Ciências ULisboa

DWSIM SOFTWARE

Biorefineries, Bioenergy and Bioproducts

April 19, 2023

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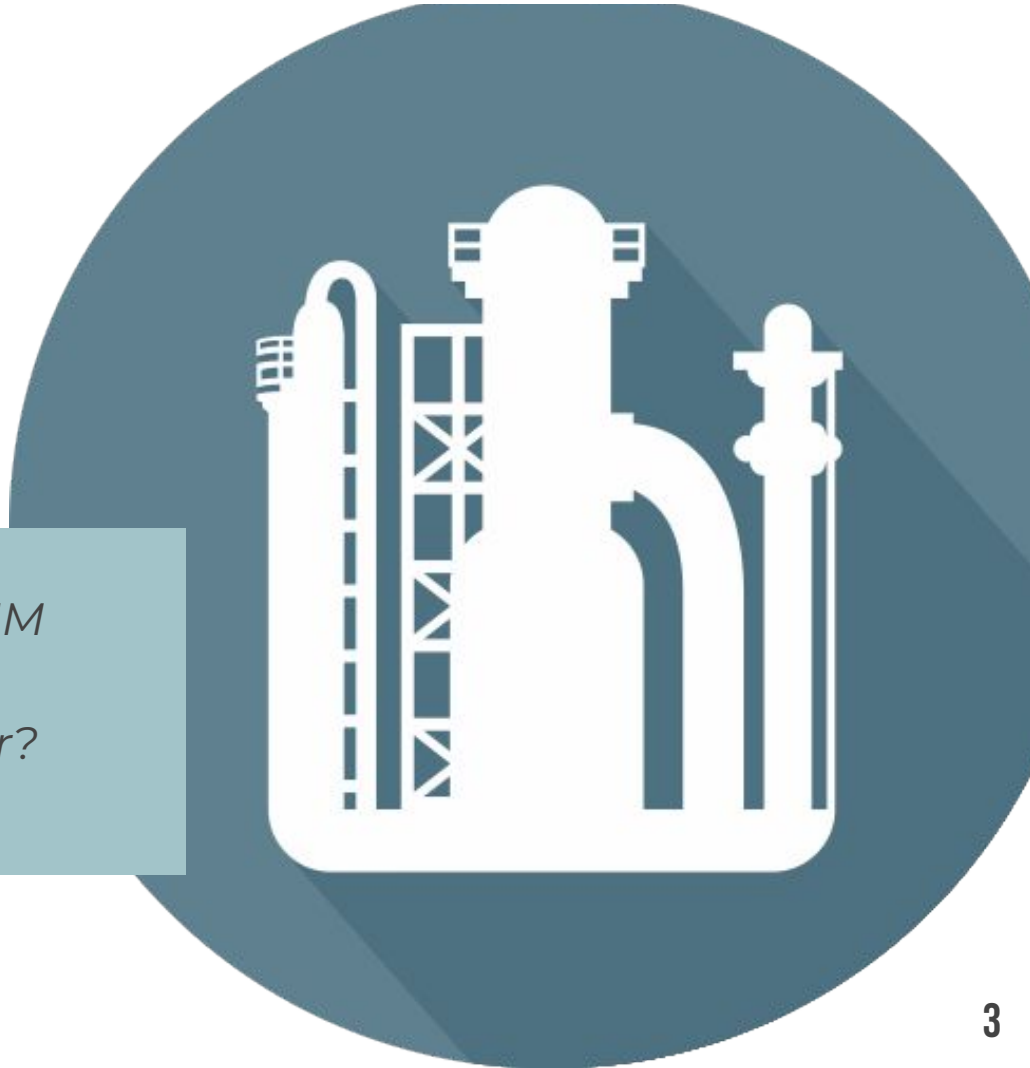
FIRST SECTION 01

- *What is the DWSIM software?*
- *What is it used for?*



DWSIM SIMULATOR

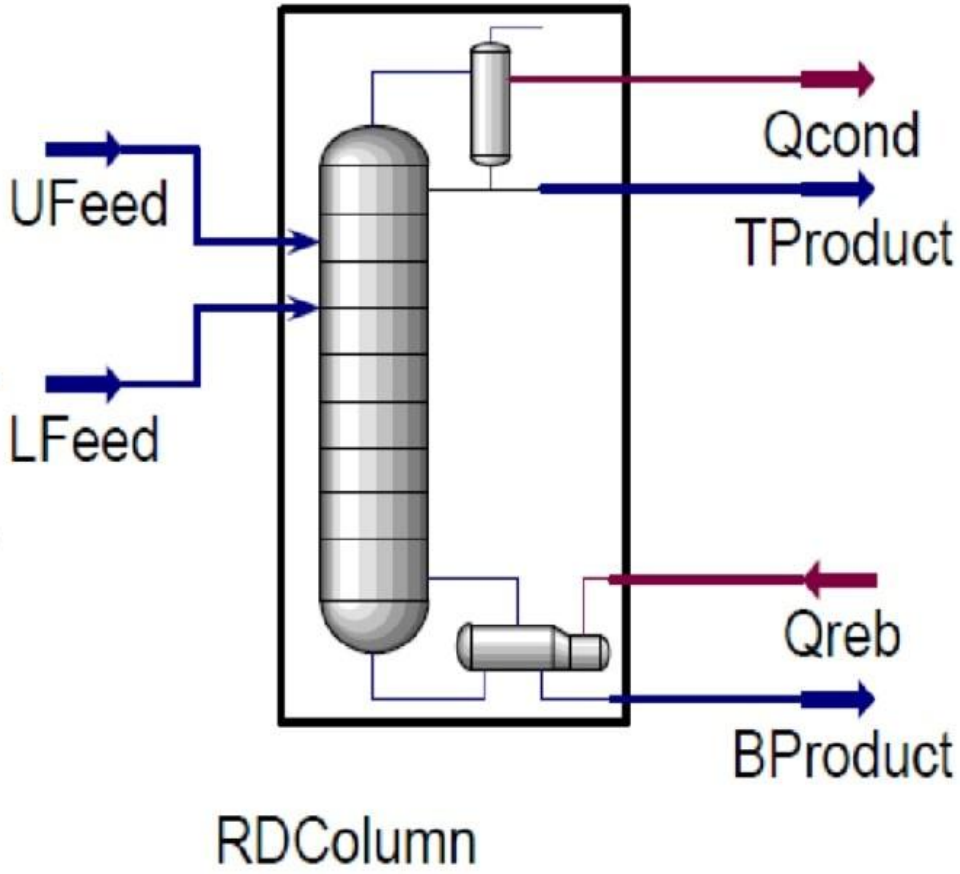
What is the DWSIM software?

- It's a free, open-source and CAPE-OPEN compliant chemical process simulator.
- It runs on all platforms, Windows, Linux, macOS, Android and iOS.

DWSIM SIMULATOR

What is DWSIM used for?

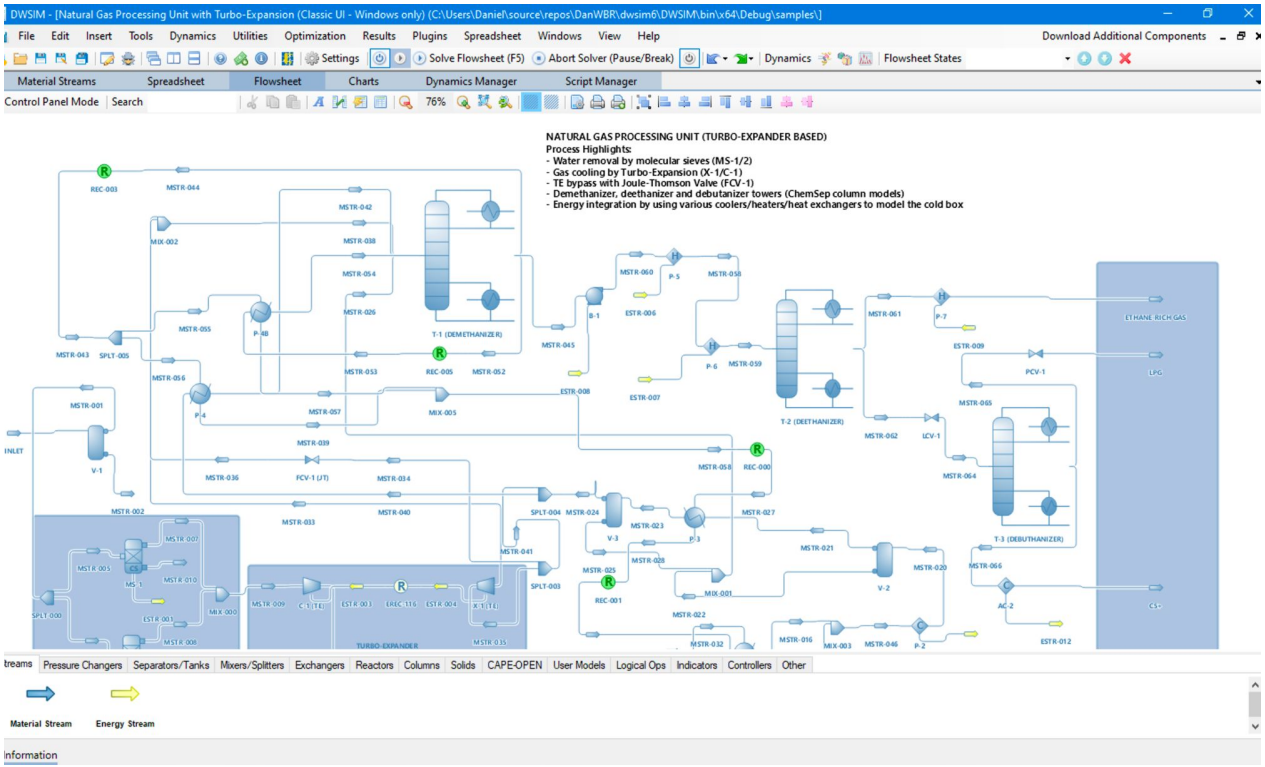
- The DWSIM simulator is used to model processes or the actual plant operation using rigorous thermodynamic and unit operations models.

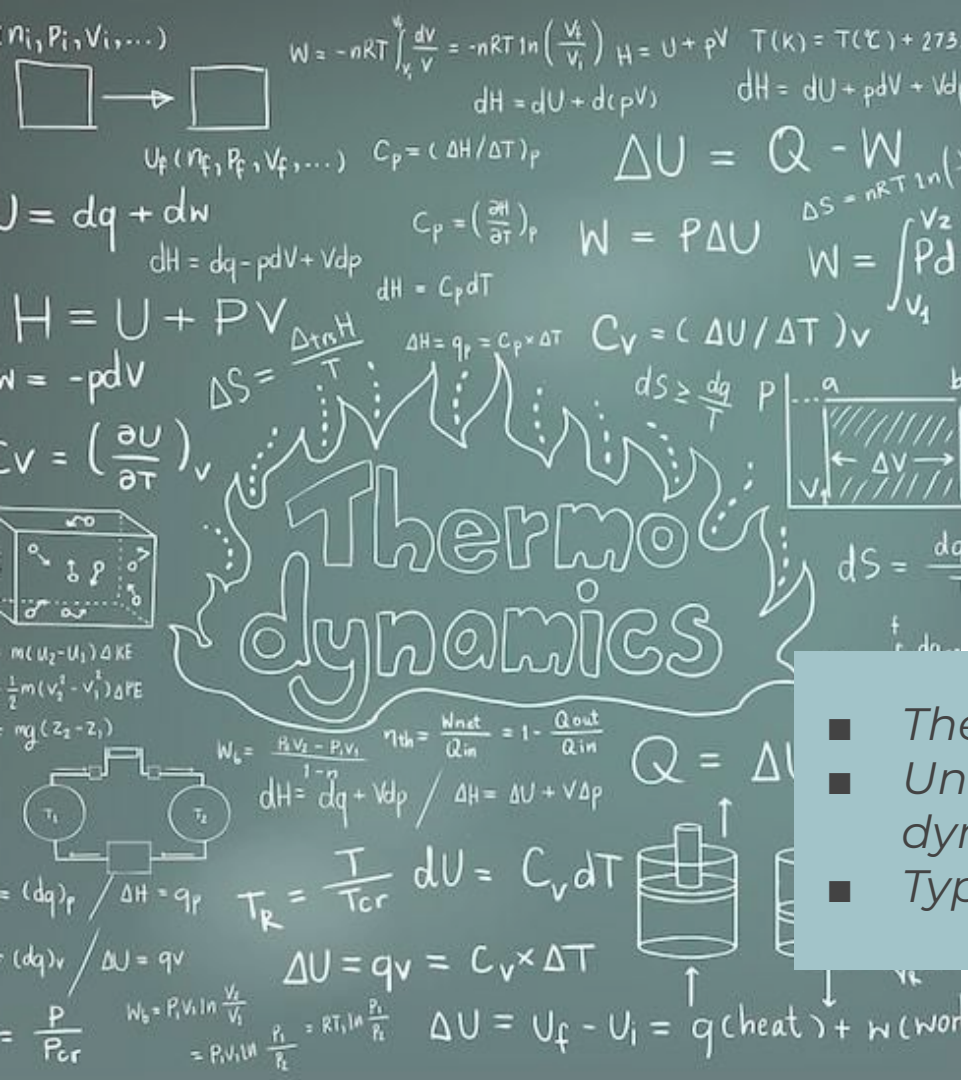


EXEMPLE FROM DWSIM

What else can DWSIM do?

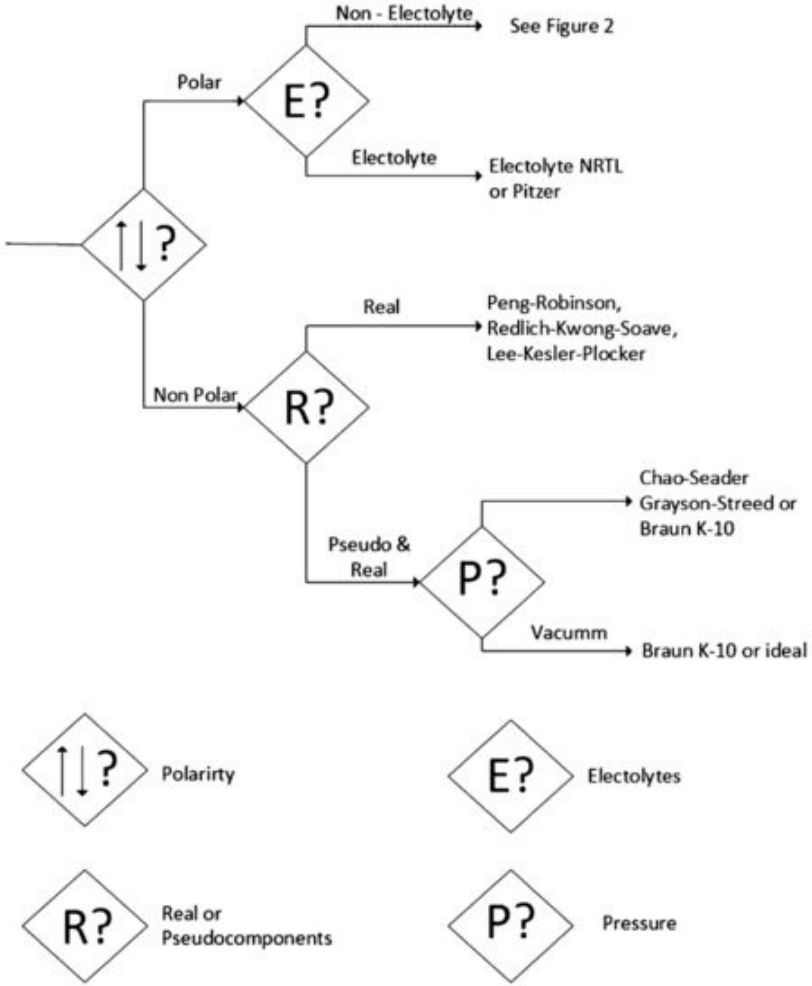
- Sensitivity Analysis.
- Mass and Energy balances.
- Spreadsheets and charts.
- And more.





02 SECOND SECTION

- *Thermodynamics models in DWSIM*
- *Unit operations in steady-state and dynamic state*
- *Types of reactors*

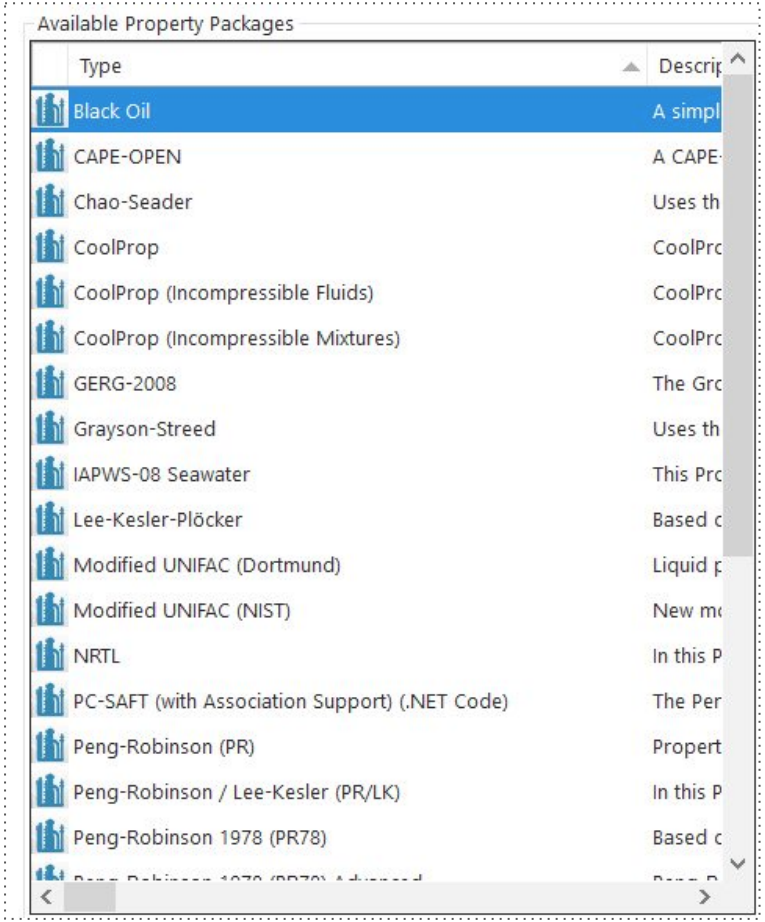


THE PROPERTY PACKAGES

- Property packages or thermodynamics models define the mathematical equations used in a simulation.
- The selection of the property package is one of the first steps necessary in simulations, as well as one of the most important.

SOME PROPERTY PACKAGES

Name	Description
Raoult's Law	Non-polar gases at low pressures (< 10 atm)
Peng-Robinson (PR)	Non-polar gases at high pressures (> 10 atm)
Soave-Redlich-Kwong	Non-polar gases at high pressures (> 10 atm)
Peng-Robinson (PRSV2)	Polar gases at high pressures (> 10 atm); Non-polar gases at high pressures (> 10 atm)
CoolProp	Air Separation / Refrigeration systems



UNIT OPERATIONS

Some types available in DWSIM:

- Mixers/Splitters - Stream mixer; Stream Splitter; Energy mixer.
- Pressure Changers - Orifice Plate; Compressor; Pipe segment; Pump; Expander (turbine); Valve.
- Separators/Tanks - Compound Separator; Tank; Gas-Liquid Separator.
- Exchangers - Cooler; Heater; Heat exchanger; Air cooler.
- Renewable Energies - Hydroelectric turbines; PEM fuel cell; Solar panel; Water electrolyzer; Wind turbine.

MAIN TYPES OF REACTORS

Reactors are specialized modules that solve a particular system of reactions of the same type in sequence or in parallel.

