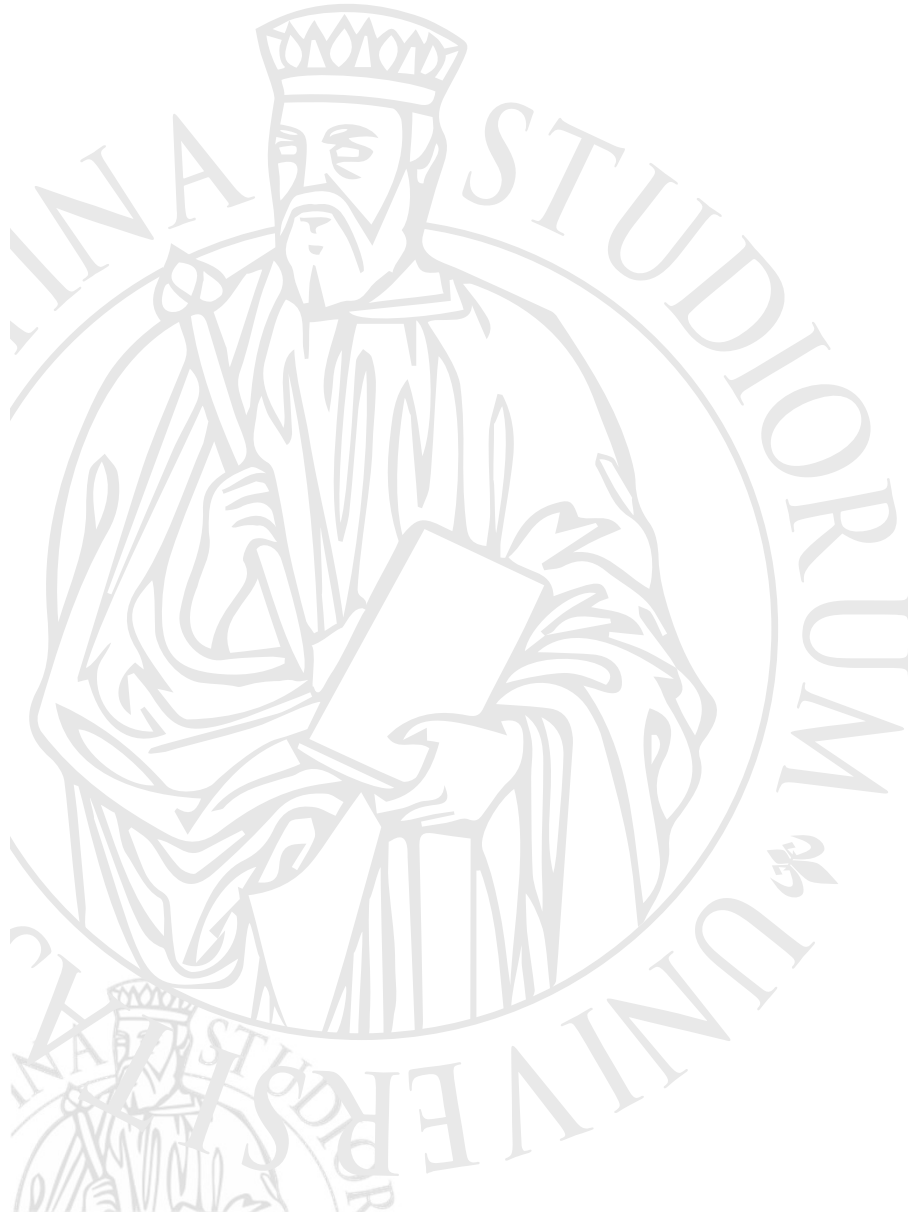




UNIVERSITÀ
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Dipartimento di
Ingegneria Industriale



Process Simulation using UNISIM Design

(Training Course - Basic level II)

Dr. Pouriya H Niknam

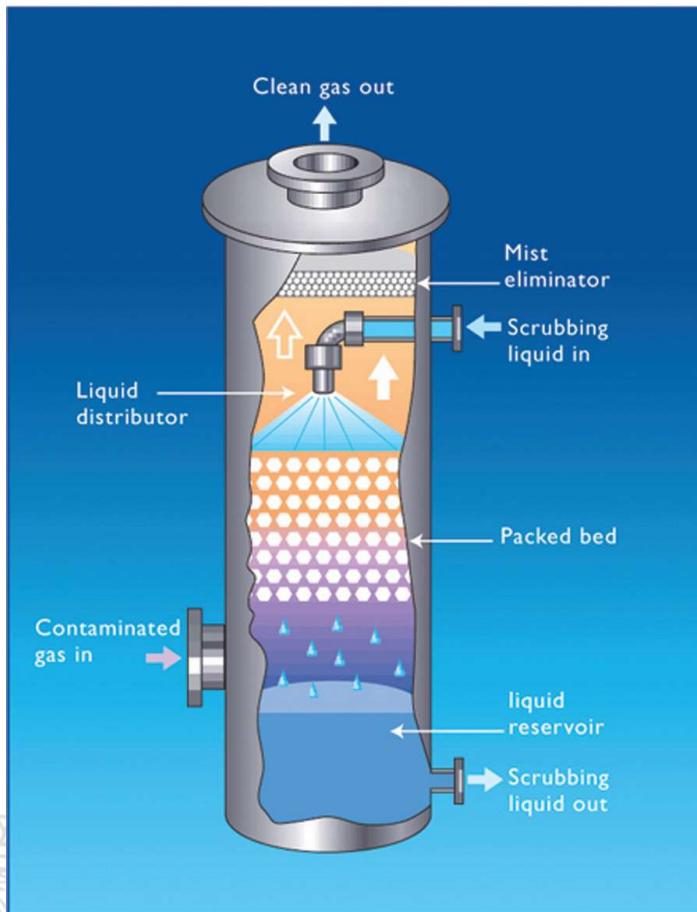
Nov,20, 2019



- Example #2.1: absorber (Scrubber)
- Example #2.2: absorber (Scrubber) with recycle
- Example #2.3: absorber (Scrubber) with recycle + precooler
- Example #2.4: absorber (Scrubber) sizing
- Example #2.5: ORC cycle
- Example #2.6: ORC cycle optimization
- Example #2.7: ORC cycle +air cooler

