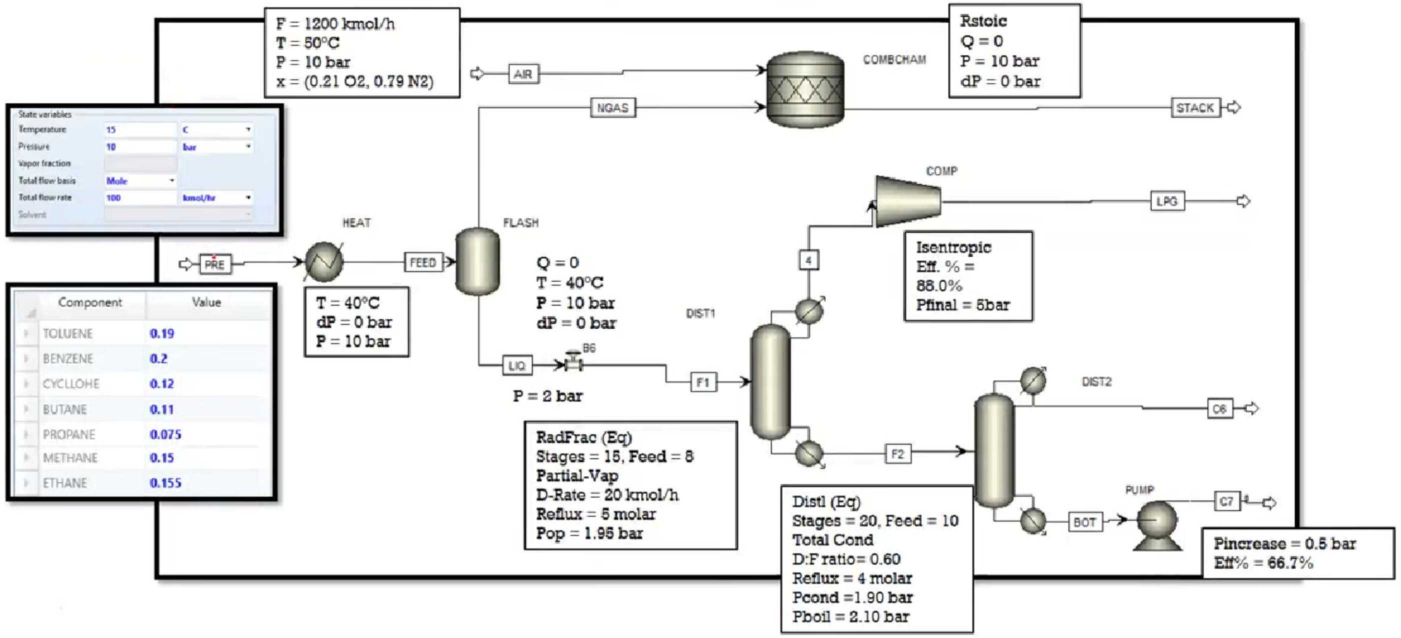
Analysis

- Manual "what if" cases
  - Change several inputs to get new outputs
    - Change of T Heat
    - Change of P valve
    - Change of P Reactor
    - Changer of Reflux Dist1
    - Change of Stages Dist2



My results

- Compare your results with mine:

	Units	STACK	LPG	PROD-C6	PROD-C7
− Mole Flows	**kmol/hr**	**1242.66**	**20**	**29.66**	**19.7733**
METHANE	kmol/hr	0	0.990716	0	0
C2	kmol/hr	0	4.59656	0	0
PROPA-01	kmol/hr	0	4.35757	9.93969e-11	0
N-BUTANE	kmol/hr	0	9.06057	6.1588e-07	0
CYCLOHEX	kmol/hr	0	0.282155	11.0809	0.463146
BENZENE	kmol/hr	0	0.712325	18.5517	0.42981
TOLUENE	kmol/hr	0	0.000109135	0.0273169	18.8804
O2	kmol/hr	152.811	0	0	0
N2	kmol/hr	948	0	0	0
CO2	kmol/hr	56.5261	0	0	0
H2O	kmol/hr	85.3257	0	0	0
− Mole Fractions					
METHANE		0	0.0495358	0	0
C2		0	0.229828	0	0
PROPA-01		0	0.217878	3.35121e-12	0
N-BUTANE		0	0.453029	2.07647e-08	0
CYCLOHEX		0	0.0141078	0.373598	0.0234228
BENZENE		0	0.0356162	0.625481	0.0217369
TOLUENE		0	5.45676e-06	0.000921004	0.95484
O2		0.122971	0	0	0
N2		0.762878	0	0	0
CO2		0.0454879	0	0	0
H2O		0.0686636	0	0	0