Conversion reactor

Mass and energy balances

Equilibrium reactor

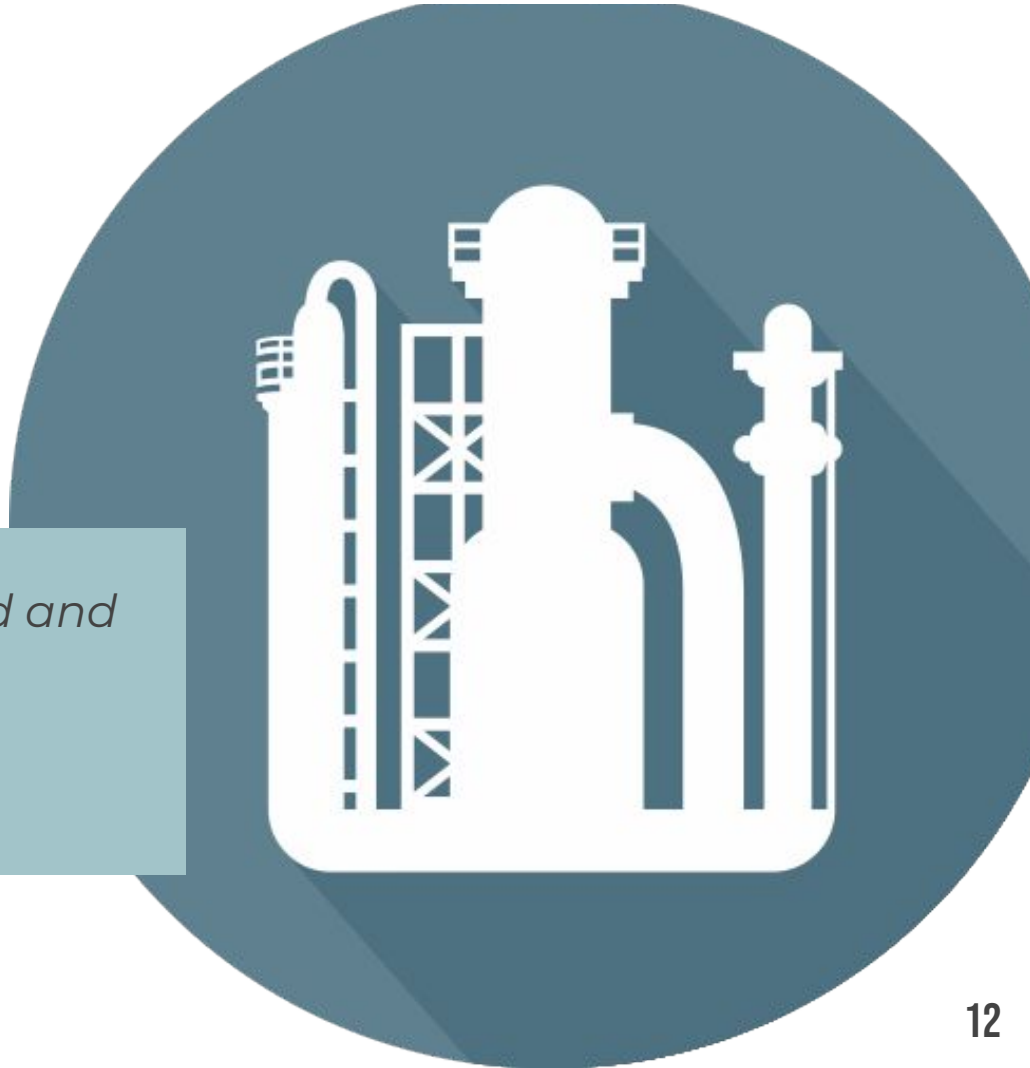
Equilibrium constant

Gibbs reactor

Multiphase Gibbs minimization problem

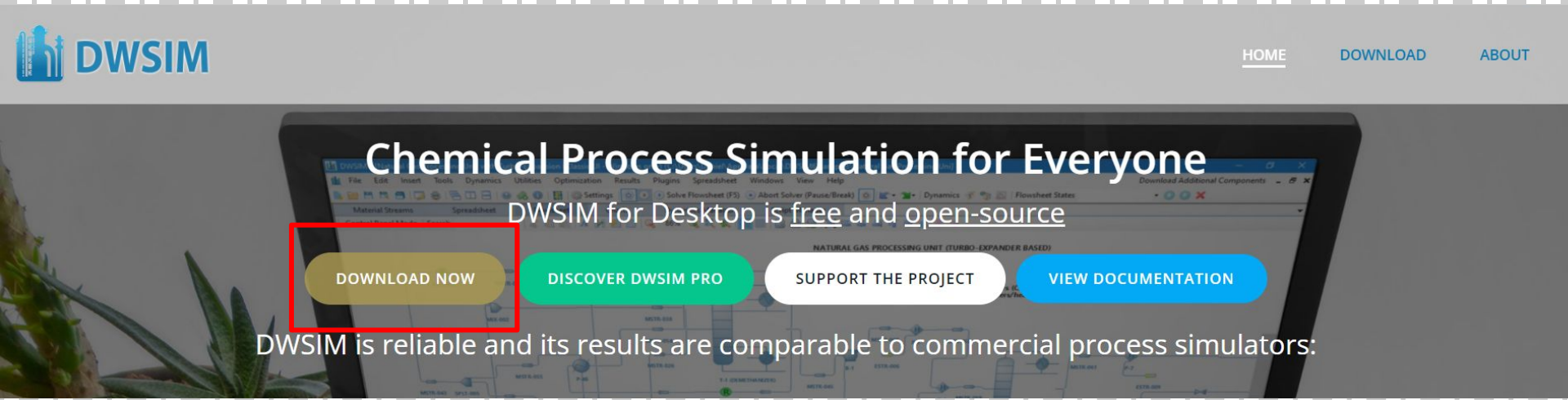
FIRST SECTION 03

- *How to download and install DWSIM simulator?*



DWSIM DOWNLOAD

https://dwsim.org/



WINDOWS (64-BIT)

Installer Package (207 MB)

DOWNLOAD

PYTHON ENVS ADD-ON

The Python Environments Add-on contains additional Python components for DWSIM. Extract the files to DWSIM's installation directory.

Portable Package (159 MB)

DOWNLOAD

Requires Microsoft .NET 4.6.2+ / Mono 6.8+

MACOS (64-BIT)

Disk Image File (152 MB)

DOWNLOAD

LINUX (32/64-BIT)

64-bit Debian Installer Package (162 MB)

DOWNLOAD

32-bit 7z-compressed Wine Package (383 MB)

DOWNLOAD

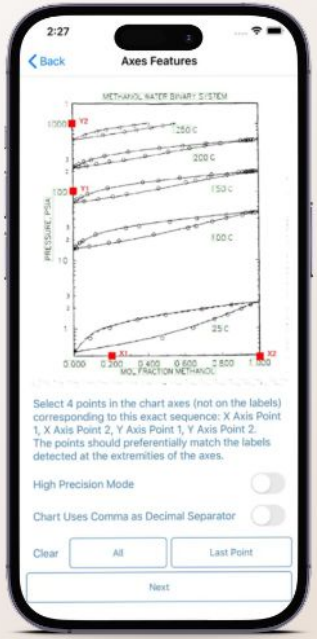
GeoTracker Pro

Record your position, speed, altitude and many more while you're on the move. Analyze and export the recorded data with this easy-to-use app.

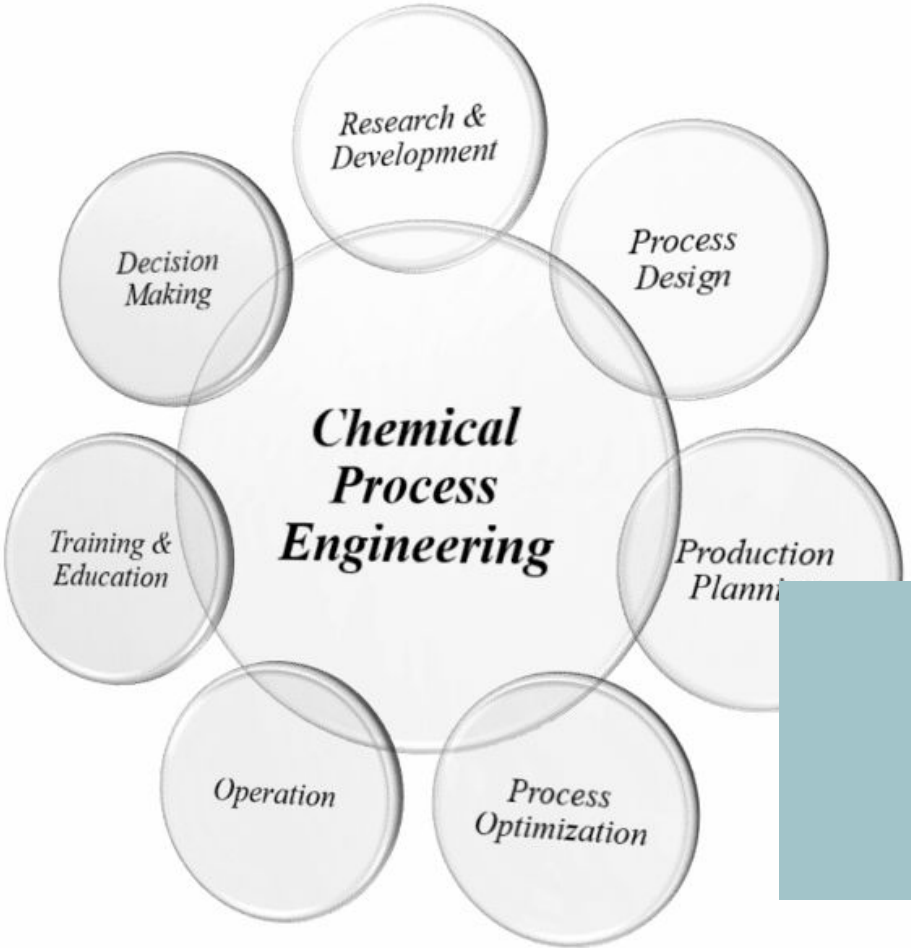
Download on the App Store

Plot Digitizer

Get data from 2D XY Plots directly on your phone. Copy data to clipboard, share it, view a digital plot or fitted equations from the digitized data.

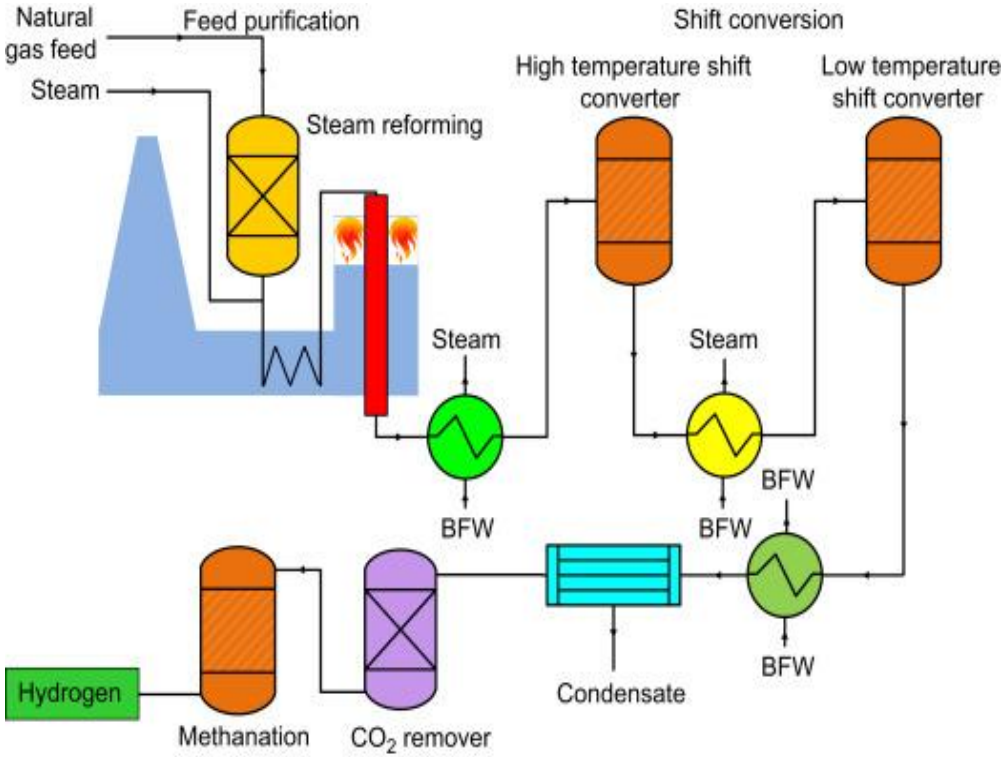


Download on the App Store



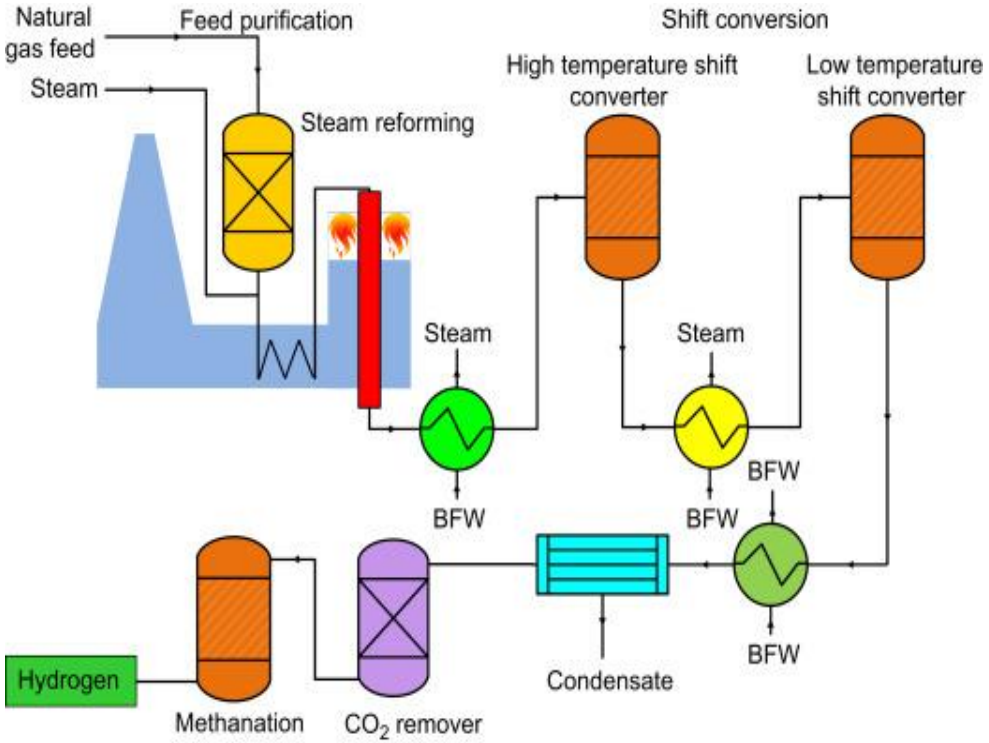
04 SECOND SECTION

- *How to create a simulation in DWSIM*
- *Example by steps*
- *Results Analysis*



EXERCISE FRAMEWORK

Objective: Simulation of the methane steam reforming, SMR, process to produce hydrogen, H_2.



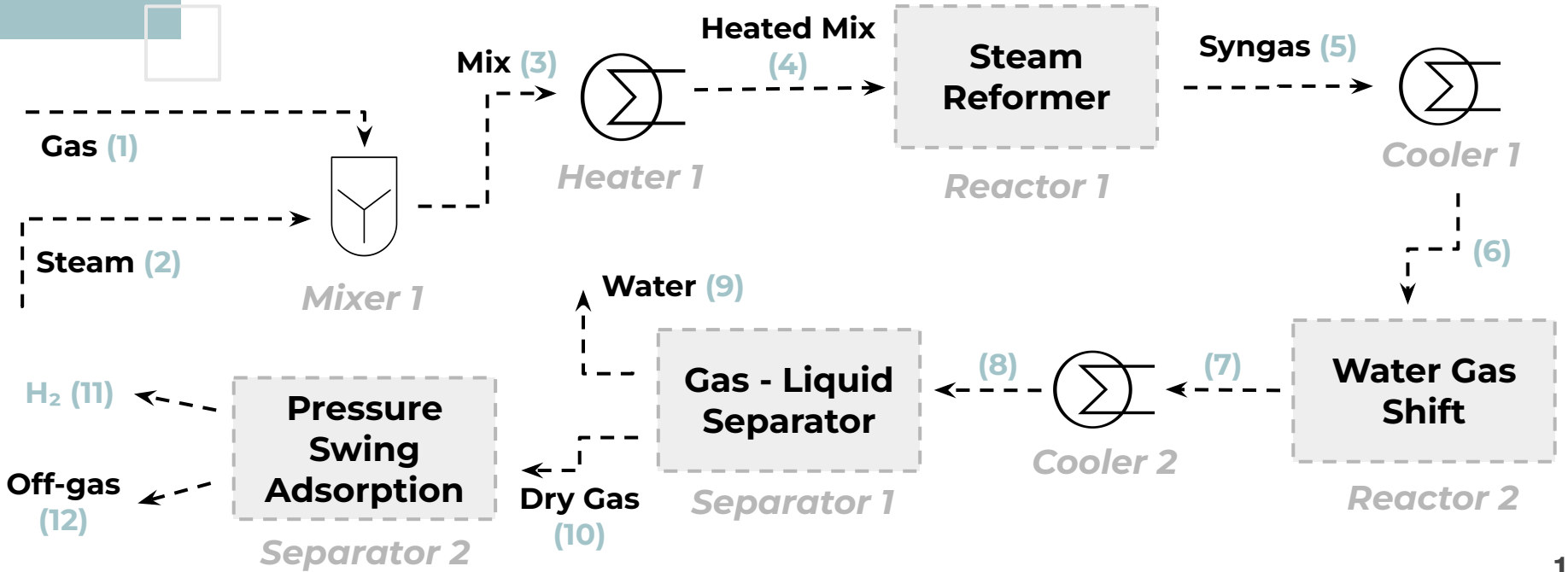
EXERCISE FRAMEWORK

Considerations:

- Shift conversion process only requires one converter instead of two. We'll consider the High Temperature Shift, HTS, reactor.
- The off-gas produced in the process will be burned to produce heat and energy.
- Hydrogen will be compressed.

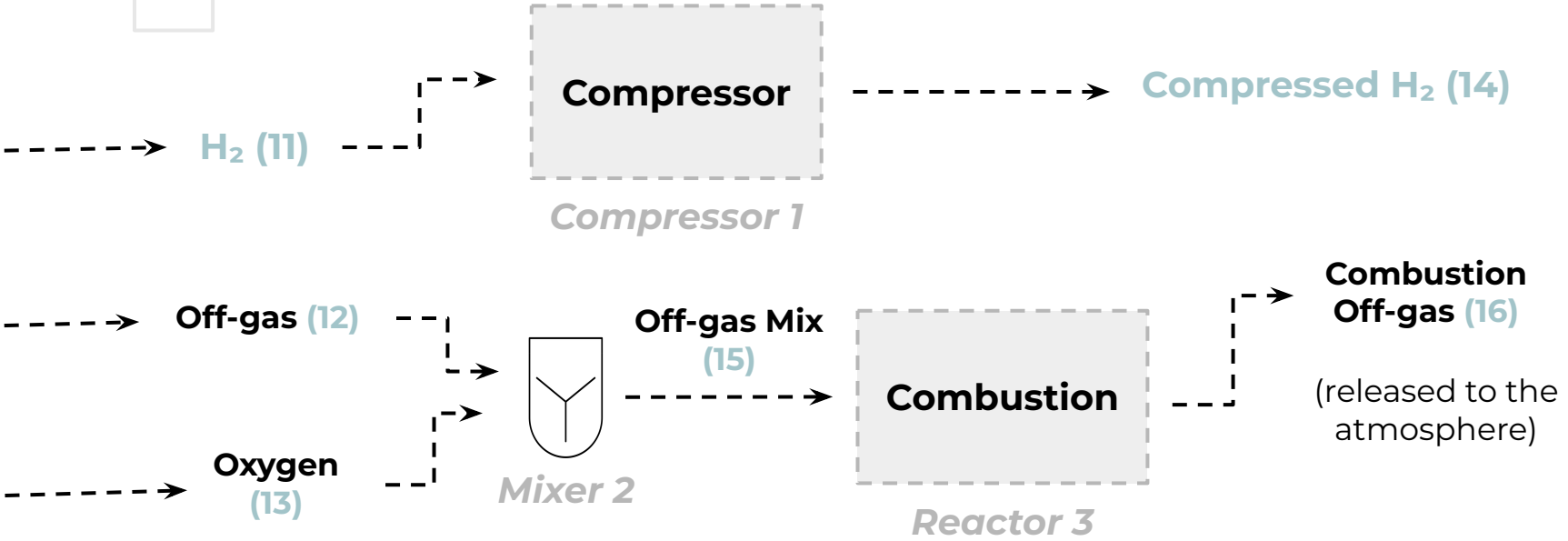
STEAM METHANE REFORMING (EXERCISE)

Scheme



STEAM METHANE REFORMING (EXERCISE)

Scheme



STEAM METHANE REFORMING (EXERCISE)

Stream Properties

		Characteristics			Composition (% mol/mol)					
		T (°C)	*P (bar)*	*Mass flow (kg/h)*	*CH_4*	*C_2H_6*	*H_2O*	*CO_2*	*N_2*	*H_2*
(1) Feed	***Natural Gas***	*25*	1	*10*	*86.0*	*11.2*	*0*	*1.5*	*0.8*	*0.5*
(2) Steam		*150*	1	*30*	*0*	*0*	*100*	*0*	*0*	*0*
(13) Oxygen		*35*	15	1						

STEAM METHANE REFORMING (EXERCISE)

SMR REACTOR

Type: Equilibrium
Operation T: 730°C
Operation P: 30 bar
Isothermic

$$CH_4 + H_2O \leftrightharpoons CO + 3H_2$$

$$CO + H_2O \leftrightharpoons CO_2 + H_2$$

WGS REACTOR

Type: Equilibrium
Operation T: 400°C
Operation P: 29 bar
Isothermic

$$CO + H_2O \leftrightharpoons CO_2 + H_2$$

COMBUSTION REACTOR

Type: Conversion
Outlet T: 200°C

$$CH_4 + 2O_2 \leftrightharpoons CO_2 + 2H_2O$$

$$2C_2H_6 + 7O_2 \leftrightharpoons 4CO_2 + 6H_2O$$

$$2H_2 + O_2 \leftrightharpoons 2H_2O$$

$$2CO + O_2 \leftrightharpoons 2CO_2$$

STEAM METHANE REFORMING (EXERCISE)