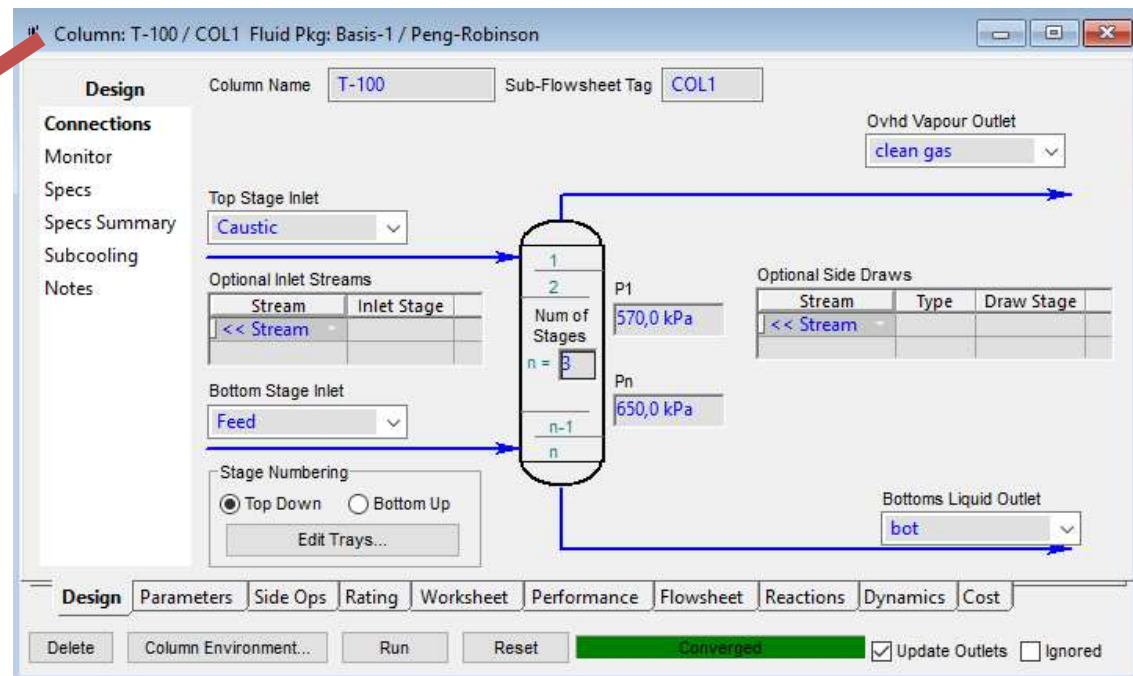
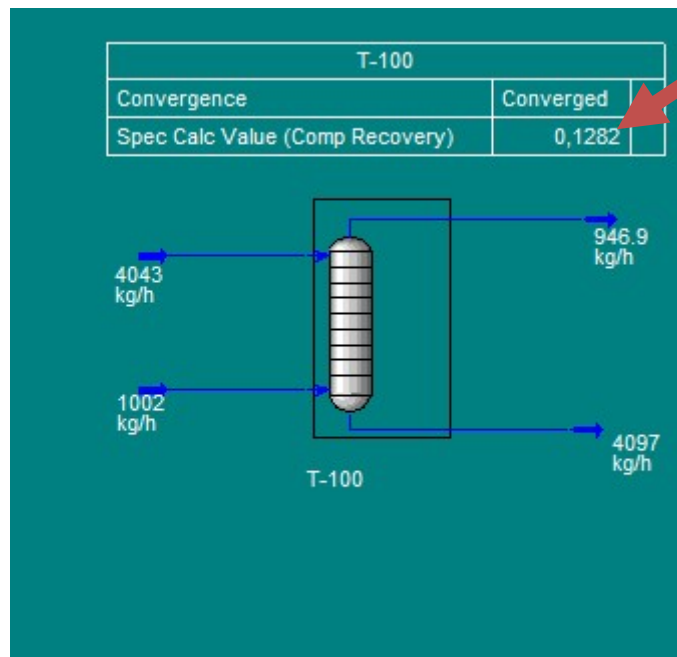
Example #2.1: absorber (Scrubber)