CASE A - Change of T Heat

- Change T = 40°C to T = 30°C of Heater

	Units	STACK	LPG	PROD-C6	PROD-C7
− Mole Flows	**kmol/hr**	**1242.66**	**20**	**29.66**	**19.7733**
METHANE	kmol/hr	0	0.990716	0	0
C2	kmol/hr	0	4.59656	0	0
PROPA-01	kmol/hr	0	4.35757	9.93969e-11	0
N-BUTANE	kmol/hr	0	9.06057	6.1588e-07	0
CYCLOHEX	kmol/hr	0	0.282155	11.0809	0.463146
BENZENE	kmol/hr	0	0.712325	18.5517	0.42981
TOLUENE	kmol/hr	0	0.000109135	0.0273169	18.8804
O2	kmol/hr	152.811	0	0	0
N2	kmol/hr	948	0	0	0
CO2	kmol/hr	56.5261	0	0	0
H2O	kmol/hr	85.3257	0	0	0
− Mole Fractions					
METHANE		0	0.0495358	0	0
C2		0	0.229828	0	0
PROPA-01		0	0.217878	3.35121e-12	0
N-BUTANE		0	0.453029	2.07647e-08	0
CYCLOHEX		0	0.0141078	0.373598	0.0234228
BENZENE		0	0.0356162	0.625481	0.0217369
TOLUENE		0	5.45676e-06	0.000921004	0.95484
O2		0.122971	0	0	0
N2		0.762878	0	0	0
CO2		0.0454879	0	0	0
H2O		0.0686636	0	0	0

	Units	STACK	LPG	PROD-C6	PROD-C7
− Mole Flows	**kmol/hr**	**1238.26**	**20**	**31.0797**	**20.7198**
METHANE	kmol/hr	0	1.15624	0	0
C2	kmol/hr	0	5.47187	1.00933e-10	0
PROPA-01	kmol/hr	0	4.92073	3.38701e-06	0
N-BUTANE	kmol/hr	0	8.45116	1.1446	5.72647e-12
CYCLOHEX	kmol/hr	0	3.8388e-10	10.985	0.909186
BENZENE	kmol/hr	0	3.52203e-09	18.9357	0.877564
TOLUENE	kmol/hr	0	5.43581e-14	0.0144238	18.933
O2	kmol/hr	164.364	0	0	0
N2	kmol/hr	948	0	0	0
CO2	kmol/hr	49.3783	0	0	0
H2O	kmol/hr	76.5157	0	0	0
− Mole Fractions					
METHANE		0	0.0578118	0	0
C2		0	0.273593	3.24757e-12	0
PROPA-01		0	0.246037	1.08978e-07	0
N-BUTANE		0	0.422558	0.0368278	2.76377e-13
CYCLOHEX		0	1.9194e-11	0.353447	0.0438801
BENZENE		0	1.76102e-10	0.609262	0.0423539
TOLUENE		0	2.71791e-15	0.000464093	0.913765
O2		0.132738	0	0	0
N2		0.765592	0	0	0
CO2		0.0398773	0	0	0
H2O		0.061793	0	0	0

CASE B - Change of P valve

- Change Pressure of Valve
  - P = 1 bar
  - P = 5 bar

	Units	STACK	LPG	PROD-C6	PROD-C7
− Mole Flows	**kmol/hr**	**1242.66**	**20**	**29.66**	**19.7733**
METHANE	kmol/hr	0	0.990716	0	0
C2	kmol/hr	0	4.59656	0	0
PROPA-01	kmol/hr	0	4.35757	9.93969e-11	0
N-BUTANE	kmol/hr	0	9.06057	6.1588e-07	0
CYCLOHEX	kmol/hr	0	0.282155	11.0809	0.463146
BENZENE	kmol/hr	0	0.712325	18.5517	0.42981
TOLUENE	kmol/hr	0	0.000109135	0.0273169	18.8804
O2	kmol/hr	152.811	0	0	0
N2	kmol/hr	948	0	0	0
CO2	kmol/hr	56.5261	0	0	0
H2O	kmol/hr	85.3257	0	0	0
− Mole Fractions					
METHANE		0	0.0495358	0	0
C2		0	0.229828	0	0
PROPA-01		0	0.217878	3.35121e-12	0
N-BUTANE		0	0.453029	2.07647e-08	0
CYCLOHEX		0	0.0141078	0.373598	0.0234228
BENZENE		0	0.0356162	0.625481	0.0217369
TOLUENE		0	5.45676e-06	0.000921004	0.95484
O2		0.122971	0	0	0
N2		0.762878	0	0	0
CO2		0.0454879	0	0	0
H2O		0.0686636	0	0	0