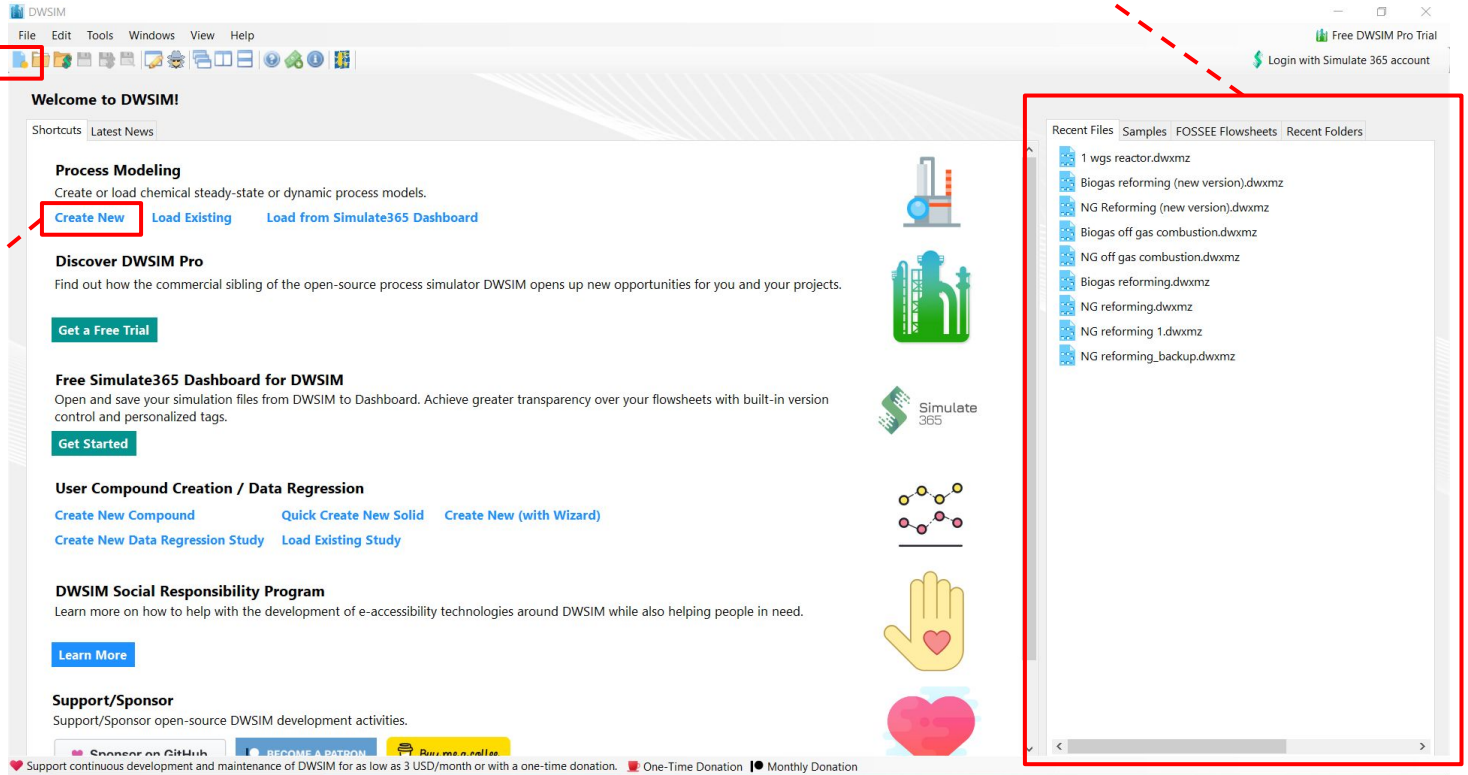
Unit Properties

	Heater 1	Cooler 1	Cooler 2	PSA	Compressor
Calculation Type	*Outlet Temperature*	*Outlet Temperature*	*Outlet Temperature*	*% Inlet molar flow*	*Outlet Pressure (Adiabatic)*
Outlet Temperature (°C)	*730*	*400*	*35*	—	—
Pressure (bar)	*30*	*29*	*15*	—	*200 (outlet P)*
Efficiency (%)	*100*	*100*	*100*	*75 (to H_2)*	*75*

DWSIM HOME PAGE

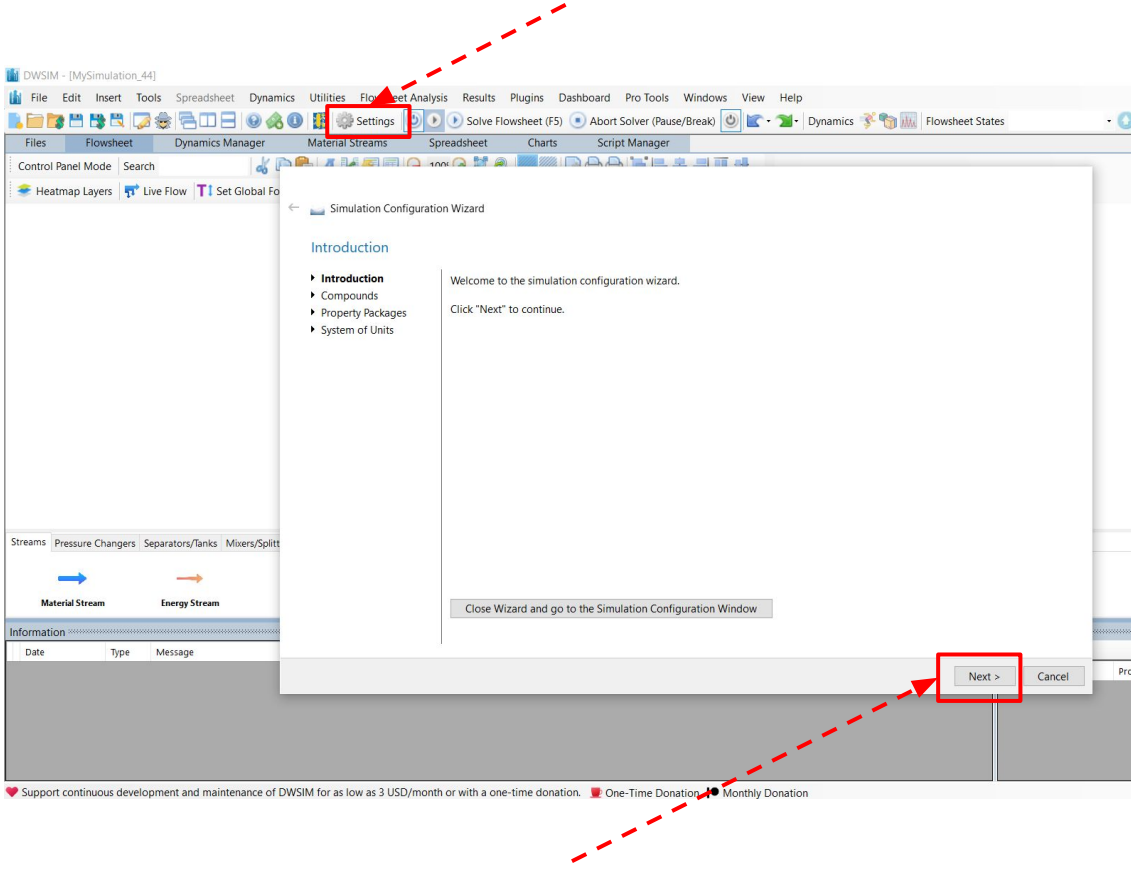
Open other recent files or other examples already given by the program

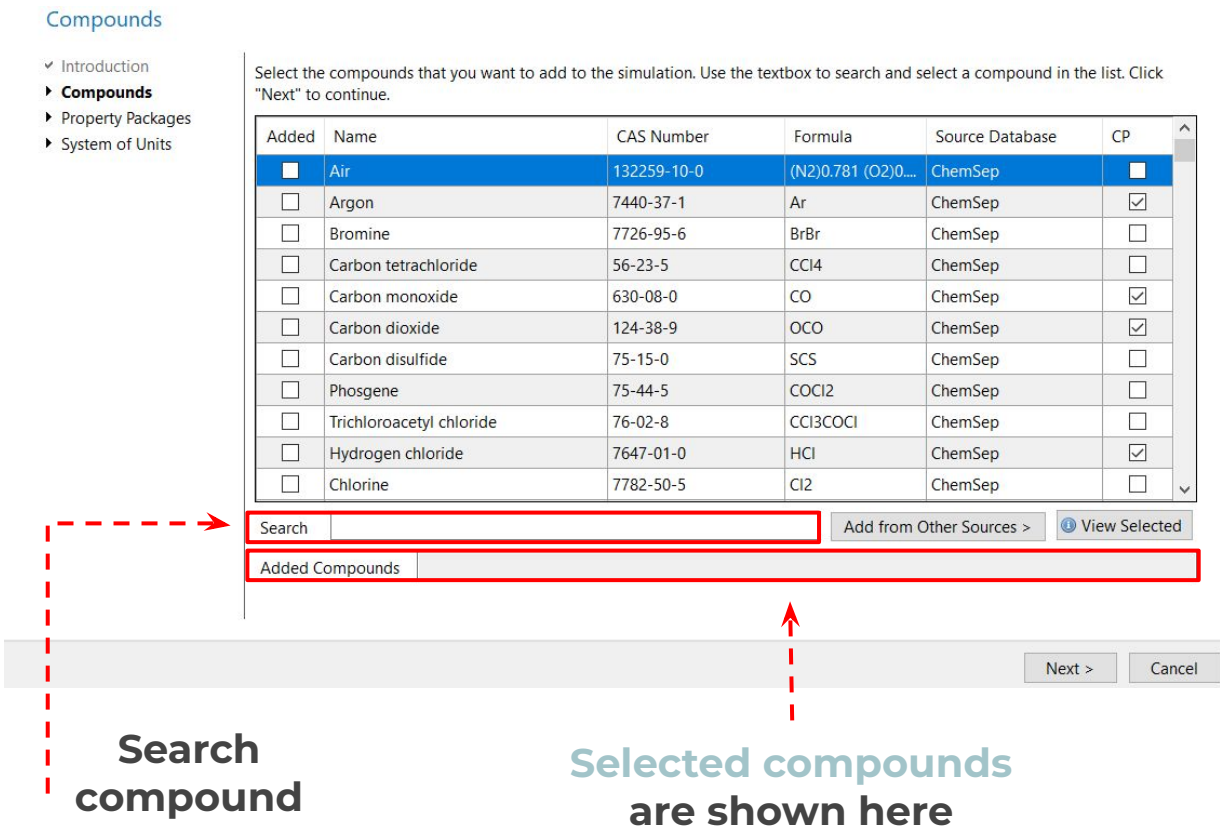
Create a new simulation



SIMULATION CONFIGURATION

- Simulation Configuration Wizard lets you pick the compounds, the property package that you want to use to solve your simulation and the unit system.
- These options can be changed anytime in the settings button.





DWSIM COMPOUNDS

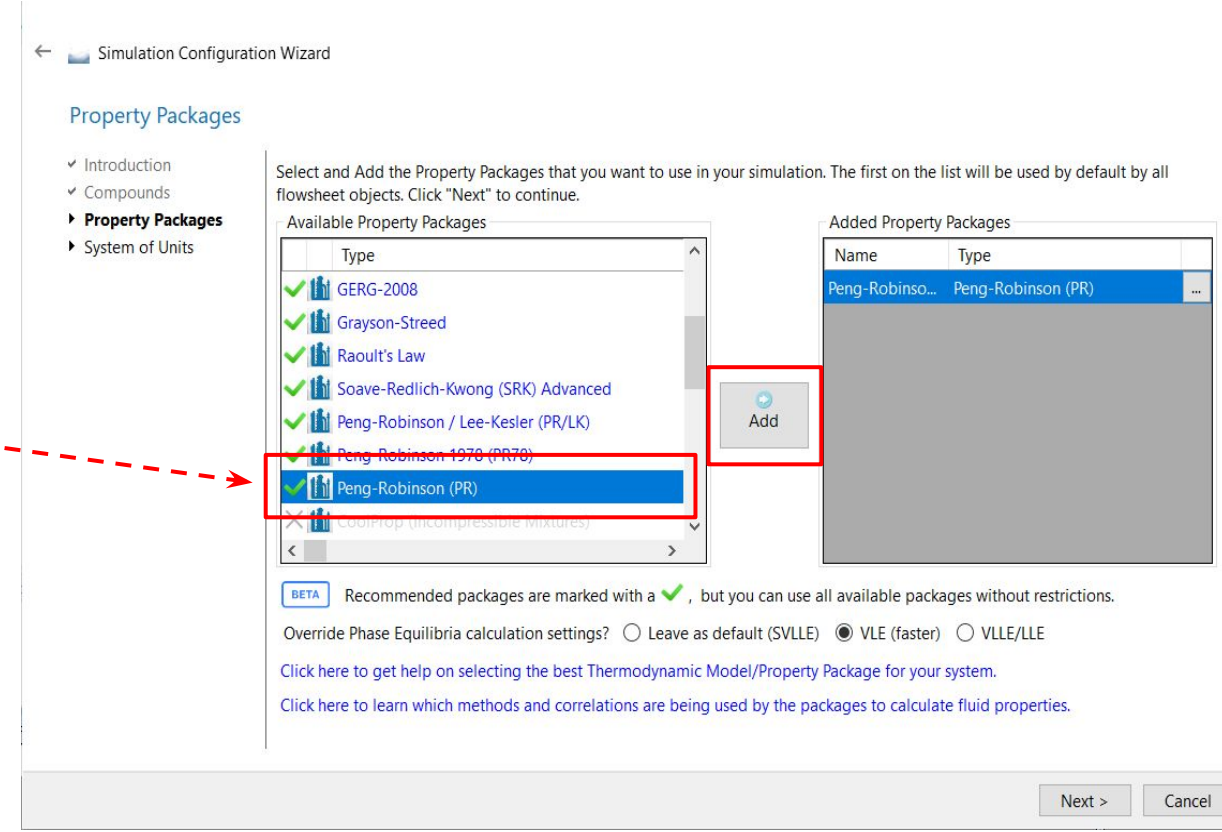
- You should add every compound that is present in the system, i.e. inputs, products and the intermediate compounds.

For this example:

- Add - CH_4; C_2H_6; CO_2; N_2; H_2; H_2O; O_2; CO;