- scrubber
- Objective: CO₂ elimination



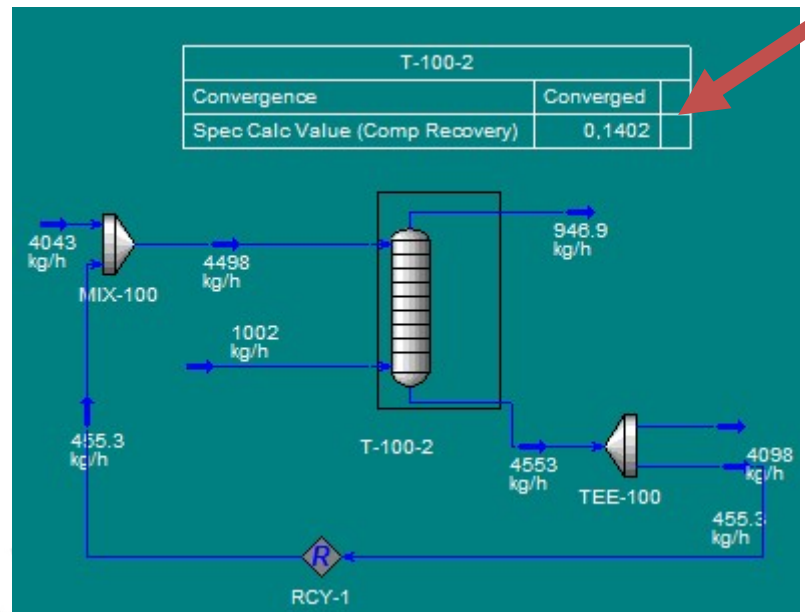
Example #2.1: absorber (Scrubber)

- Absorber
- Objective: CO₂ elimination
- Gas Feed2 : CO₂ 30% + CH₄ 70% 9,2bar 50C 40kgmol/hr
- Liq. Feed1 : NaOH 10% + water 90% 6,5bar 54C 200 kgmol/hr



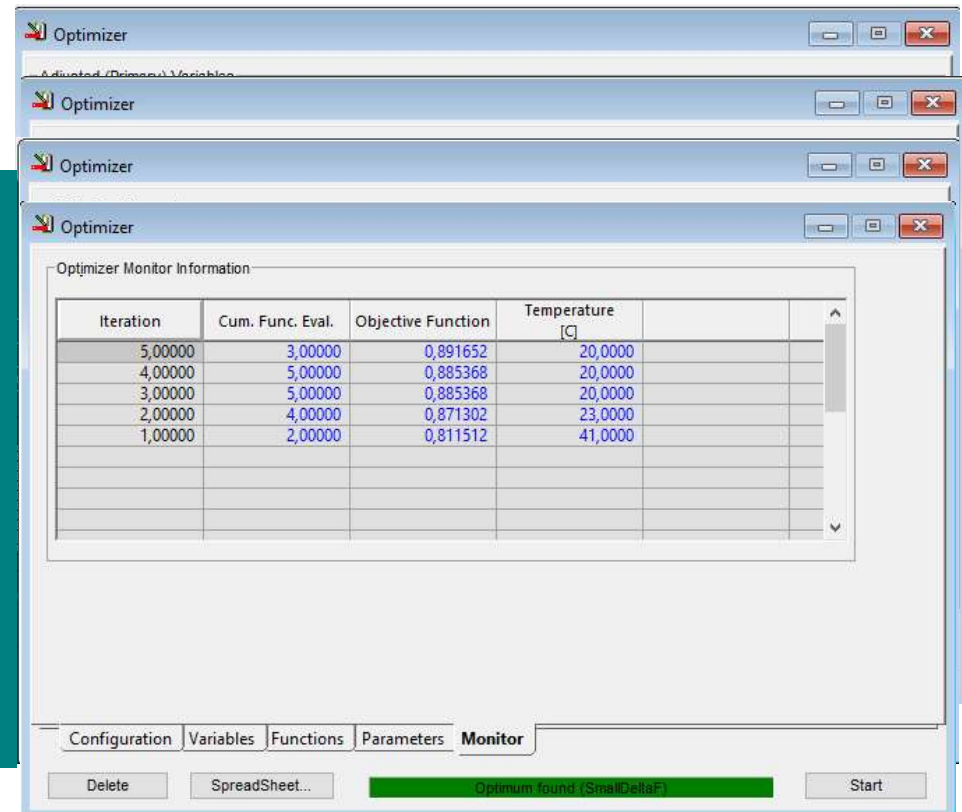
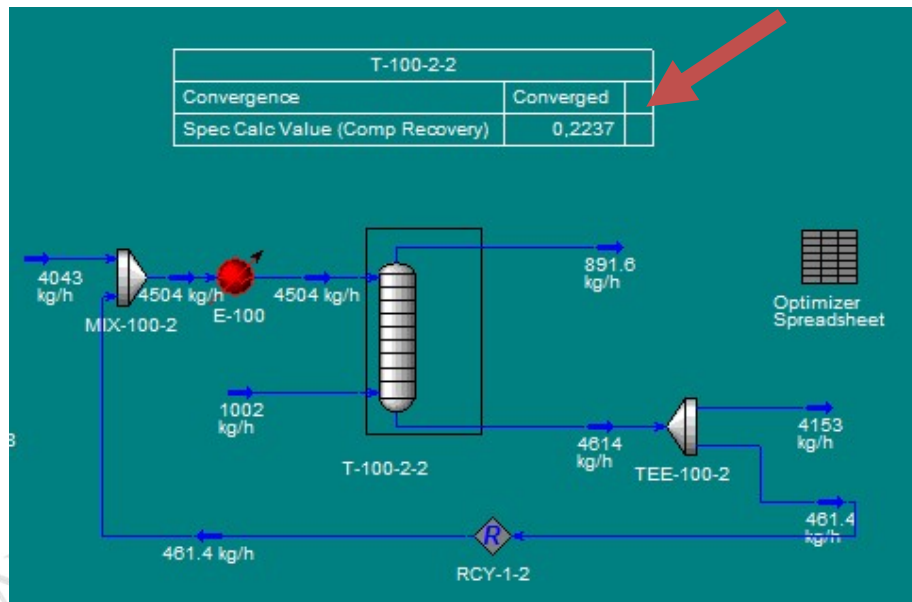
Example #2.2: absorber (Scrubber)