No Drastic Change

CASE C - Change of P Reactor

- Change Pressure of Reactor
  - P = -5bar
  - P = 1bar

	Units	STACK	LPG	PROD-C6	PROD-C7
− Mole Flows	**kmol/hr**	**1242.66**	**20**	**29.66**	**19.7733**
METHANE	kmol/hr	0	0.990716	0	0
C2	kmol/hr	0	4.59656	0	0
PROPA-01	kmol/hr	0	4.35757	9.93969e-11	0
N-BUTANE	kmol/hr	0	9.06057	6.1588e-07	0
CYCLOHEX	kmol/hr	0	0.282155	11.0809	0.463146
BENZENE	kmol/hr	0	0.712325	18.5517	0.42981
TOLUENE	kmol/hr	0	0.000109135	0.0273169	18.8804
O2	kmol/hr	152.811	0	0	0
N2	kmol/hr	948	0	0	0
CO2	kmol/hr	56.5261	0	0	0
H2O	kmol/hr	85.3257	0	0	0
− Mole Fractions					
METHANE		0	0.0495358	0	0
C2		0	0.229828	0	0
PROPA-01		0	0.217878	3.35121e-12	0
N-BUTANE		0	0.453029	2.07647e-08	0
CYCLOHEX		0	0.0141078	0.373598	0.0234228
BENZENE		0	0.0356162	0.625481	0.0217369
TOLUENE		0	5.45676e-06	0.000921004	0.95484
O2		0.122971	0	0	0
N2		0.762878	0	0	0
CO2		0.0454879	0	0	0
H2O		0.0686636	0	0	0

CASE D - Change of Reflux Dist2

- Change Reflux Ratio from 4 to 2 and/or 6 and/or 15

	Units	STACK	LPG	PROD-C6	PROD-C7
− Mole Flows	**kmol/hr**	**1242.66**	**20**	**29.66**	**19.7733**
METHANE	kmol/hr	0	0.990716	0	0
C2	kmol/hr	0	4.59656	0	0
PROPA-01	kmol/hr	0	4.35757	9.93969e-11	0
N-BUTANE	kmol/hr	0	9.06057	6.1588e-07	0
CYCLOHEX	kmol/hr	0	0.282155	11.0809	0.463146
BENZENE	kmol/hr	0	0.712325	18.5517	0.42981
TOLUENE	kmol/hr	0	0.000109135	0.0273169	18.8804
O2	kmol/hr	152.811	0	0	0
N2	kmol/hr	948	0	0	0
CO2	kmol/hr	56.5261	0	0	0
H2O	kmol/hr	85.3257	0	0	0
− Mole Fractions					
METHANE		0	0.0495358	0	0
C2		0	0.229828	0	0
PROPA-01		0	0.217878	3.35121e-12	0
N-BUTANE		0	0.453029	2.07647e-08	0
CYCLOHEX		0	0.0141078	0.373598	0.0234228
BENZENE		0	0.0356162	0.625481	0.0217369
TOLUENE		0	5.45676e-06	0.000921004	0.95484
O2		0.122971	0	0	0
N2		0.762878	0	0	0
CO2		0.0454879	0	0	0
H2O		0.0686636	0	0	0

Course Closure

1. Introduction
2. Our Chemical Process!
3. Setting up the Physical Property Environment
4. Simulation Environment I – The Flowsheet
5. Simulation Environment II – Unit Operations
6. Running, Results & Analysis
7. Case Studies
8. Conclusion