DWSIM PROPERTY PACKAGES

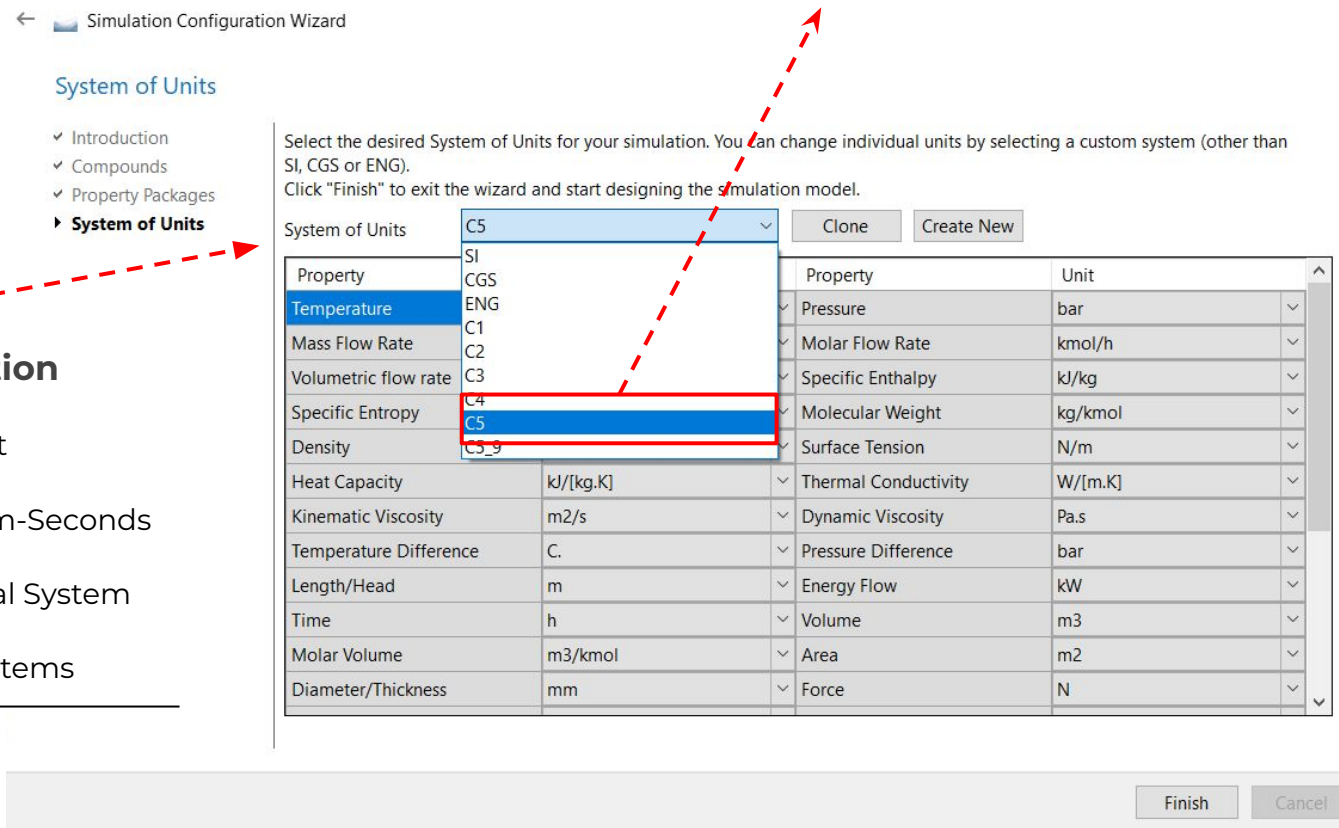
We'll use the Peng-Robinson (PR) model

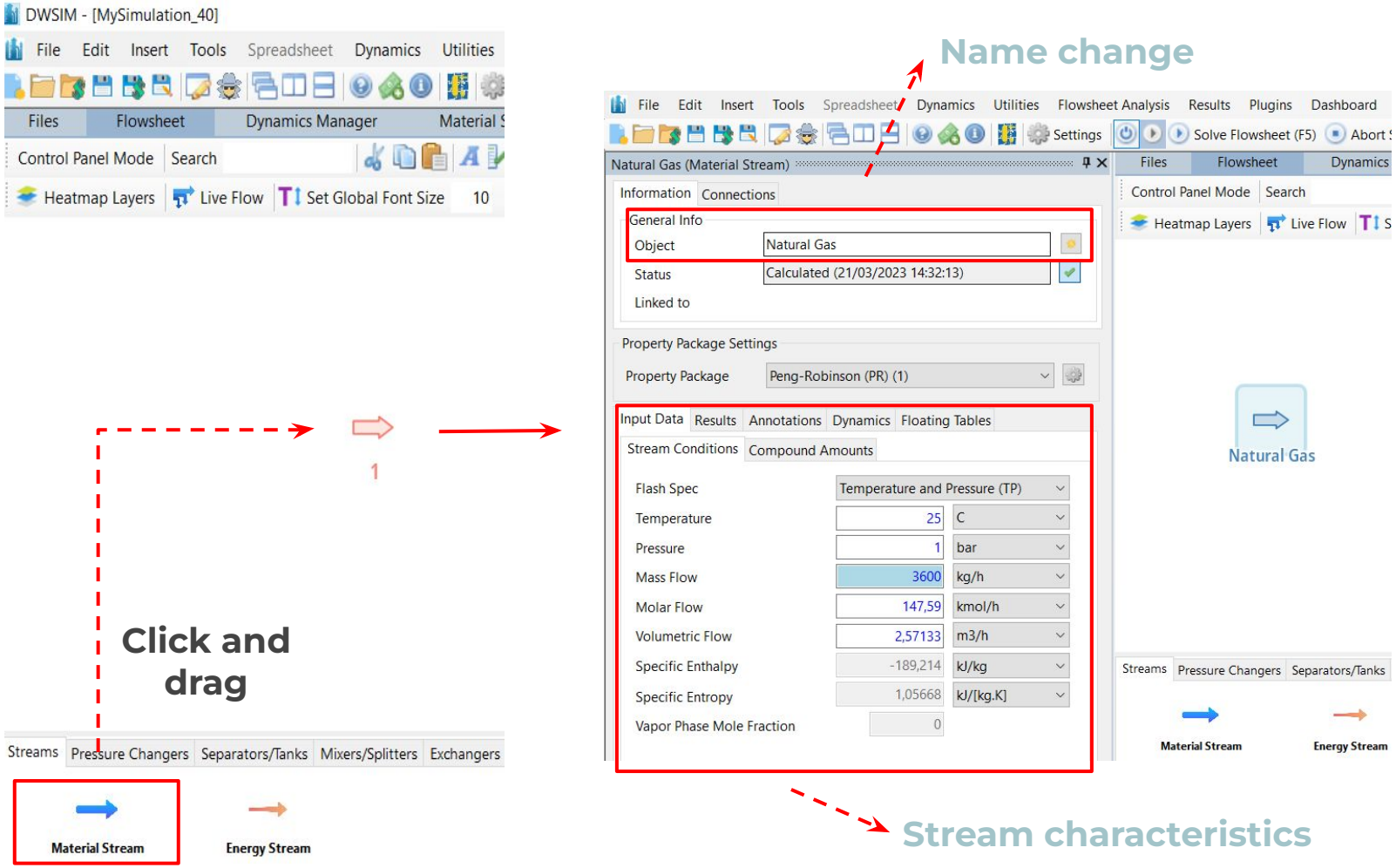


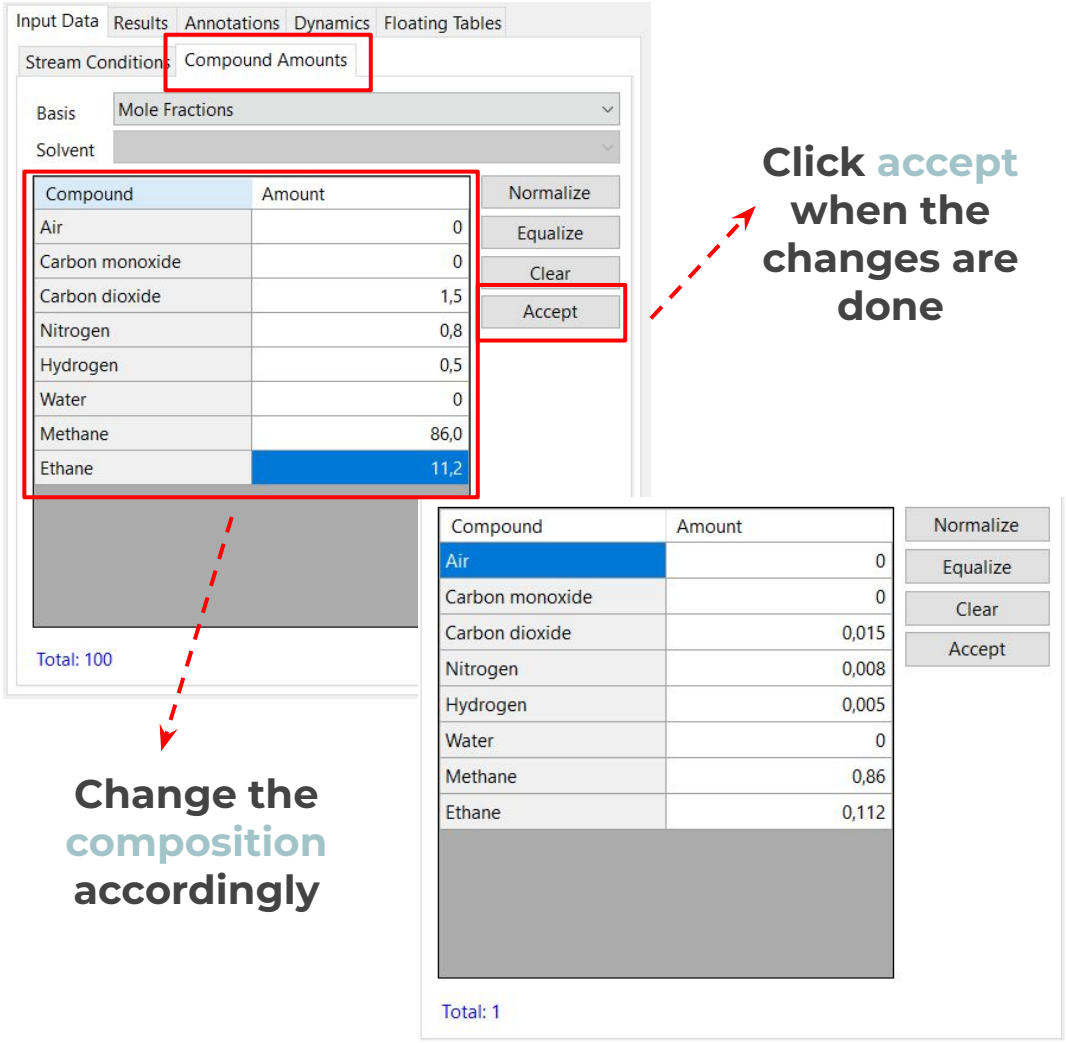
DWSIM SYSTEM OF UNITS

We'll use a custom unit system, C5

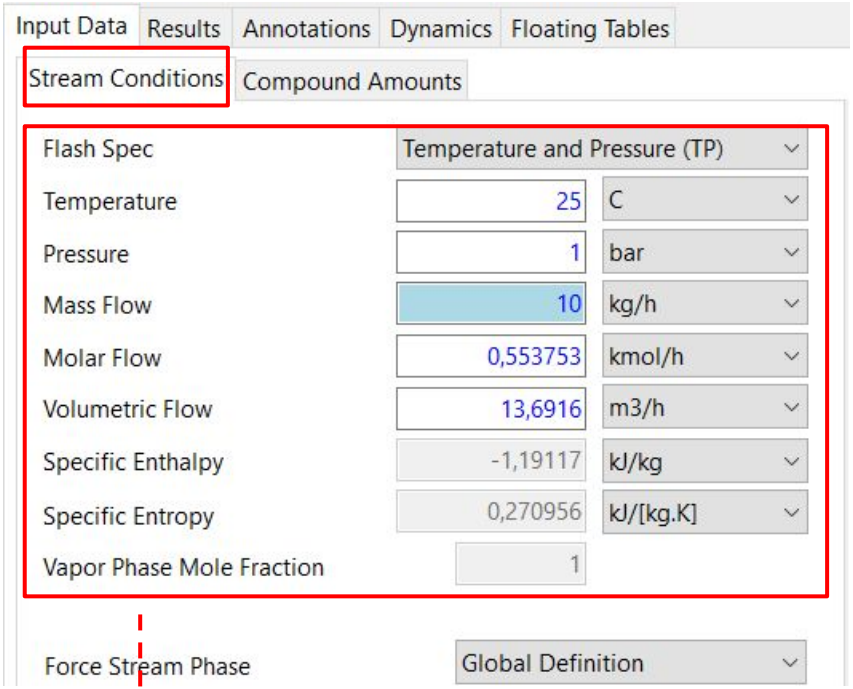
System	Description
SI	Default
CGS	Centimeter-Gram-Seconds
ENG	English Imperial System
C(n)	Custom systems




DWSIM - [MySimulation_40]
File Edit Insert Tools Spreadsheet Dynamics Utilities
Files Flowsheet Dynamics Manager Material
Control Panel Mode Search
Heatmap Layers Live Flow Set Global Font Size 10
Name change
File Edit Insert Tools Spreadsheet Dynamics Utilities Flowsheet Analysis Results Plugins Dashboard
Settings Solve Flowsheet (F5) Abort
Natural Gas (Material Stream)
Information Connections
General Info
Object Natural Gas
Status Calculated (21/03/2023 14:32:13)
Linked to
Property Package Settings
Property Package Peng-Robinson (PR) (1)
Input Data Results Annotations Dynamics Floating Tables
Stream Conditions Compound Amounts
Flash Spec Temperature and Pressure (TP)
Temperature 25 C
Pressure 1 bar
Mass Flow 3600 kg/h
Molar Flow 147,59 kmol/h
Volumetric Flow 2,57133 m3/h
Specific Enthalpy -189,214 kJ/kg
Specific Entropy 1,05668 kJ/[kg.K]
Vapor Phase Mole Fraction 0
Files Flowsheet Dynamics
Control Panel Mode Search
Heatmap Layers Live Flow
Natural Gas
Streams Pressure Changers Separators/Tanks
Material Stream Energy Stream
1
Click and drag
Streams Pressure Changers Separators/Tanks Mixers/Splitters Exchangers
Material Stream Energy Stream
Stream characteristics

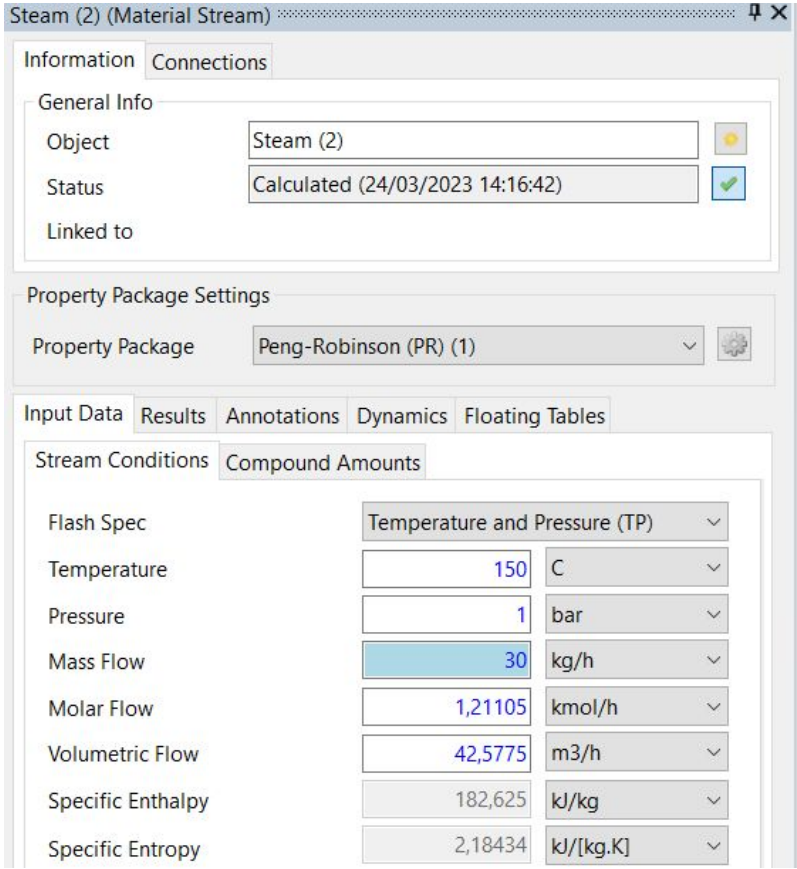


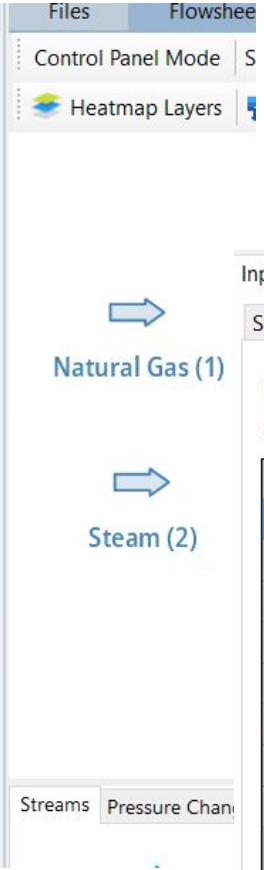
- On the input data separator, go to *compound amounts*.
- On *basis*, 7 types of inputs for compositions are given - mole fractions; mass fractions; mole flows; mass flows; standard liquid volume flows; molarities; molalities.
- Data is given in mole fractions, so that's the one we pick.
- Change the amounts accordingly to the data and press *Accept*, otherwise the program will go back to the original compositions.



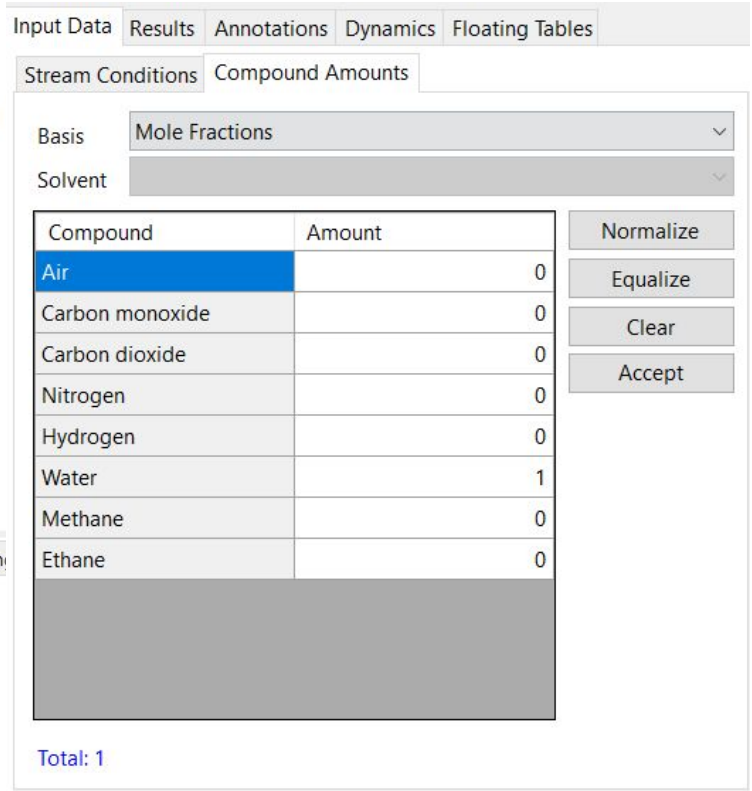
Change the temperature, pressure and mass flow and hit enter. The other characteristics will change automatically.

- Go back to *stream conditions*.
- *Flash Spec* allows the user to pick which of the main conditions he wants to use as base. This choice changes the conditions the program allows to change.
- From the data, we have the stream temperatures and pressures, so we pick *Temperature and Pressure (TP)*.
- Add the information given by the exercise and press Enter.

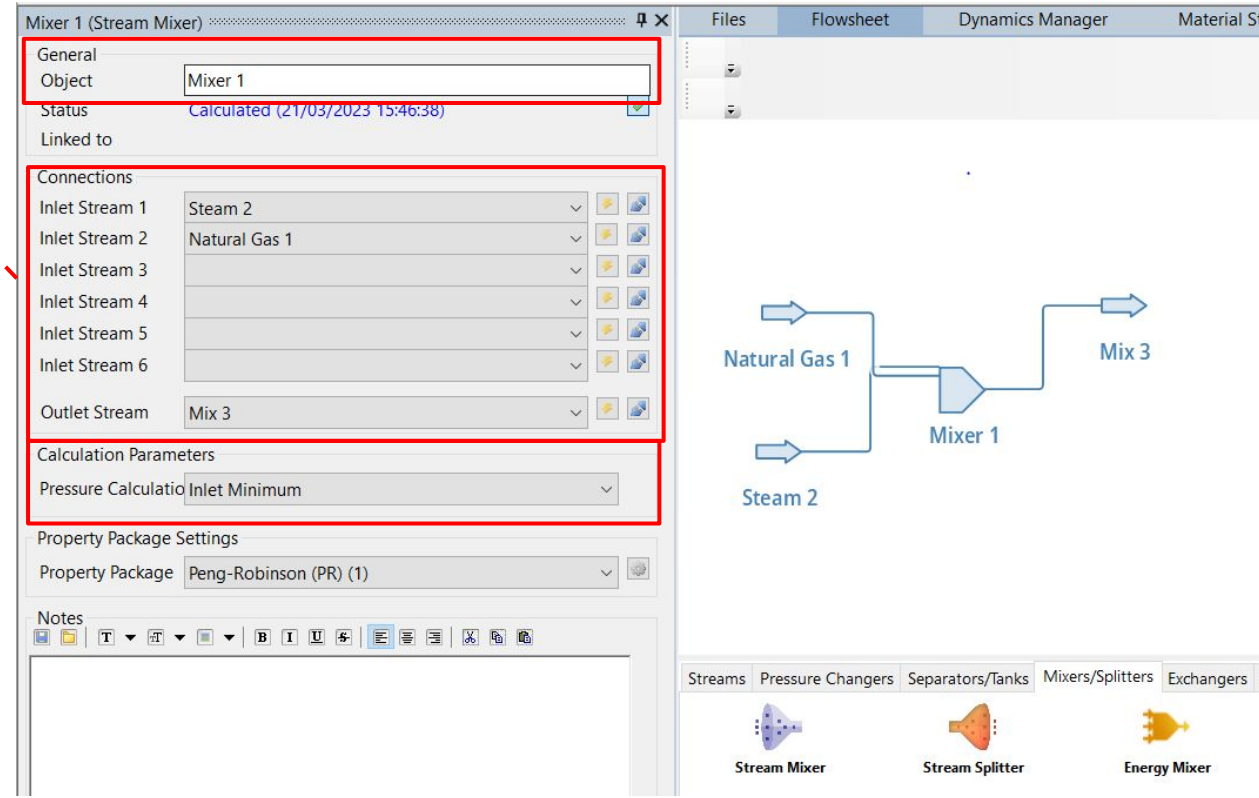




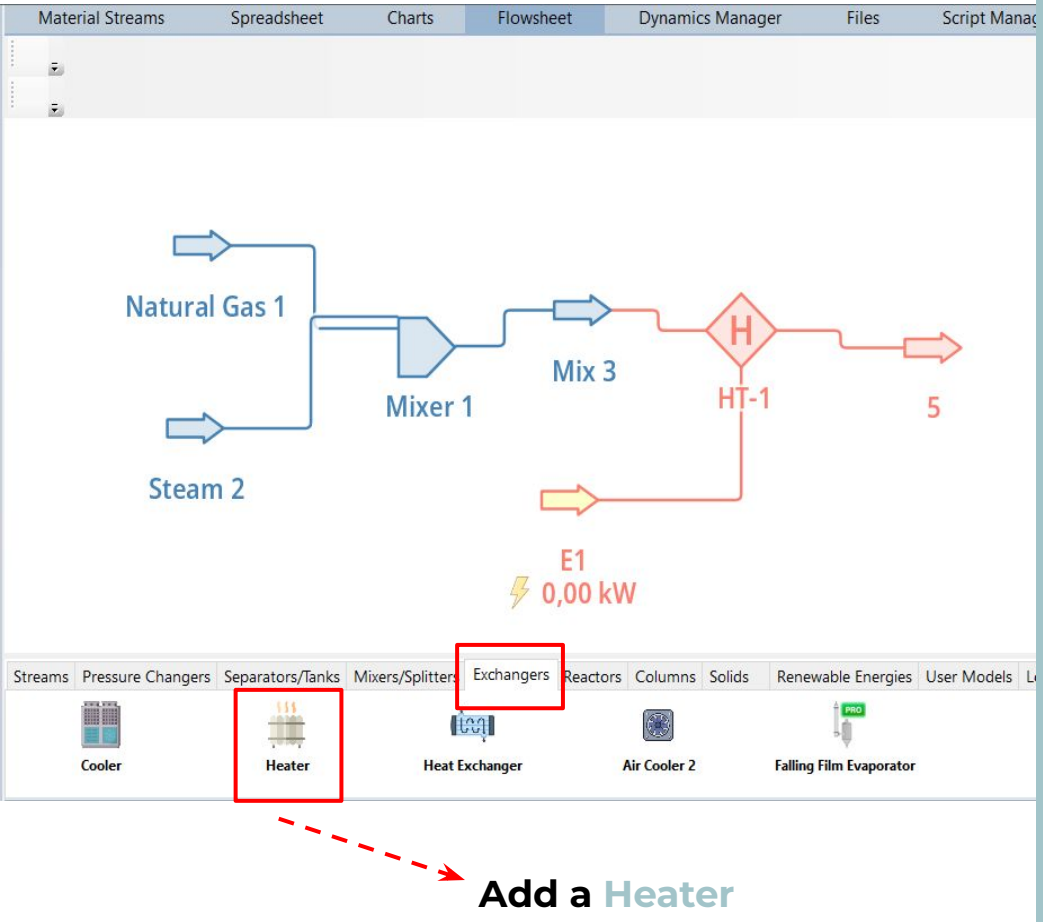
Do the same for Steam



In here you can add/remove other connections to the mixer

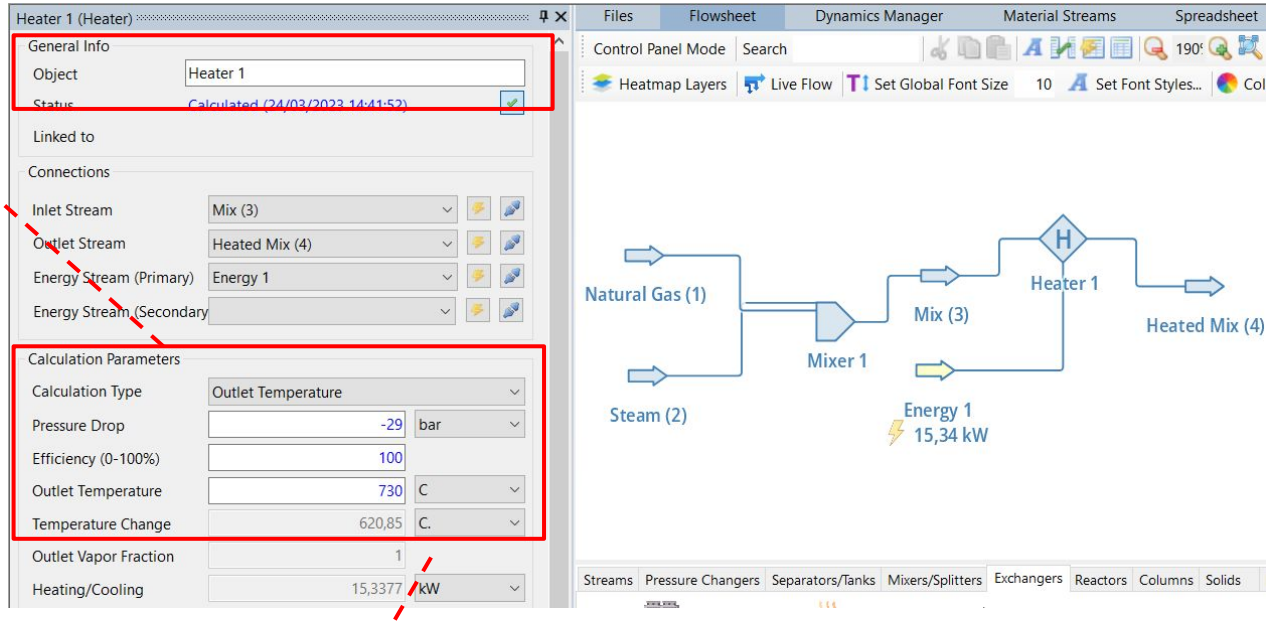


- On the units bar, go to *mixers/splitters* and drag a stream mixer to the flowsheet. Automatically the program will connect the material streams to the mixer.
- Change the object name and choose the calculation method - *Inlet Minimum*.



- Automatically, the software will give the *mixer* output stream characteristics (mix 3).
- According to the scheme of the system, the next step is to add a heater. For that, go back to the unit operations bar, go to *Exchangers* and drag the *Heater*. The program immediately connects the last stream to the heater unit.
- It also adds another input stream, *E1*, which is an energy stream. By altering the conditions of operation of the heater, the program calculates himself the amount of energy needed for this unit to work properly.

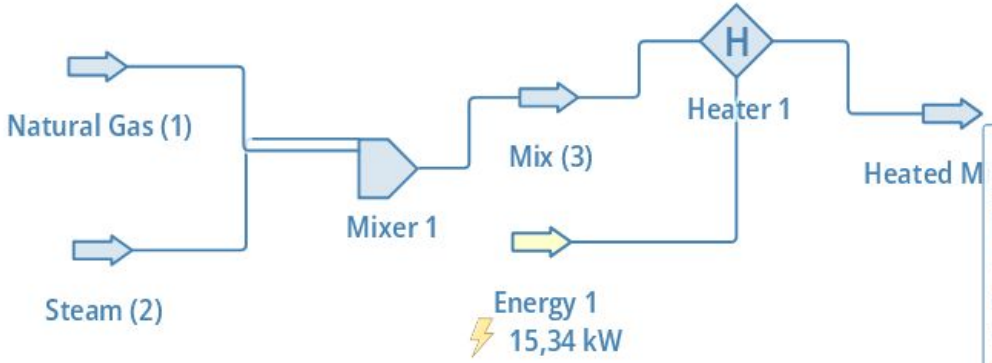
Change conditions **according to data**



- Heaters and coolers allow for 5 types of calculation - heat added/removed; temperature change; outlet temperature; outlet vapor mole fraction; energy stream. Pick outlet temperature.
- **Don't forget to press Enter with every change you do.**

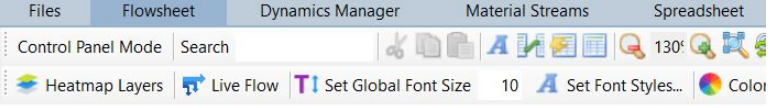
Attention to pressure - it says pressure drop, meaning how much does the pressure decreased. We want the pressure at 30 bar, and the stream is at 1 bar. Hence comes the -29.