- Absorber with Recycle
- Objective: CO₂ elimination
- Gas Feed1 : CO₂ 30% + CH₄ 70% 9,2bar 50C 40kgmol/hr
- Liq. Feed2 : NaOH 10% + water 90% 6,5bar 54C 200 kgmol/hr



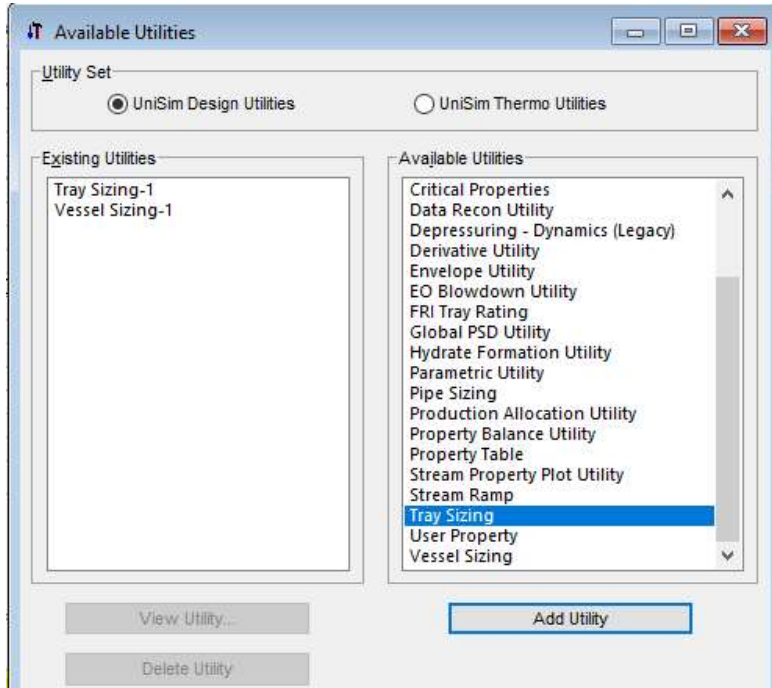
Example #2.3: absorber (Scrubber)

- Absorber with Recycle + Caustic cooler
- Objective: CO₂ elimination
- Gas Feed1 : CO₂ 30% + CH₄ 70% 9,2bar 50C 40kgmol/hr
- Liq. Feed2 : NaOH 10% + water 90% 6,5bar 54C 200 kgmol/hr



Example #2.4: absorber (Scrubber)

- Sizing of final column



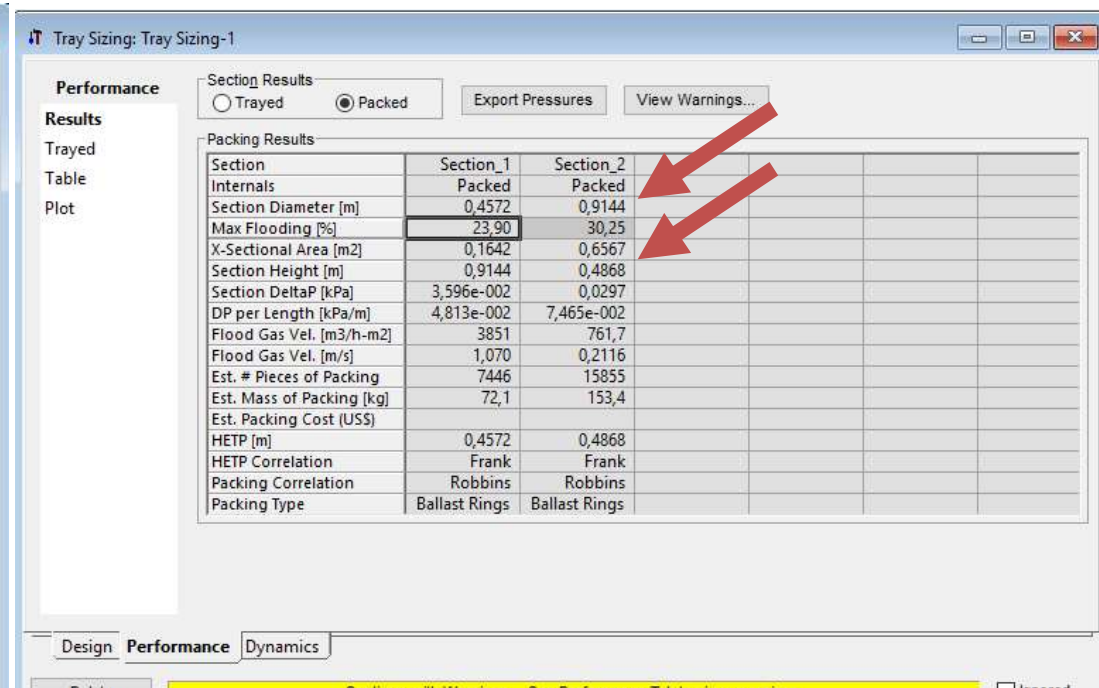
Available Utilities

Utility Set: ☒ UniSim Design Utilities ☐ UniSim Thermo Utilities

Existing Utilities: Tray Sizing-1, Vessel Sizing-1

Available Utilities: Critical Properties, Data Recon Utility, Depressuring - Dynamics (Legacy), Derivative Utility, Envelope Utility, EO Blowdown Utility, FRI Tray Rating, Global PSD Utility, Hydrate Formation Utility, Parametric Utility, Pipe Sizing, Production Allocation Utility, Property Balance Utility, Property Table, Stream Property Plot Utility, Stream Ramp, **Tray Sizing**, User Property, Vessel Sizing