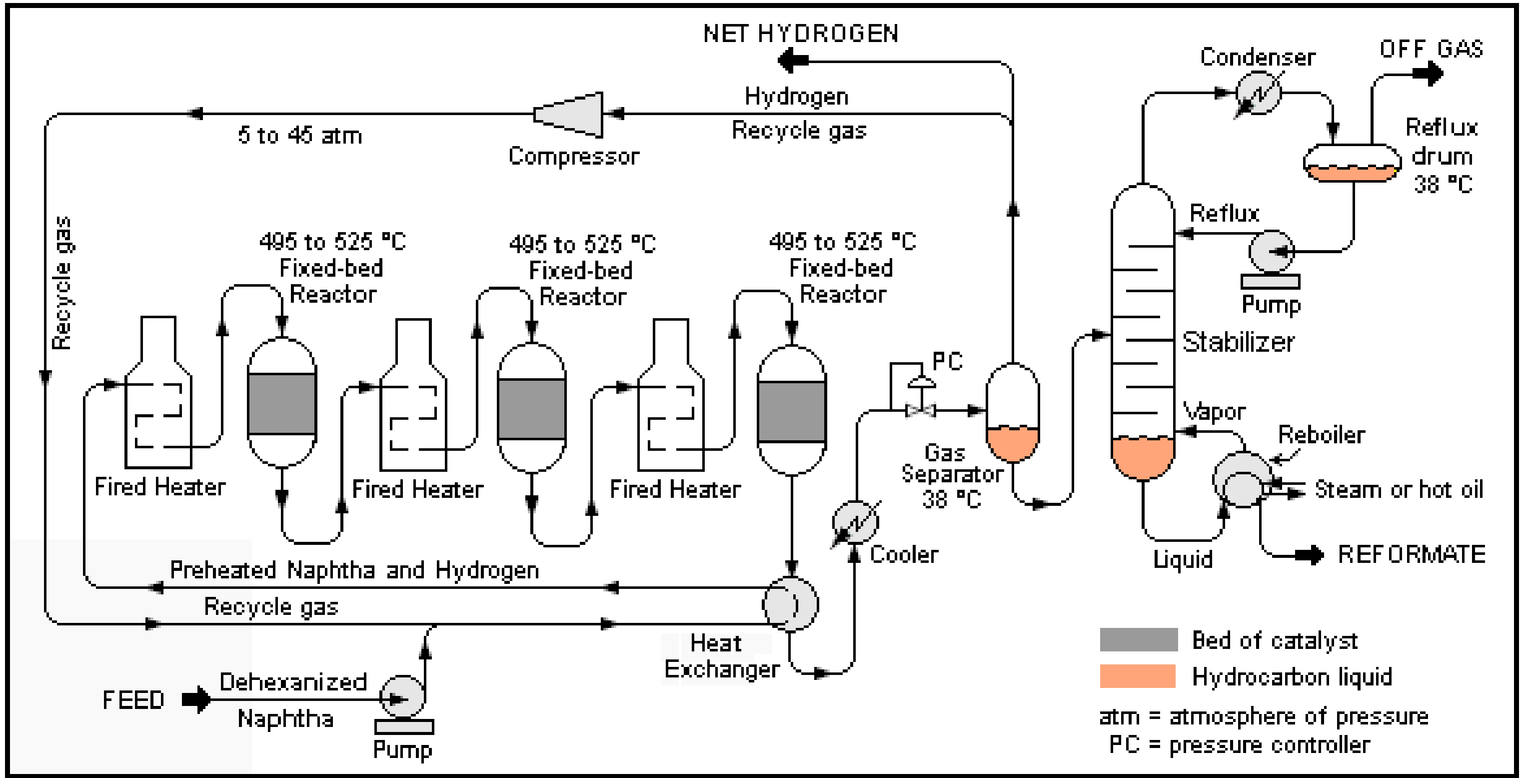
Course Closure

- **Introductory Knowledge of Processes Modeling**
  - General Flowsheet Concepts
  - Setting the adequate Physical Properties
  - Basic Flowsheet “manipulation”
  - Minimum Requirements to set up & run a Simulation
  - Common Unit Operations
  - Create an interest in Process Modeling

Solve this!

Change:

- All T of Reactors
- Feed Composition
- No. of Plates in Distl. Col
- T of Heat Ex
- Gas Sep. T
- Compressor P
- Utility Costs



Process flow diagram of a semi-regenerative catalytic reforming unit in an oil refinery

What's Next?

- Typically, you will follow your training with
  - **Basic Course**
- What do you learn there:
  - More on Aspen Plus
  - More on Physical Property Environment
  - Flowsheet techniques
  - More Unit Operations
  - Analysis Tools
  - Plenty Workshops
  - Process & Industry Case Studies

For my students!

- Aspen Plus – Basic Course!
  - 1 Month Free Trial then $8.00 USD/month

For my students!

- **Aspen Plus – Training Bundle** includes:
  - Aspen Plus – Getting Started
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