We now have the heated mix with the correct characteristics from data and compatible with the operation conditions of the first reactor.

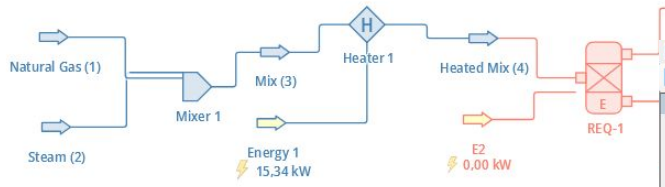


Heated Mix (4) Material Stream	
Temperature	730 C
Pressure	30 bar
Mass Flow	40 kg/h
Molar Flow	1,76481 kmol/h
Volumetric Flow	4,94461 m3/h
Molar Enthalpy (Mixture)	34384,8 kJ/kmol
Molar Entropy (Mixture)	60,8784 kJ/[kmol.K]
Molar Fraction (Vapor)	1
Phases	V
Energy Flow	-33,3755 kW

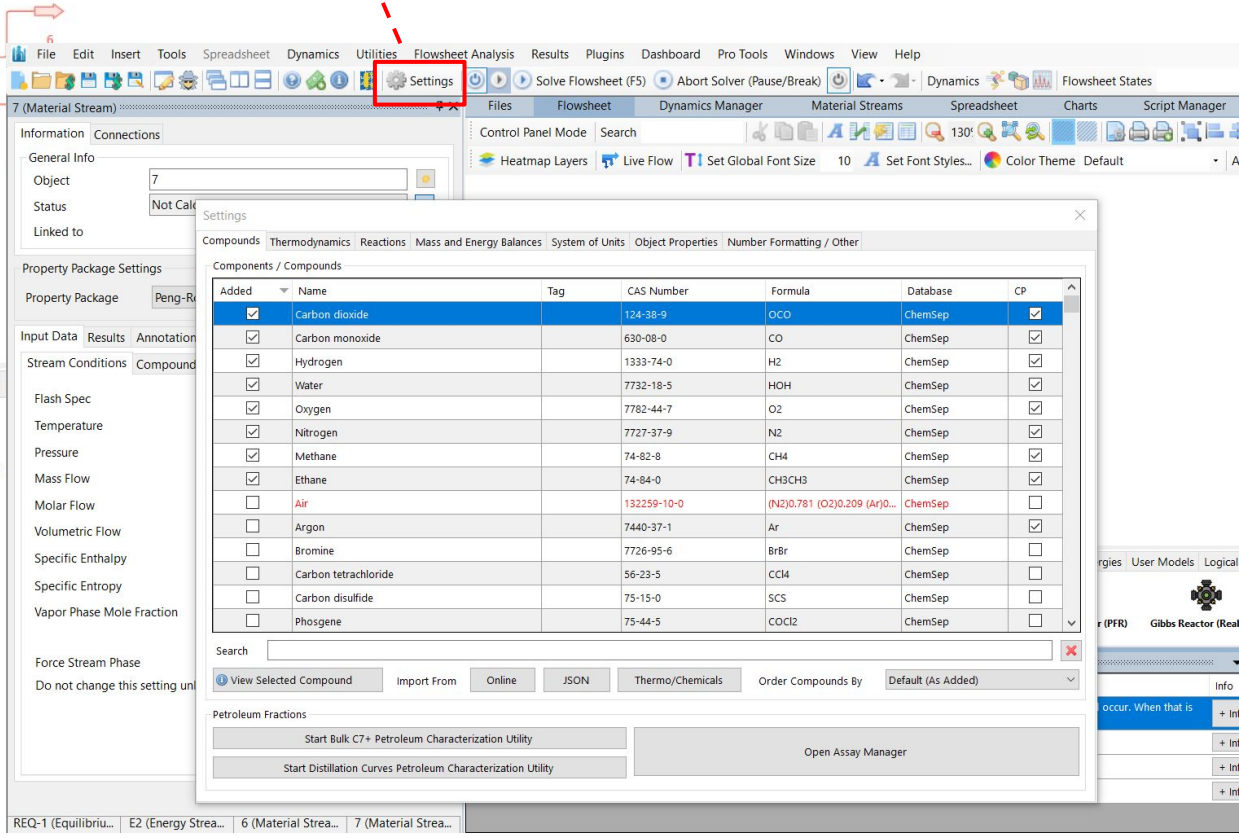
Now, we'll add an *equilibrium reactor*.

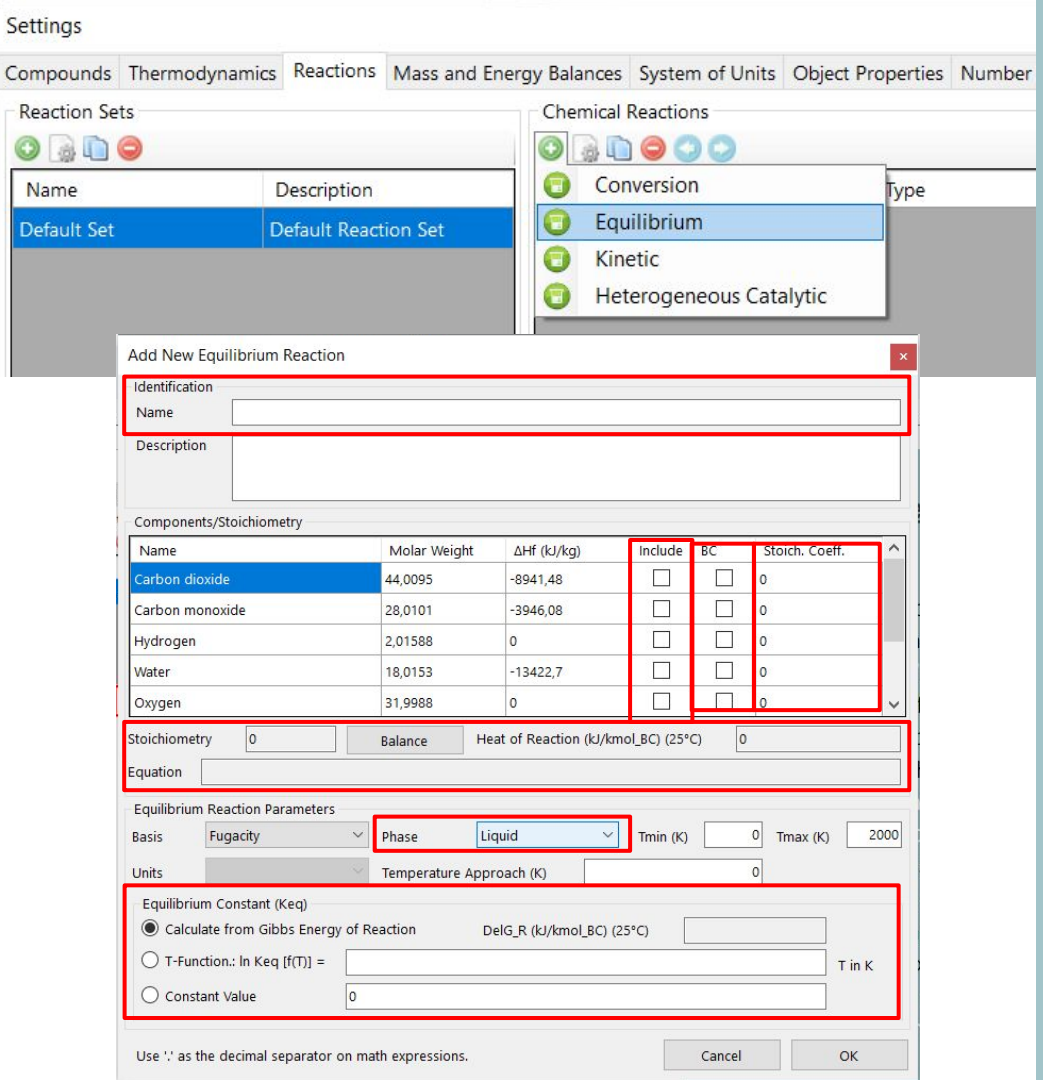


Now, we need to *insert the reactions* that are going to occur in the reactor. For that go to *settings*.



Go to *reactors* and add an *equilibrium reactor*.

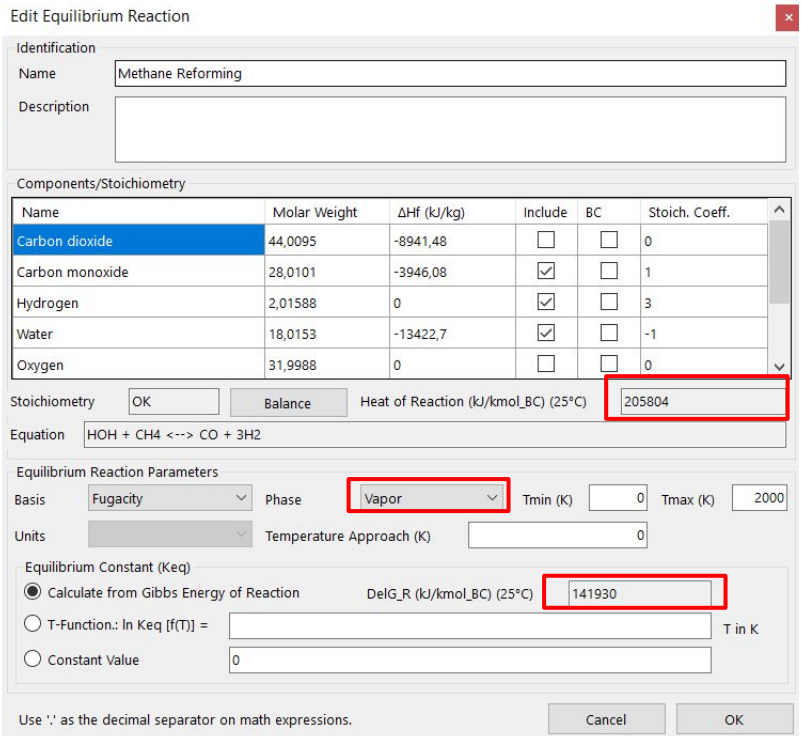




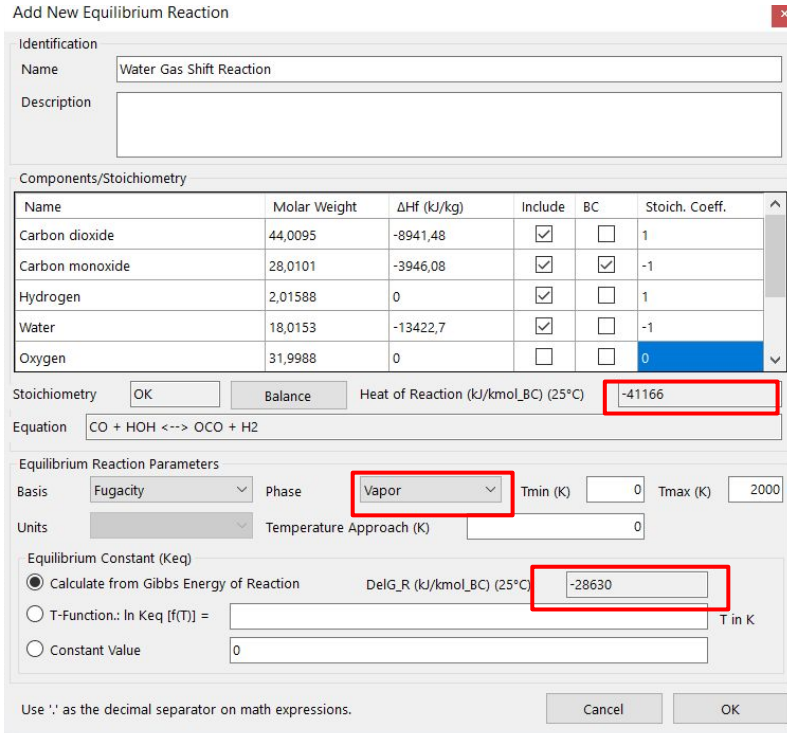
How to add reactions in DWSIM:

1. Give a *name*;
2. Pick the components present in the reaction on the *include boxes*;
3. On the *BC column*, pick the base component of the reaction - CH_4;
4. Now we give the stoichiometric coefficients. The program considers negative numbers for reagents and positive numbers for products;
5. The equation appears in the equation box and if the stoichiometry is correct then *OK* will appear on top.
6. On *Phase* choose *Vapor*.
7. Then pick the calculation method - calculate from Gibbs Energy of Reaction;

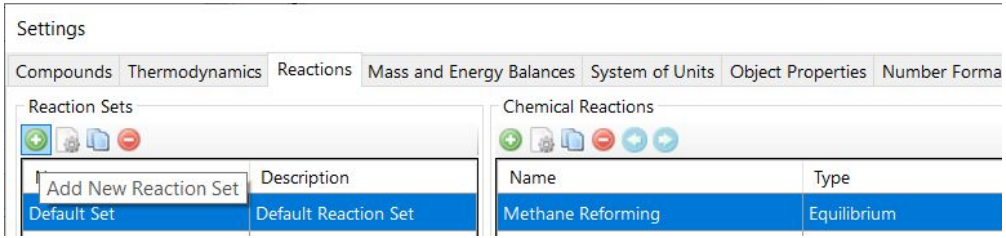
$$CH_4 + H_2O \leftrightharpoons CO + 3H_2$$



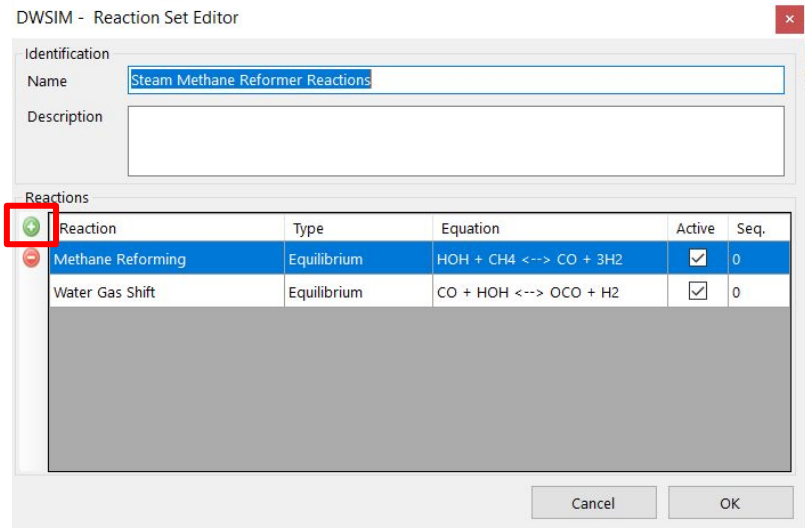
$$CO + H_2O \leftrightharpoons CO_2 + H_2$$

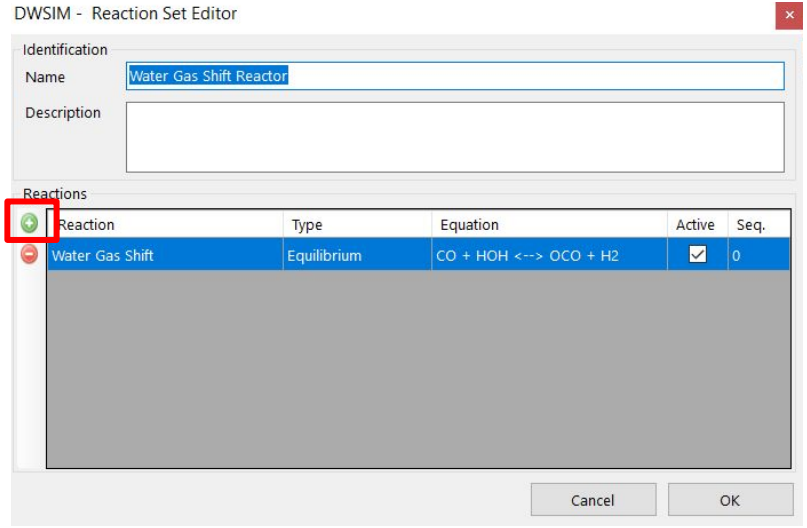


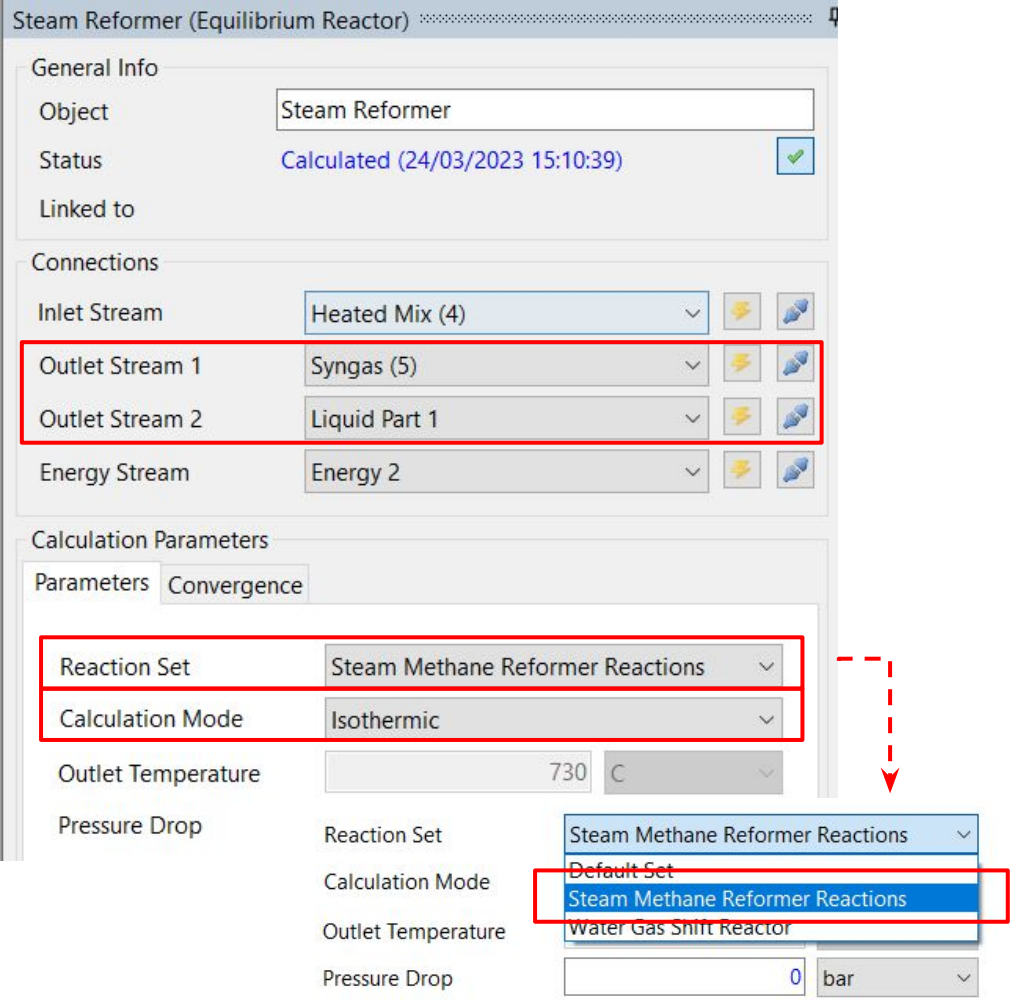
- **Still in the reactions settings, go to *reaction Sets* and *add new reaction set*.**



- **Here we can create *groups of chemical reactions* deliberately for each reactor.**