Buttons: View Utility..., Add Utility, Delete Utility



Tray Sizing: Tray Sizing-1

Performance: ☐ Tray Results ☒ Packed

Results: Tray, Table, Plot

Section	Section_1	Section_2
Internals	Packed	Packed
Section Diameter [m]	0,4572	0,9144
Max Flooding [%]	23,90	30,25
X-Sectional Area [m2]	0,1642	0,6567
Section Height [m]	0,9144	0,4868
Section DeltaP [kPa]	3,596e-002	0,0297
DP per Length [kPa/m]	4,813e-002	7,465e-002
Flood Gas Vel. [m3/h-m2]	3851	761,7
Flood Gas Vel. [m/s]	1,070	0,2116
Est. # Pieces of Packing	7446	15855
Est. Mass of Packing [kg]	72,1	153,4
Est. Packing Cost (US\$)		
HETP [m]	0,4572	0,4868
HETP Correlation	Frank	Frank
Packing Correlation	Robbins	Robbins
Packing Type	Ballast Rings	Ballast Rings

Design Performance Dynamics

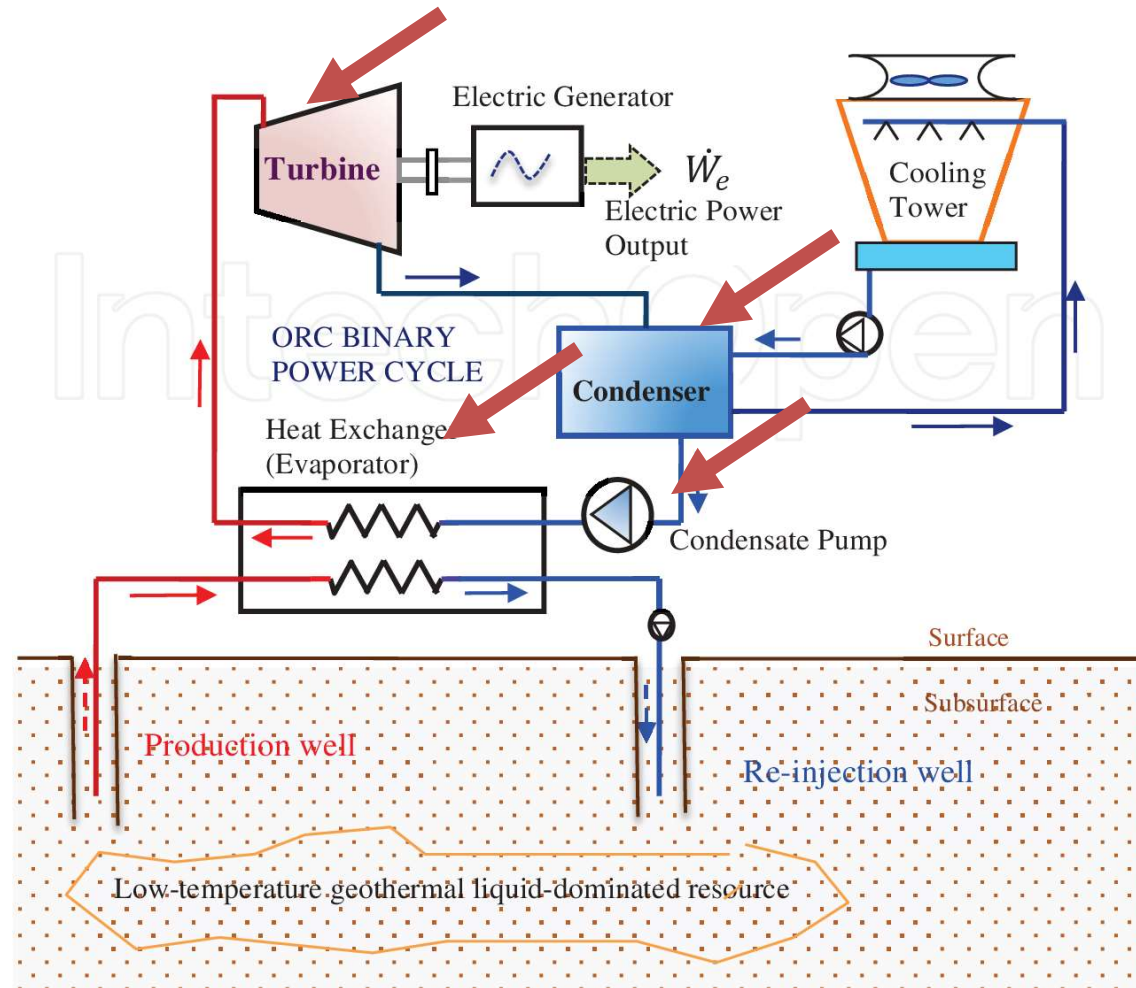
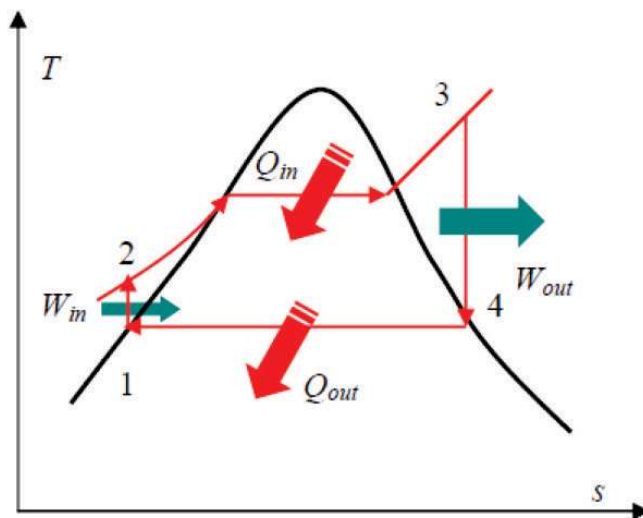