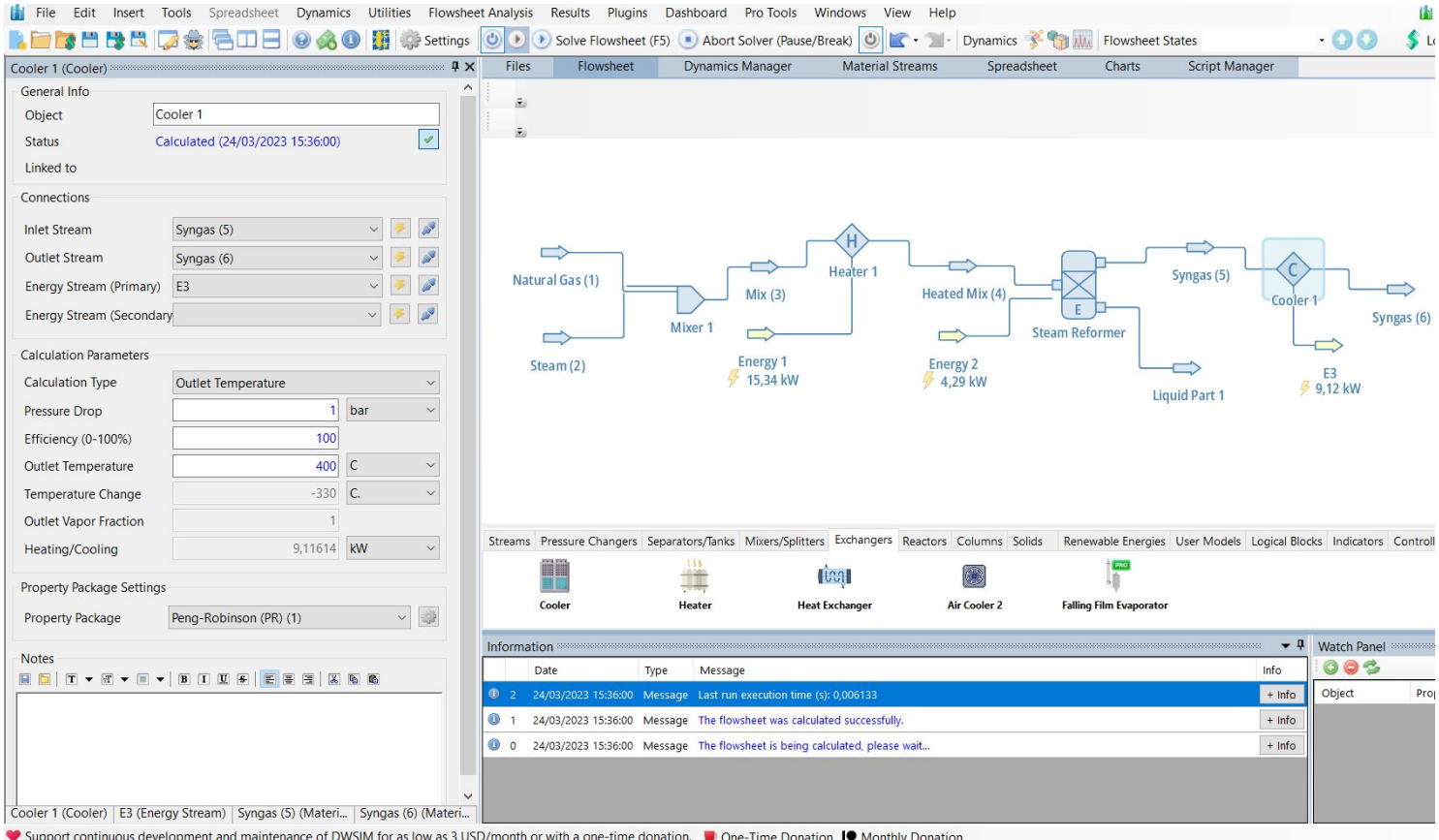


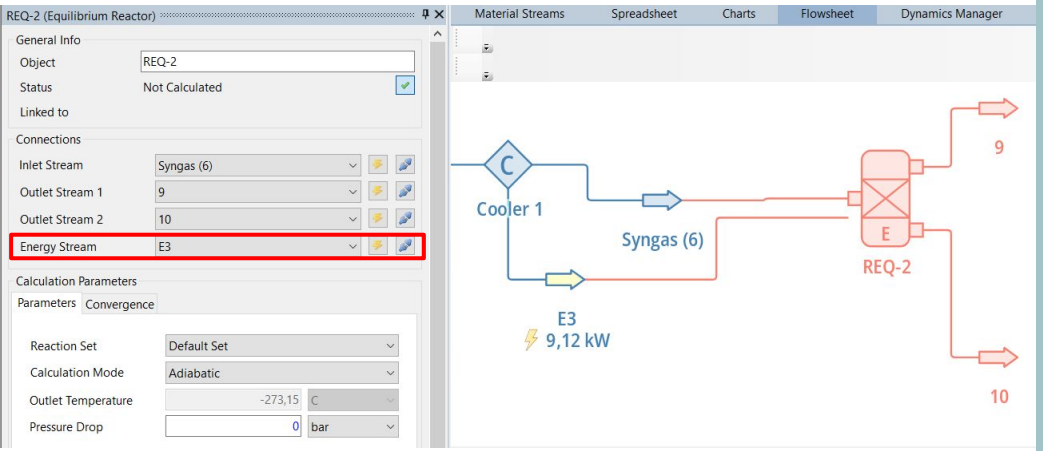


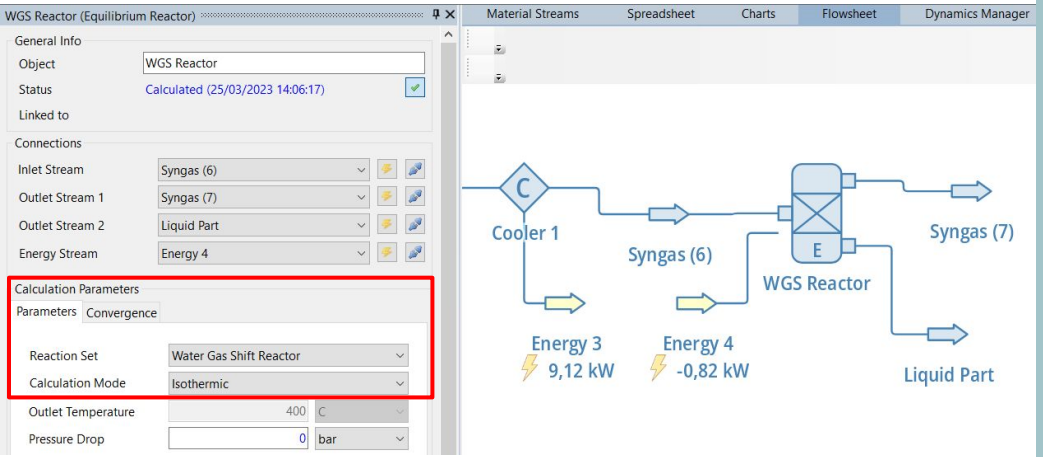


- Reactors appear with 2 output streams. *Outlet Stream 1* corresponds to the gas part of the products and the *Outlet Stream 2* represents the liquid part of the output.
- For this case study, the liquid part should have null flow. Whether or not this stream has any flow, it still needs to be connected to the reactor otherwise calculation errors will appear.
- On *reaction set*, instead of the default set, pick the set you created with the two reactions that will occur in the SR. On *calculation mode*, we'll use the isothermic mode.

Now a cooler...

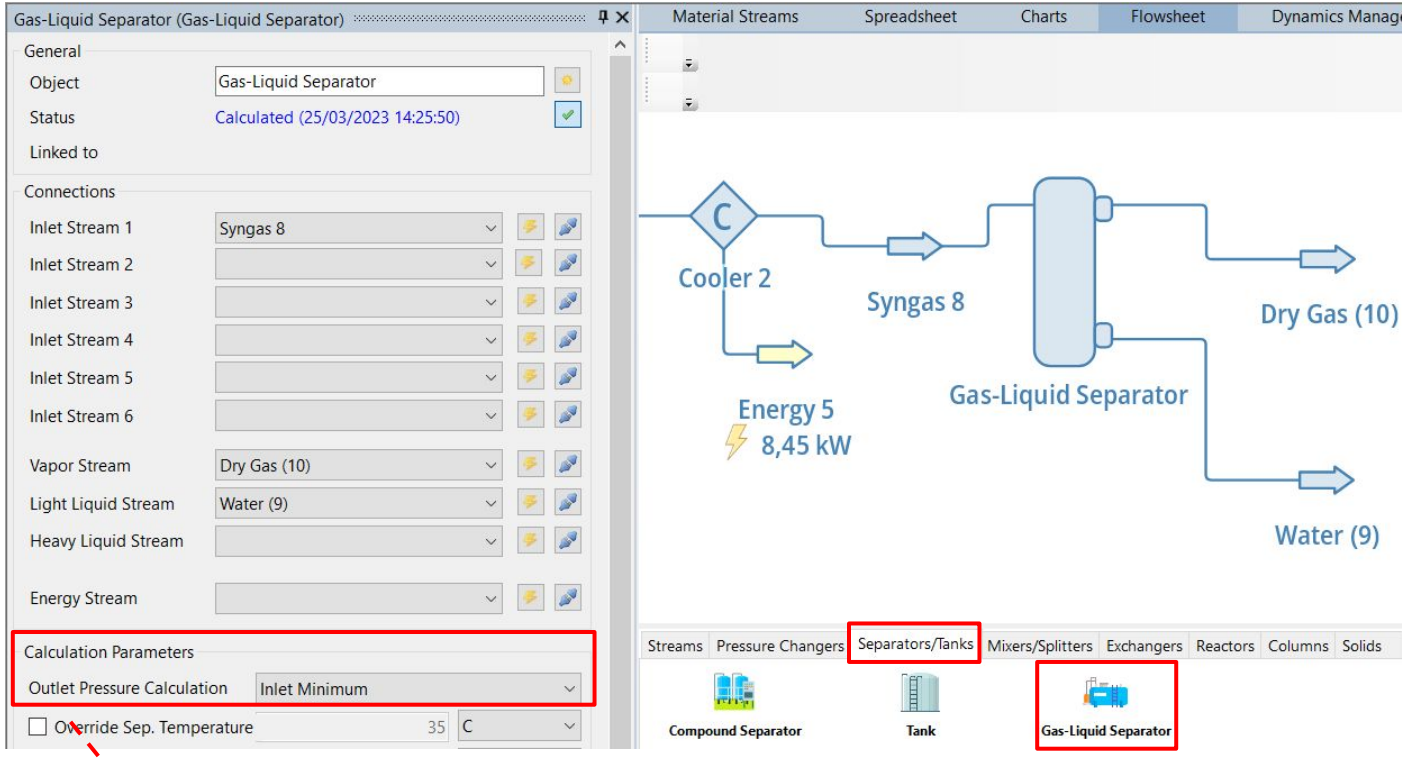

File Edit Insert Tools Spreadsheet Dynamics Utilities Flowsheet Analysis Results Plugins Dashboard Pro Tools Windows View Help
Settings
Solve Flowsheet (F5)
Abort Solver (Pause/Break)
Dynamics
Flowsheet States
Cooler 1 (Cooler)
General Info
Object
Cooler 1
Status
Calculated (24/03/2023 15:36:00)
Linked to
Connections
Inlet Stream
Syngas (5)
Outlet Stream
Syngas (6)
Energy Stream (Primary)
E3
Energy Stream (Secondary
Calculation Parameters
Calculation Type
Outlet Temperature
Pressure Drop
1
bar
Efficiency (0-100%)
100
Outlet Temperature
400
C
Temperature Change
-330
C.
Outlet Vapor Fraction
1
Heating/Cooling
9,11614
kW
Property Package Settings
Property Package
Peng-Robinson (PR) (1)
Notes
Cooler 1 (Cooler)
E3 (Energy Stream)
Syngas (5) (Materi...
Syngas (6) (Materi...
Files
Flowsheet
Dynamics Manager
Material Streams
Spreadsheet
Charts
Script Manager
Natural Gas (1)
Steam (2)
Mixer 1
Mix (3)
H
Heater 1
Energy 1
15,34 kW
Heated Mix (4)
Energy 2
4,29 kW
E
Steam Reformer
Syngas (5)
Liquid Part 1
C
Cooler 1
Syngas (6)
E3
9,12 kW
Streams
Pressure Changers
Separators/Tanks
Mixers/Splitters
Exchangers
Reactors
Columns
Solids
Renewable Energies
User Models
Logical Blocks
Indicators
Cooler
Heater
Heat Exchanger
Air Cooler 2
Falling Film Evaporator
Information
Date
Type
Message
Info
2 24/03/2023 15:36:00 Message Last run execution time (s): 0,006133 + Info
1 24/03/2023 15:36:00 Message The flowsheet was calculated successfully. + Info
0 24/03/2023 15:36:00 Message The flowsheet is being calculated, please wait... + Info
Watch Panel
Object
Support continuous development and maintenance of DWSIM for as low as 3 USD/month or with a one-time donation.
One-Time Donation
Monthly Donation



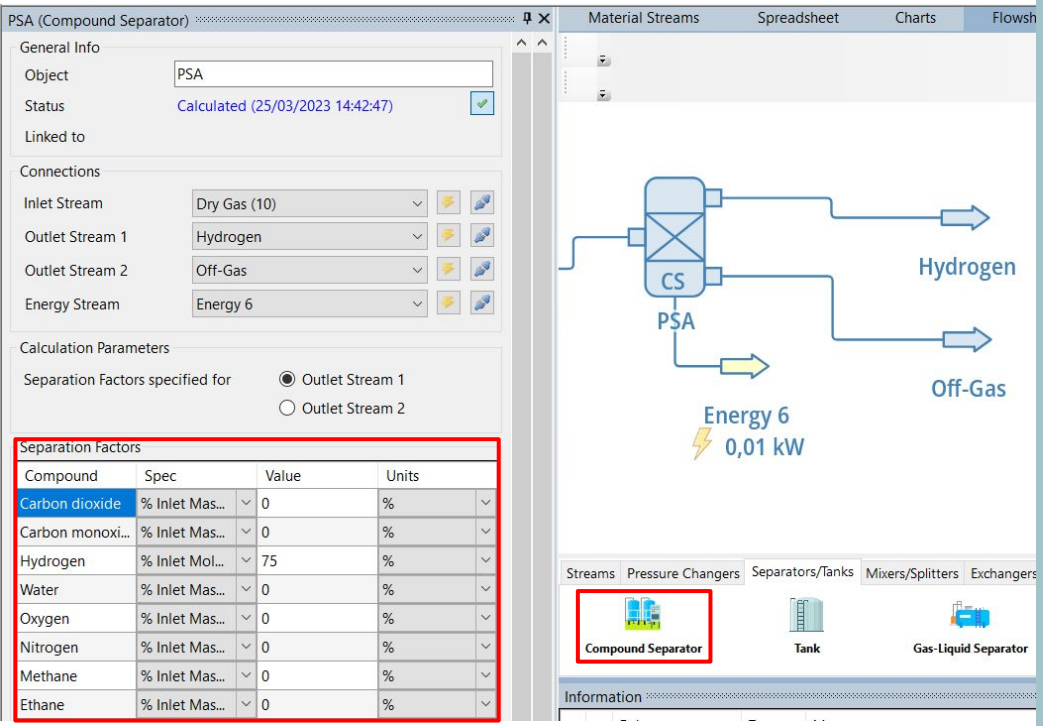


- Add a new *equilibrium reactor*. Sometimes the program automatically connects the energy stream of the reactor to the energy stream from the former unit, presenting the energy balance between these operations.
- However, to make the reading easier we'll separate the energy balance into two different streams. On *energy stream* click on the blue button (*disconnect*) and then in the yellow (*create and connect*).
- On *Reaction Set* pick the set you created with just the water-gas shift reaction and pick isothermic as the *Calculation Mode*.

Add a new *cooler* and change the characteristics. Now, go to *Separators/Tanks* and add a *Gas-Liquid Separator*.



On *Outlet Pressure Calculation* pick *Inlet Minimum*.



- To simulate the Pressure Swing Adsorption, PSA, we'll use a *Compound Separator* on the Separators/Tanks.
- *Compound Separator* is a mass balance unit operation, and divides one stream into two, specified as fractions or absolute flow rates.
- We're considering that the PSA has an efficiency of 75% of splitting the hydrogen from the gas.
- On *Separation Factors* go to Hydrogen, on *spec*, choose % Inlet Molar Flow or % Inlet Mass Flow (in this case, the result will be the same) and on *value* write 75%.

Compressor (Compressor)

General Info

Object	Compressor
Status	Calculated (27/03/2023 15:17:56)
Linked to	

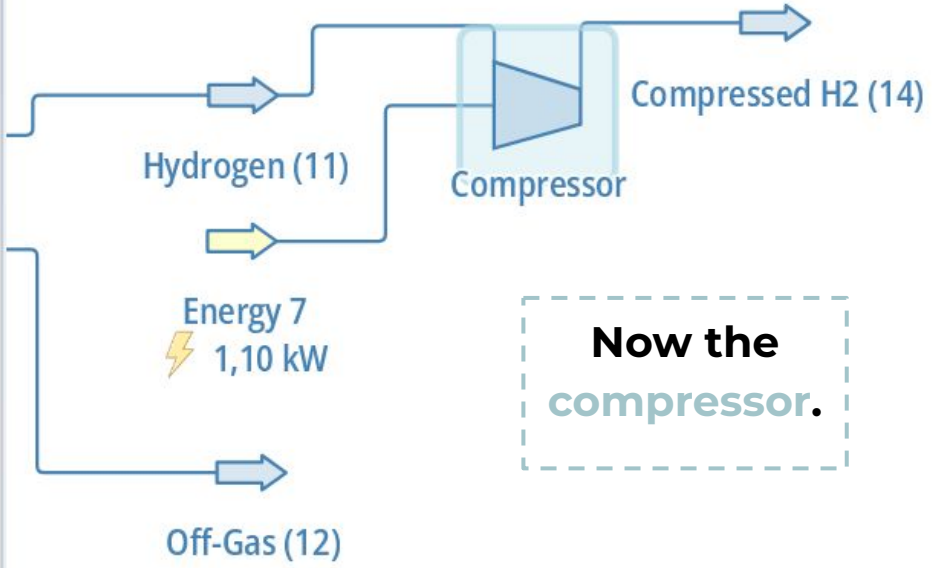
Connections

Inlet Stream	Hydrogen (11)
Outlet Stream	Compressed H2 (14)
Energy Stream	Energy 7

Calculation Parameters

Calculation Type	Outlet Pressure	
Thermodynamic Process	Adiabatic	
Performance Curves	Edit Performance Curves	
Rotation Speed	1500	rpm
Pressure Increase	185	bar
Outlet Pressure	200	bar
Adiabatic Efficiency (0-100)	75	%
Polytropic Efficiency (0-100)	81,9477	%
Power Required	1,09611	kW
Outlet Temperature	483,82	C
Temperature Change	448,82	C.

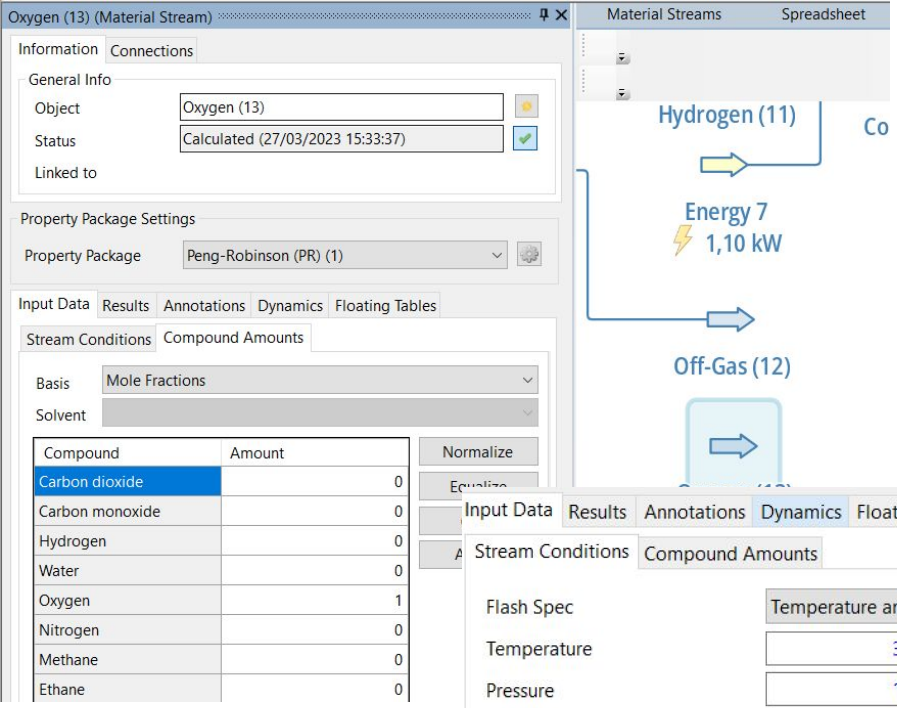
Material Streams | Spreadsheet | Charts | Flowsheet | Dynamic

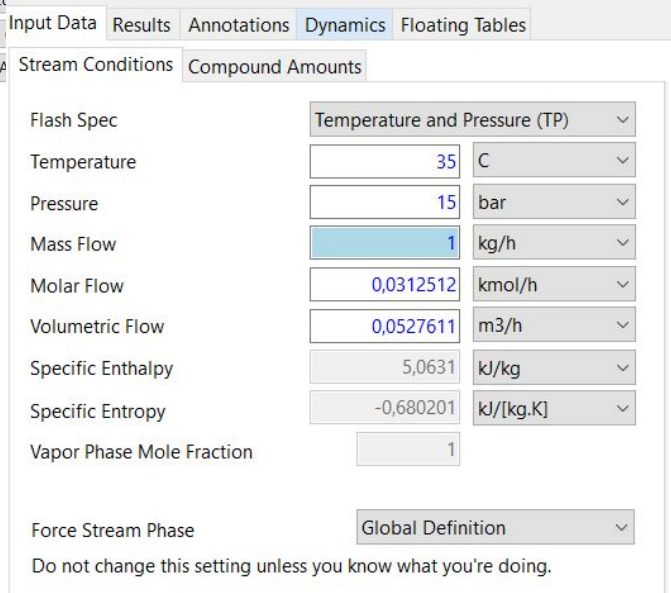


Now the compressor.