Break time



Ex. #2.5: ORC cycle

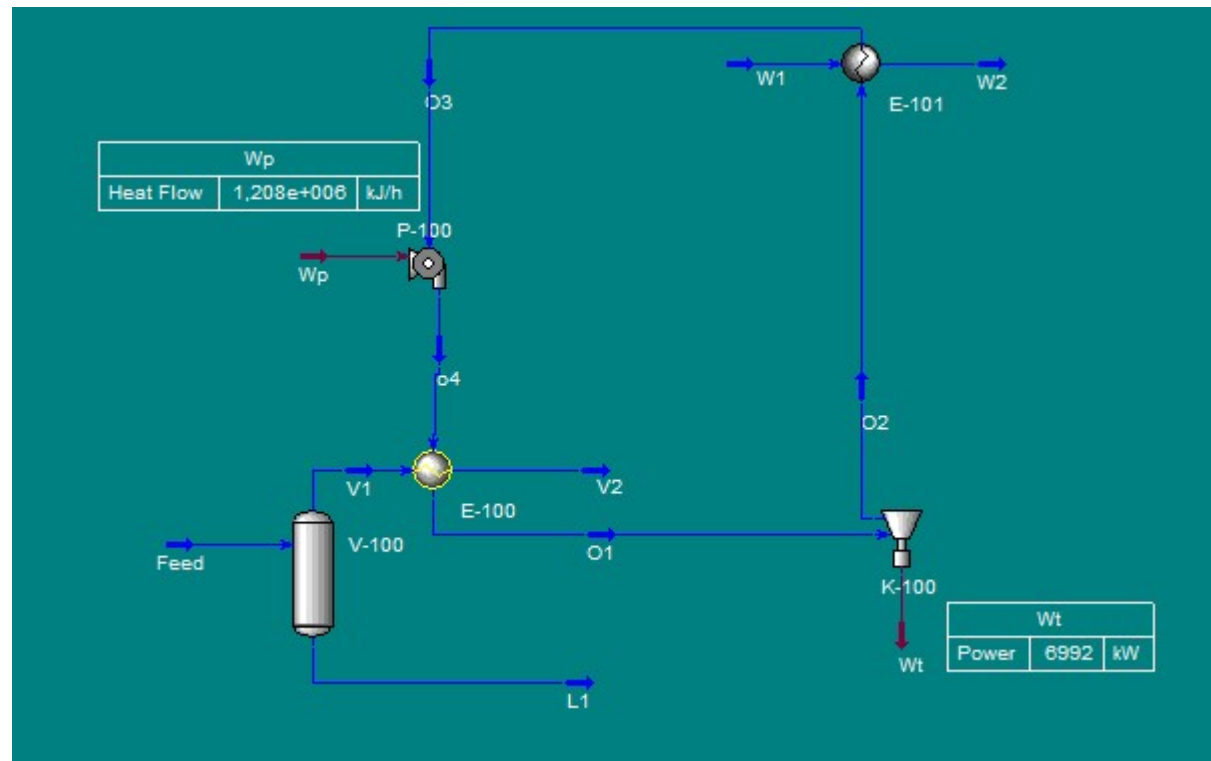
- ORC cycle-Basic



Ex. #2.5: ORC cycle

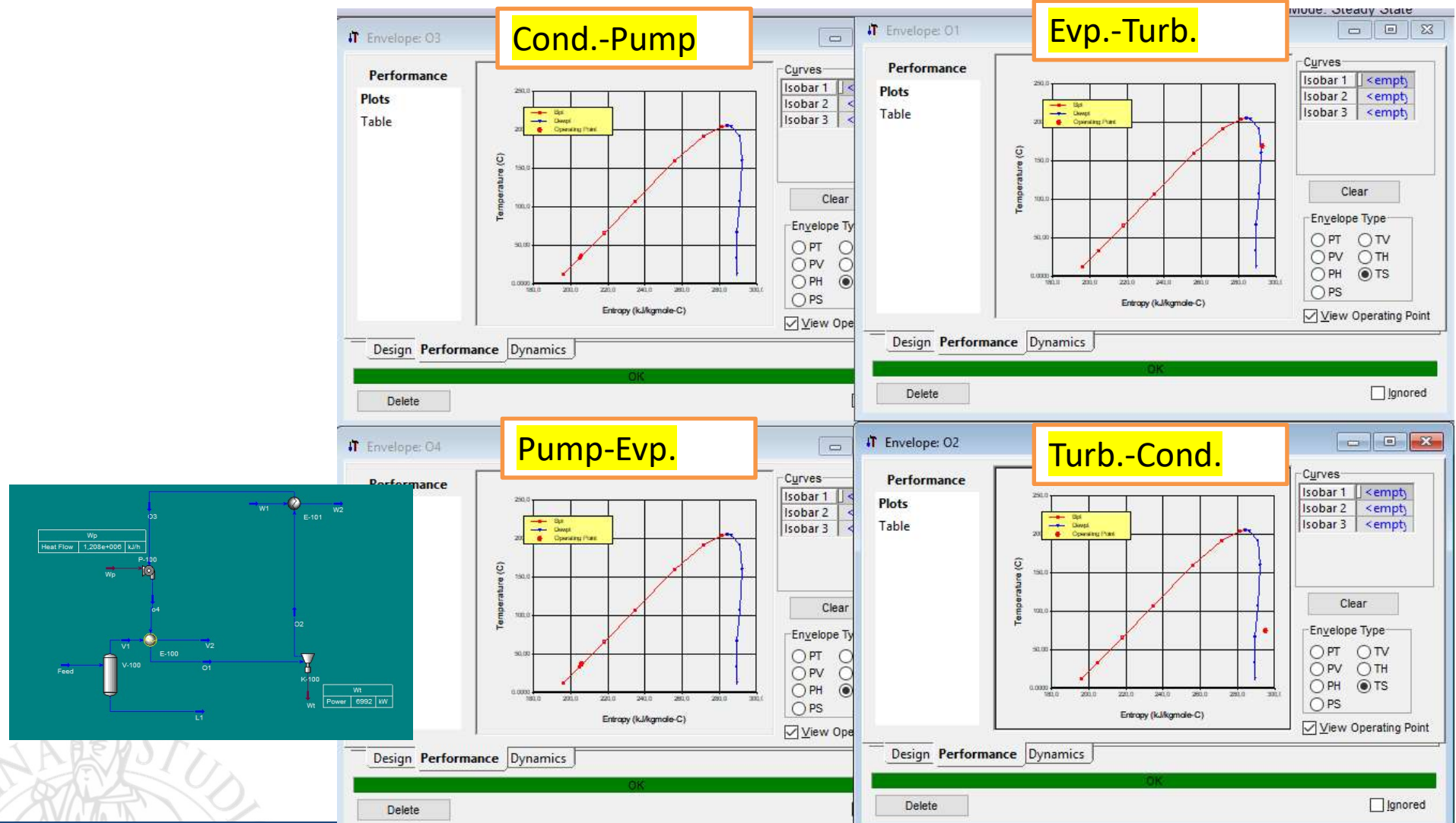
- Simulating ORC

- Feed: superheated steam: H₂O:92% + CO₂:8% 10bar 180C
 - After evaporator : 10bar 89C
- ORC cycle composition : R141b 100%
 - After evaporator: 170C
 - Pump output pressure: 2300 kPa
 - Turbine output : 200 kPa
 - Turbine efficiency: 88%
 - Condenser output: 35C
 - Condenser $\Delta P_{tube} = 0$
 - Condenser $\Delta P_{shell} = 0$
 - Evap. $\Delta P_{tube} = 0$
 - Evap. $\Delta P_{shell} = 0$



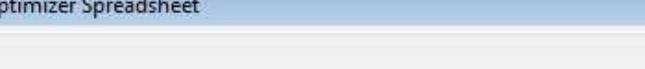
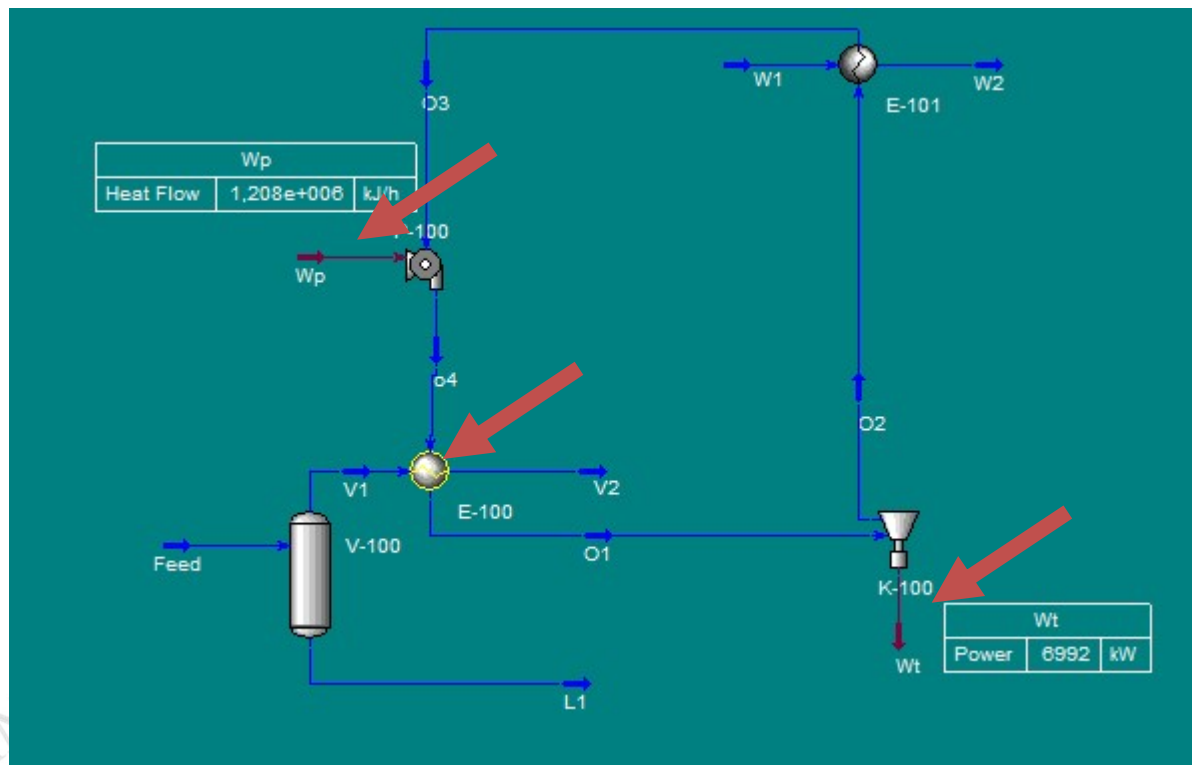
Ex. #2.5: ORC cycle