Streams | Pressure Changers | Separators/Tanks | Mixers/Splitters | Exchangers | Reactors | Columns

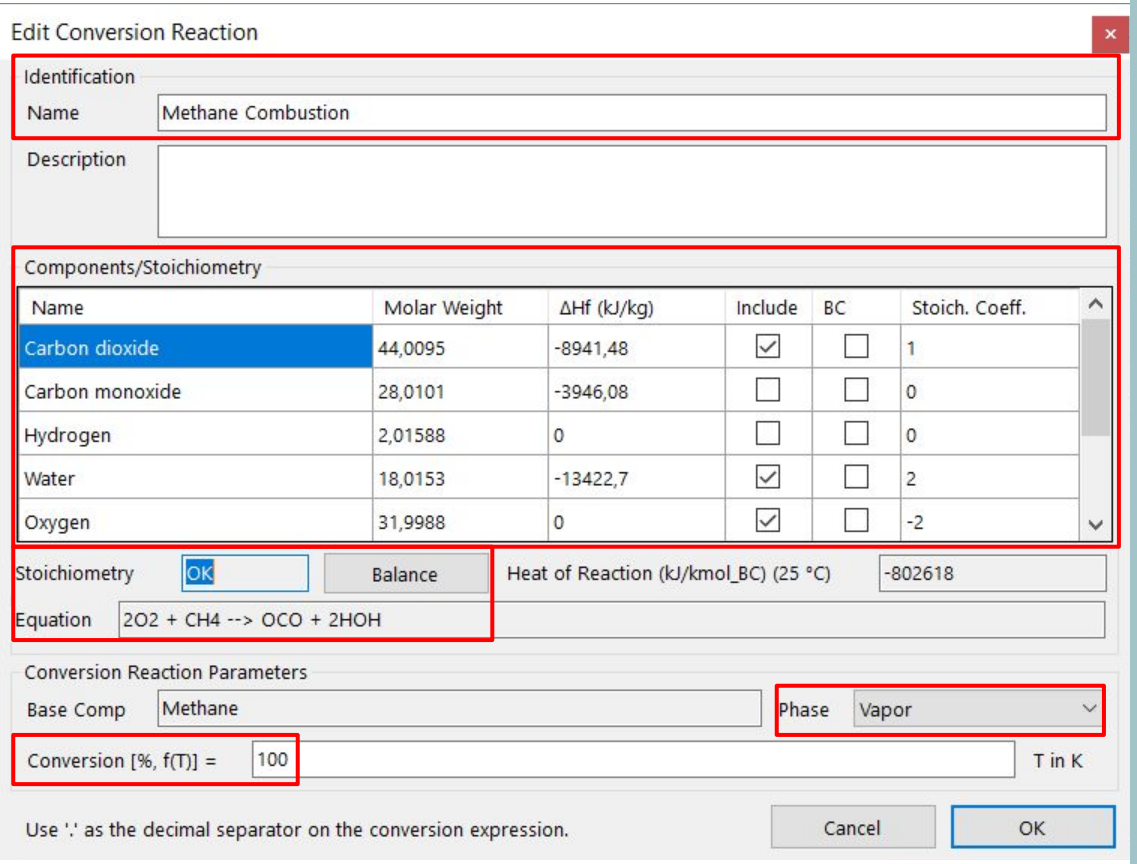
Orifice Plate | Compressor | Pipe Segment | Pump



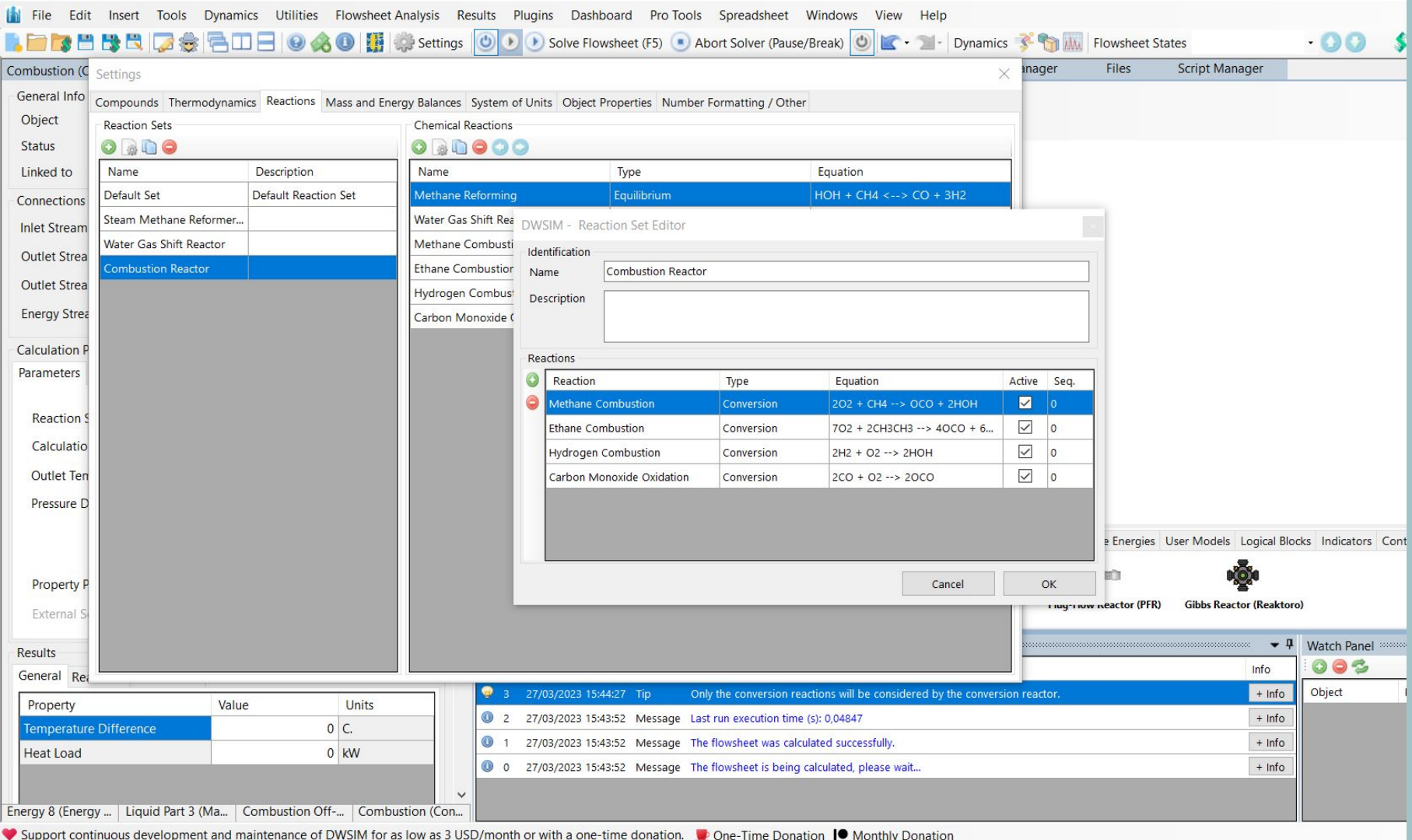


Now the combustion part:

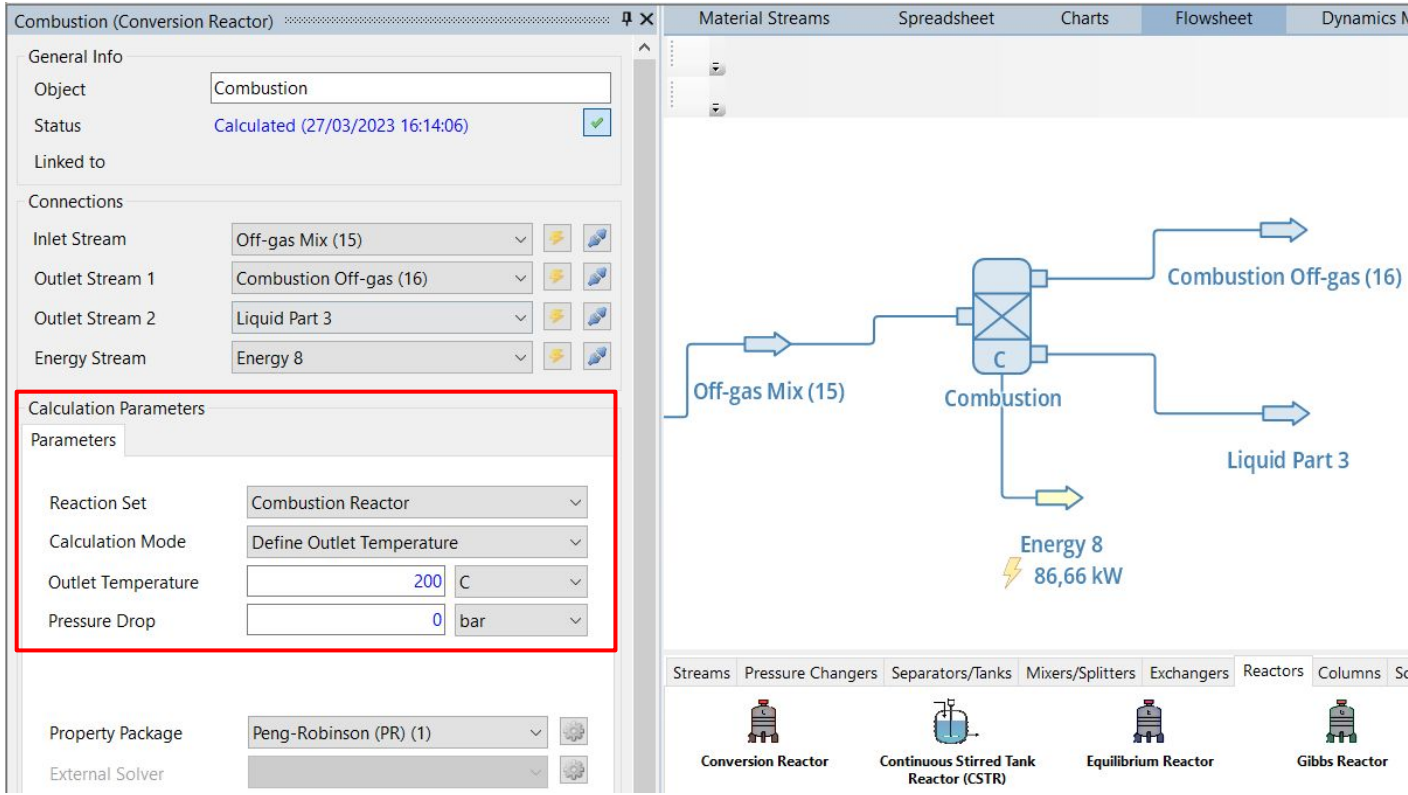
- First we'll add a new material stream for the oxygen. Change the inputs accordingly.
- Add a new mixer that connects the off-gas stream with the new oxygen stream.
- Use the *Inlet Minimum* as the calculation parameter.
- Now, go to reactors and drag a *conversion reactor*.

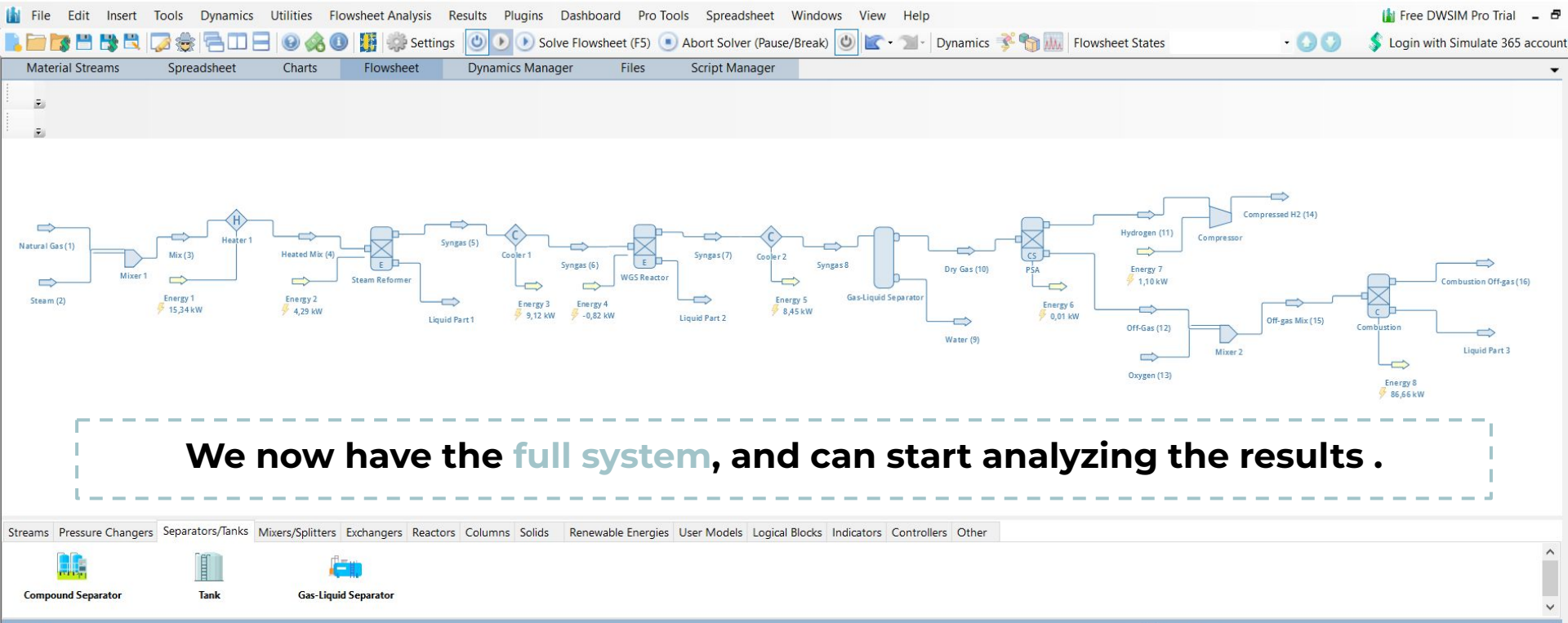


- First we need to add the combustion reactions, so check slide 21 and on the program go back to *Settings → Reactions → Chemical Reactions → Add Conversion*.
- Add all 4 reactions. Remember - negative stoichiometric coefficients mean reagents and positive stoichiometric coefficients mean products.
- On *Phase* choose Vapor.
- On *Conversion* we'll consider 100%.
- On *Reactions* go to *Reactions Sets* and create a new set with the four reactions you just added.


File Edit Insert Tools Dynamics Utilities Flowsheet Analysis Results Plugins Dashboard Pro Tools Spreadsheet Windows View Help
Settings
Solve Flowsheet (F5)
Abort Solver (Pause/Break)
Dynamics
Flowsheet States
Settings
Compounds Thermodynamics Reactions Mass and Energy Balances System of Units Object Properties Number Formatting / Other
Reaction Sets
Name Description
Default Set Default Reaction Set
Steam Methane Reformer...
Water Gas Shift Reactor
Combustion Reactor
Chemical Reactions
Name Type Equation
Methane Reforming Equilibrium HOH + CH4 <--> CO + 3H2
DWSIM - Reaction Set Editor
Identification
Name Combustion Reactor
Description
Reactions
Reaction Type Equation Active Seq.
Methane Combustion Conversion 2O2 + CH4 --> OCO + 2HOH 0
Ethane Combustion Conversion 7O2 + 2CH3CH3 --> 4OCO + 6... 0
Hydrogen Combustion Conversion 2H2 + O2 --> 2HOH 0
Carbon Monoxide Oxidation Conversion 2CO + O2 --> 2OCO 0
Cancel
OK
Gibbs Reactor (Reaktoro)
Watch Panel
Object
Results
General
Property Value Units
Temperature Difference 0 C.
Heat Load 0 kW
3 27/03/2023 15:44:27 Tip Only the conversion reactions will be considered by the conversion reactor.
2 27/03/2023 15:43:52 Message Last run execution time (s): 0,04847
1 27/03/2023 15:43:52 Message The flowsheet was calculated successfully.
0 27/03/2023 15:43:52 Message The flowsheet is being calculated, please wait...
Energy 8 (Energy ...
Liquid Part 3 (Ma...
Combustion Off-...
Combustion (Con...
Support continuous development and maintenance of DWSIM for as low as 3 USD/month or with a one-time donation. One-Time Donation Monthly Donation

Alter the parameters.





We now have the full system, and can start analyzing the results .

Streams | Pressure Changers | Separators/Tanks | Mixers/Splitters | Exchangers | Reactors | Columns | Solids | Renewable Energies | User Models | Logical Blocks | Indicators | Controllers | Other

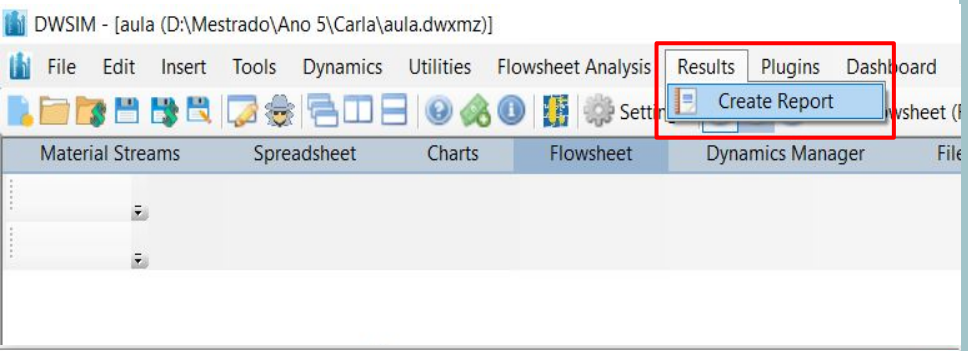
Compound Separator **Tank** **Gas-Liquid Separator**

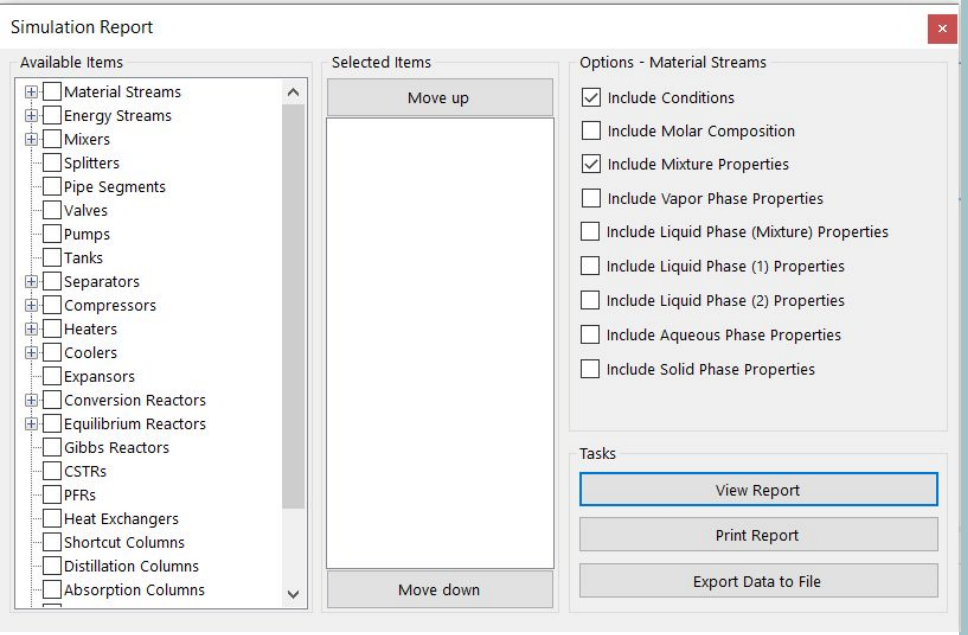
Information

	Date	Type	Message	Info
4	27/03/2023 16:18:32	Message	File D:\Mestrado\Ano 5\Carla\aula.dwxmz saved successfully.	+ Info
3	27/03/2023 16:14:07	Message	Last run execution time (s): 0,01934	+ Info
2	27/03/2023 16:14:07	Message	The flowsheet was calculated successfully.	+ Info
1	27/03/2023 16:14:07	Warning	Combustion: the energy balance did not converge within tolerance. (0,188381237831456 > 0,01)	+ Info
0	27/03/2023 16:14:07	Message	The flowsheet is being calculated, please wait...	+ Info

Watch Panel

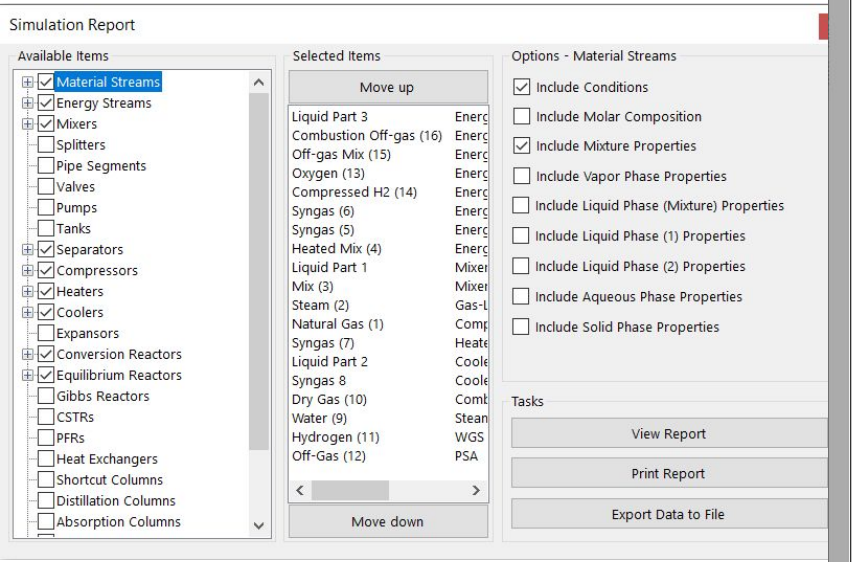
Object	Property	Value



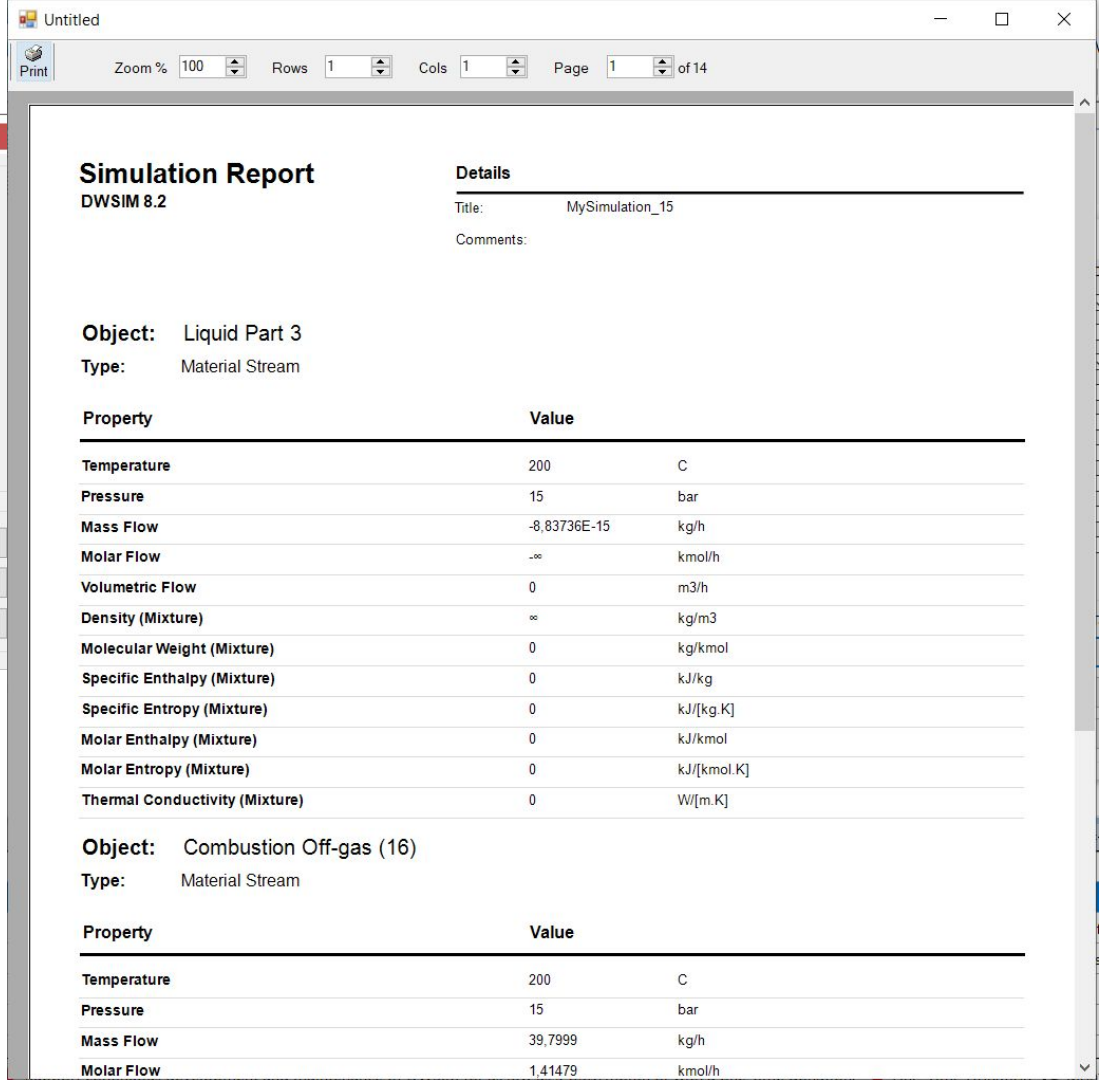


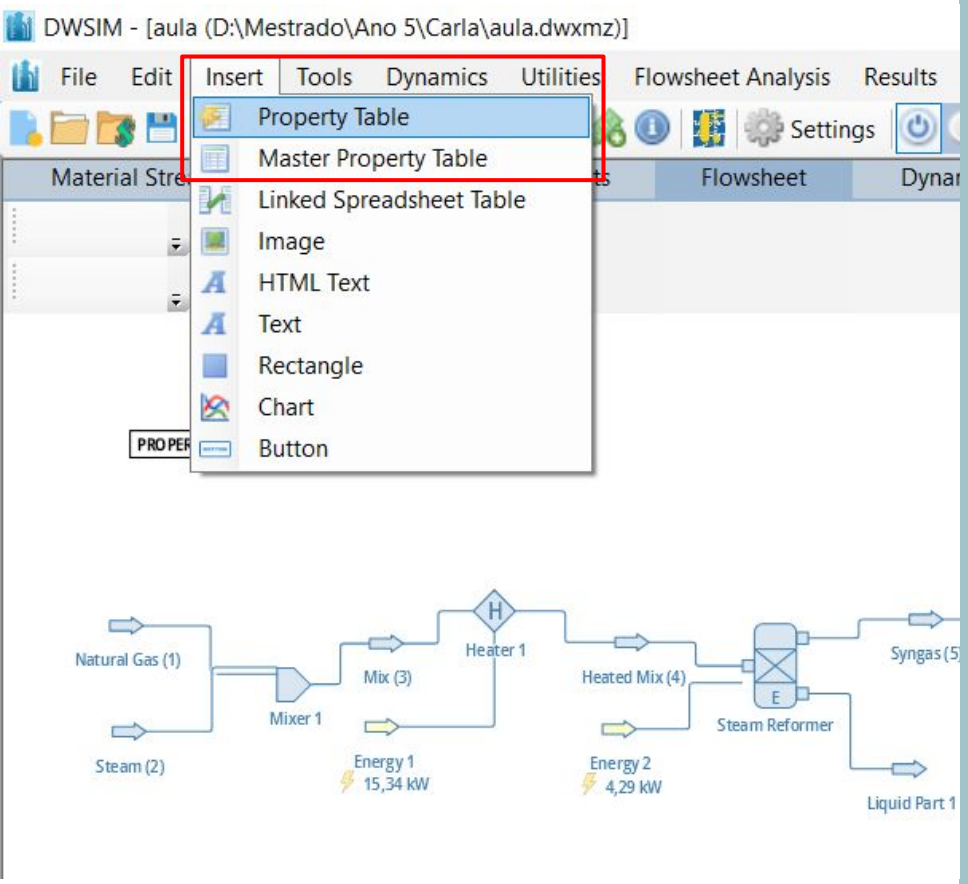
The full view of the process shown in the last slide already displays some results of the system, but not all. ***Here's some other ways to obtain more information about our simulation*****.**

- Go to *Results* and *Create Report*.
- A window like the one on the left will open, where you can pick the type of data you want to analyse. For example, on *Available Items* check all boxes that have a plus sign on the side (plus sign means that those are the components with information/ components you implemented in the system).

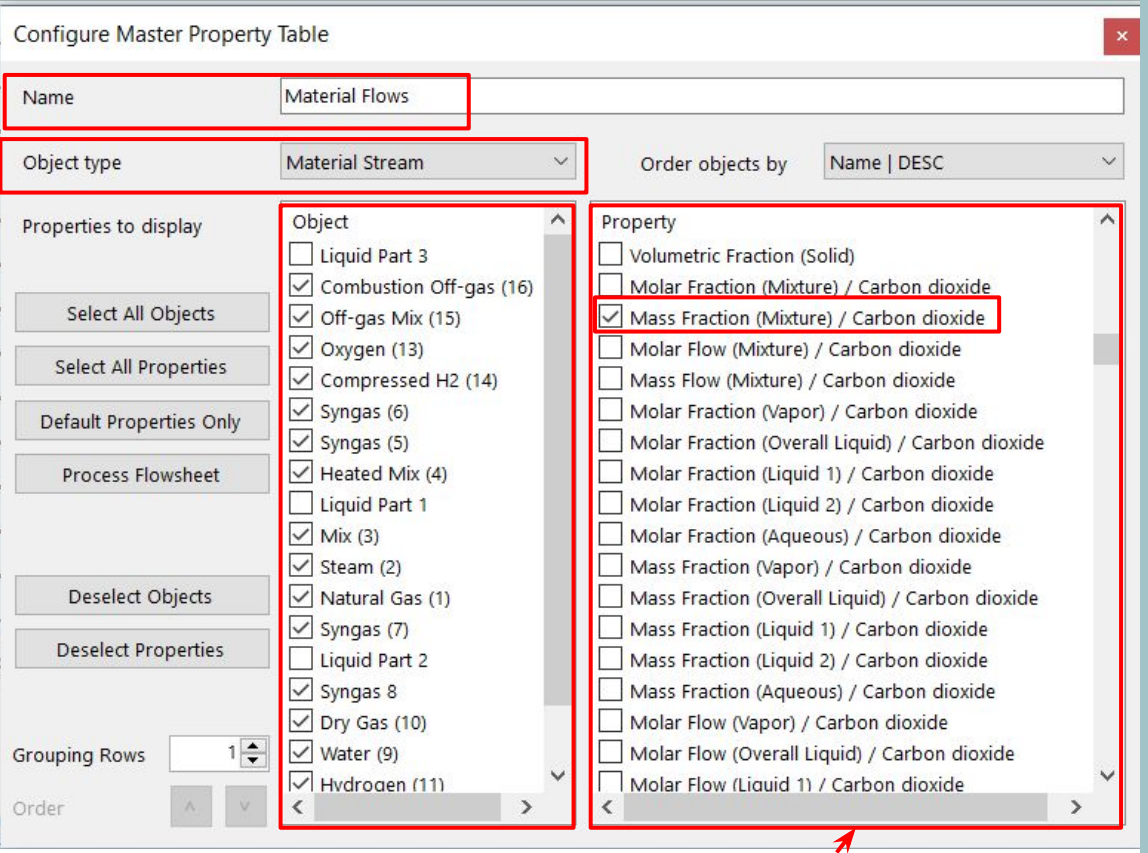


You'll get this document with more detailed information.





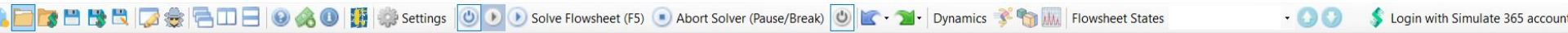
- Another way to see results is by adding a property table.
- Go to *Insert* and pick *Master Property Table (for this case)*, or property table .
- As you can see you can also insert other components to your flowsheet, for example, *Charts*.
- Once you click on master property table, a little box will appear on the flowsheet. Double click on it.
- On this table you can add every detail you want.
- Let's create TWO tables, one for material flows and one for energy.



For the compositions you can also pick *Molar Fraction (Mixture) / Compound*.

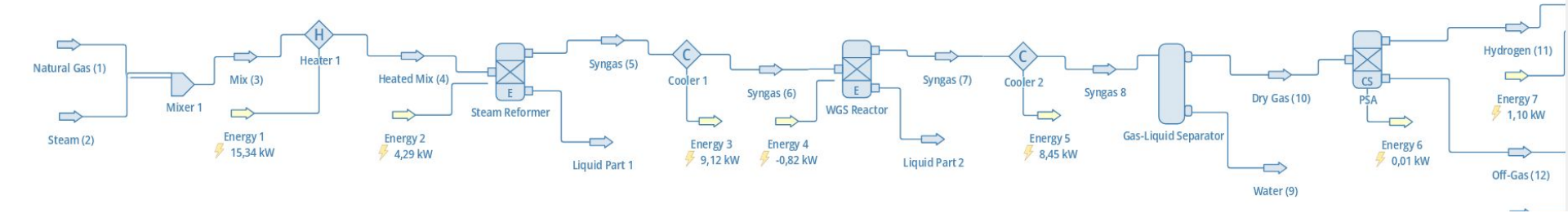
- Give a *Name* to your table.
- On *Object Type* choose *Material Stream*.
- On object, you'll have every material stream that appear in your simulation. We are not interested in the liquid parts so pick all boxes except these ones.
- On Property, you can choose the information you want to the represented in your table. Let's go with: Temperature; Pressure; Mass Flow; Molar Flow. And for the compositions you have to pick, Mass Fraction (Mixture) / Compound , for every element.

- **After selection just close the window and a table will appear.**



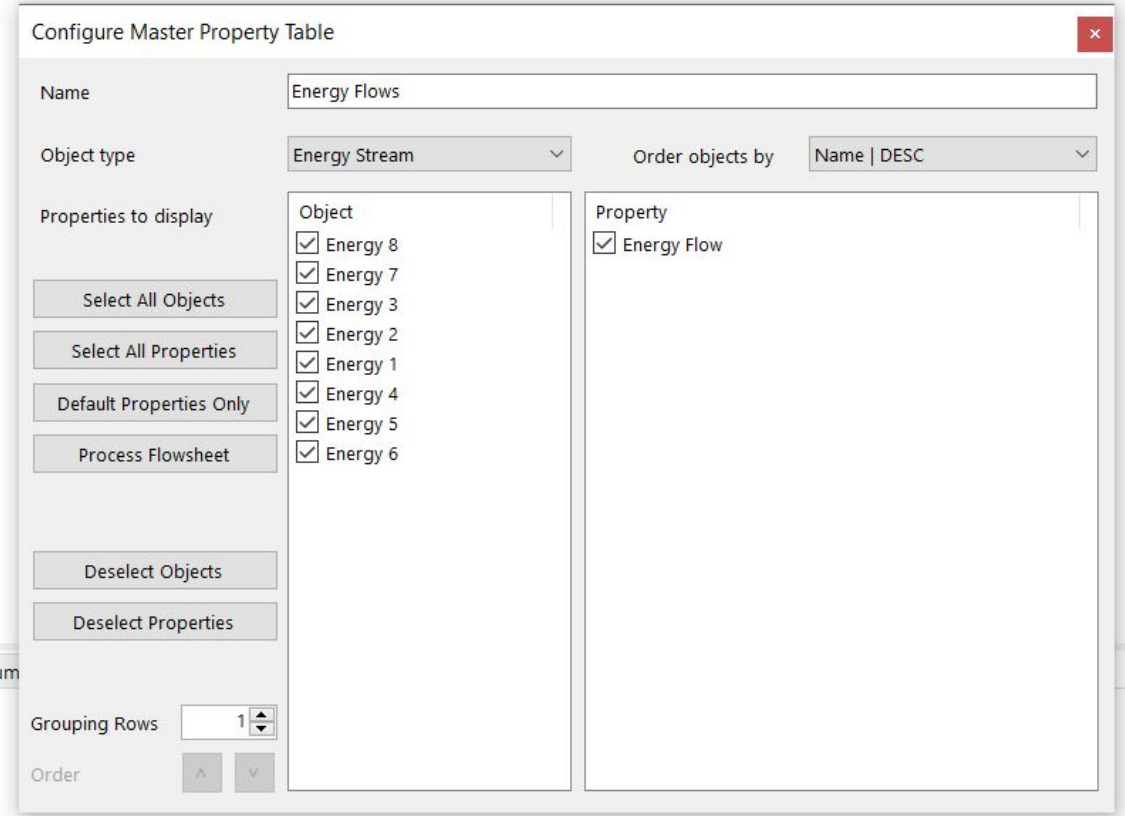
Material Flows

Object	Water (9)	Syngas 8	Syngas (7)	Syngas (6)	Syngas (5)	Steam (2)	Oxygen (13)	Off-gas Mix (15)	Off-Gas (12)	Natural Gas
Temperature	35	35	400	400	730	150	35	34,9901	35	
Pressure	15	15	29	29	30	1	15	15	15	
Mass Flow	0,606252	40	40	40	40	30	1	39,7999	38,7999	
Molar Flow	0,0336145	1,8923	1,8923	1,8923	1,8923	1,21105	0,0312512	1,59536	1,56411	0,553
Mass Fraction (Mixture) / Carbon dioxide	0,00188463	0,227821	0,227821	0,142514	0,142514	0,222075	0	0,228937	0,234838	0,0365
Mass Fraction (Mixture) / Carbon monoxide	3,56782E-07	0,117467	0,117467	0,171761	0,171761	0,141341	0	0,118058	0,1211	
Mass Fraction (Mixture) / Hydrogen	1,58741E-07	0,019794	0,019794	0,0158865	0,0158865	0,0101722	0	0,00497338	0,00510157	0,00055
Mass Fraction (Mixture) / Water	0,998108	0,0181324	0,0181324	0,0530528	0,0530528	0,0909062	0	0,0030196	0,00309743	
Mass Fraction (Mixture) / Oxygen	6,85612E-06	0,121101	0,121101	0,121101	0,121101	0,161468	1	0,146835	0,124846	
Mass Fraction (Mixture) / Nitrogen	3,18278E-07	0,10912	0,10912	0,10912	0,10912	0,141357	0	0,109669	0,112496	0,01
Mass Fraction (Mixture) / Methane	2,97275E-08	0,226144	0,226144	0,226144	0,226144	0,0809512	0	0,227281	0,233139	0,763
Mass Fraction (Mixture) / Ethane	5,06766E-10	0,16042	0,16042	0,16042	0,16042	0,15173	0	0,161226	0,165382	0,186



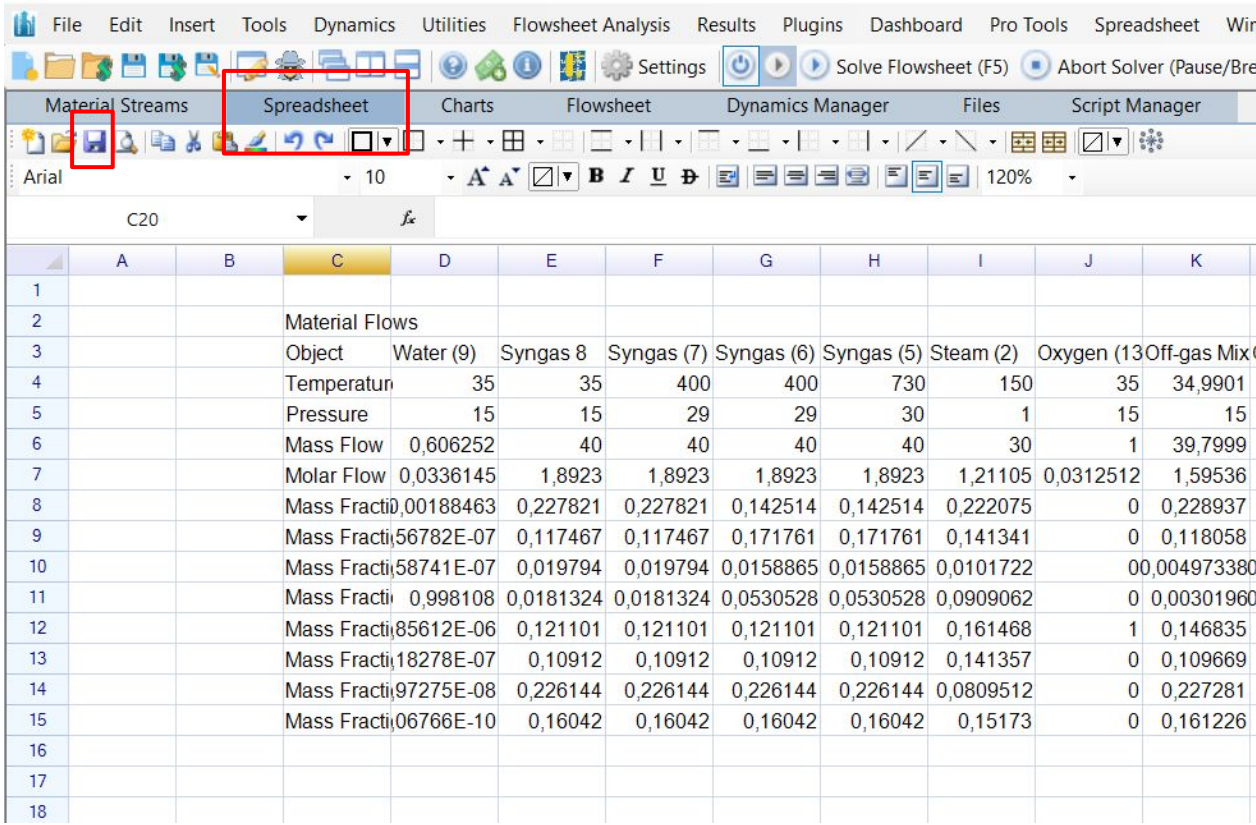
Energy Flows									
Object	Energy 8	Energy 7	Energy 6	Energy 5	Energy 4	Energy 3	Energy 2	Energy 1	
Energy Flow	86,6642	1,09611	0,0105673	8,45411	-0,816428	9,11614	4,28632	15,3377	kW

Now, let's do the same for the energy flows.



Results in the format of the property table are more useful if you're interested in doing more calculation.

- You can right click on the tables, *Copy Process Data to Clipboard*, and then paste on the spreadsheet separator.
- You can use this separator as your calculation sheet, or save it an open it on Excel.



	A	B	C	D	E	F	G	H	I	J	K
1											
2			Material Flows								
3			Object	Water (9)	Syngas 8	Syngas (7)	Syngas (6)	Syngas (5)	Steam (2)	Oxygen (13	Off-gas Mix
4			Temperatur	35	35	400	400	730	150	35	34,9901
5			Pressure	15	15	29	29	30	1	15	15
6			Mass Flow	0,606252	40	40	40	40	30	1	39,7999
7			Molar Flow	0,0336145	1,8923	1,8923	1,8923	1,8923	1,21105	0,0312512	1,59536
8			Mass Fracti	0,00188463	0,227821	0,227821	0,142514	0,142514	0,222075	0	0,228937
9			Mass Fracti	56782E-07	0,117467	0,117467	0,171761	0,171761	0,141341	0	0,118058
10			Mass Fracti	58741E-07	0,019794	0,019794	0,0158865	0,0158865	0,0101722	0	0,00497338
11			Mass Fracti	0,998108	0,0181324	0,0181324	0,0530528	0,0530528	0,0909062	0	0,00301960
12			Mass Fracti	85612E-06	0,121101	0,121101	0,121101	0,121101	0,161468	1	0,146835
13			Mass Fracti	18278E-07	0,10912	0,10912	0,10912	0,10912	0,141357	0	0,109669
14			Mass Fracti	97275E-08	0,226144	0,226144	0,226144	0,226144	0,0809512	0	0,227281
15			Mass Fracti	06766E-10	0,16042	0,16042	0,16042	0,16042	0,15173	0	0,161226
16											
17											
18											

THANKS

Do you have any questions?

fc49714@alunos.fc.ul.pt