• Simulating ORC



Ex. #2.6: ORC optimization

- Calculate efficiency of ORC
- Optimizing the cycle



The screenshot shows the 'Optimizer Spreadsheet' window. A red arrow points to the 'Imported Variables' section. Below this section is a table with the following data:

Cell	Object	Variable Description
B1	Wt	Heat Flow
B2	Wp	Heat Flow
B3	E-100	Exchanger Hot Duty

Optimizer Spreadsheet

Current Cell
Variable Type: Variable Type: ▾

B4 Variable: Variable:

$$=-(B1-B2)/B3$$

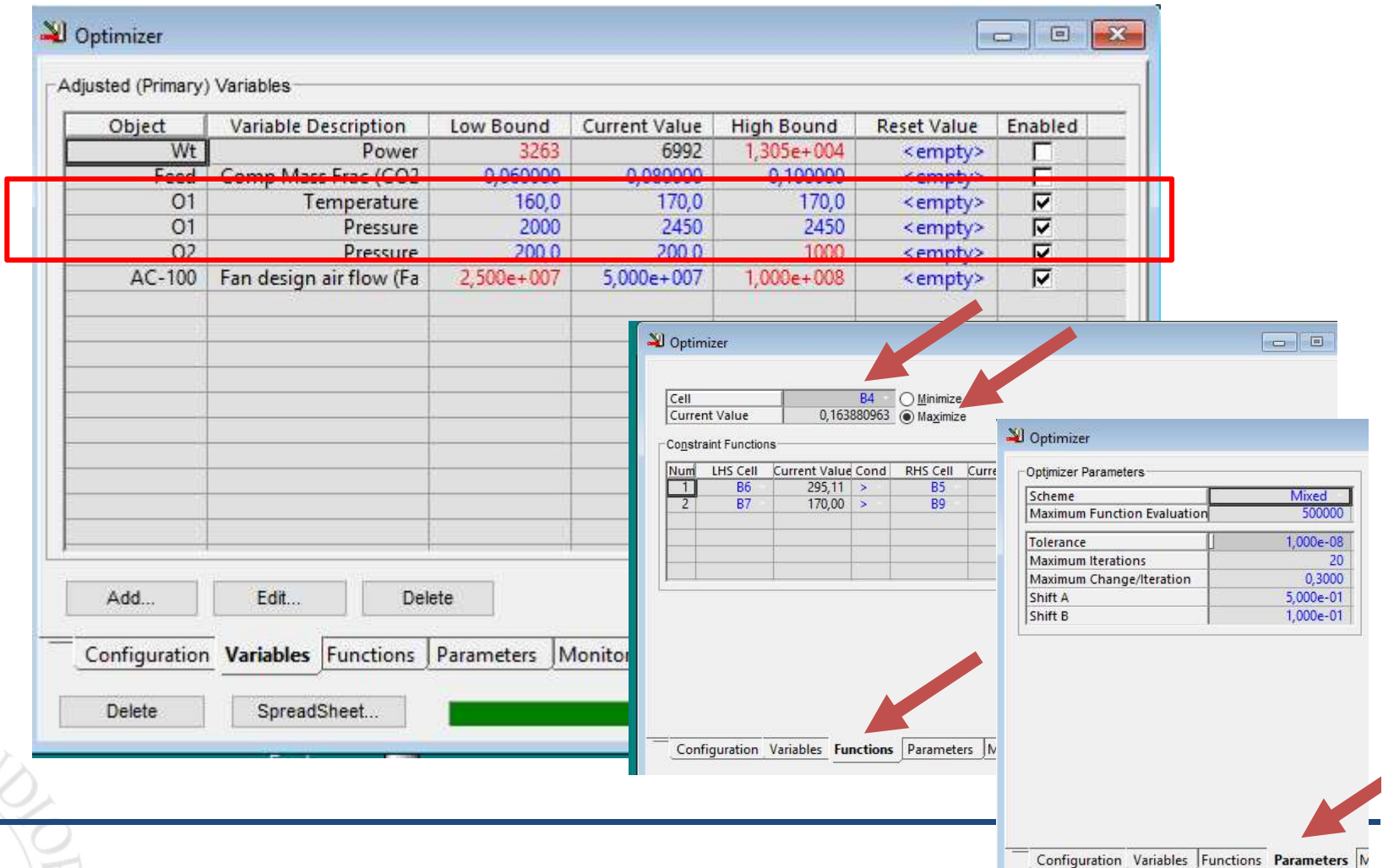
	A	B
1	Wt	6.039e+006 kcal/h
2	Wp	2.904e+005 kcal/h
3	Qeva	-3.495e+007 kcal/h
4	Eff	0.1645
5	St,i	293.0 kJ/kgmole-C
6	St,o	295.1 kJ/kgmole-C
7	Tt,i	170.0 C
8	Ts	167.7 C
9	limit	168.7 C
10		
11		

Connections Parameters Formulas **Spreadsheet** Calc

Function Help... Spreadsheet O

Ex. #2.6: ORC optimization

- Calculate efficiency of ORC
- Optimizing the cycle



The screenshot displays the Optimizer software interface, which is used for optimizing the cycle. The main window shows a table of Adjusted (Primary) Variables, with a red box highlighting the variables O1 (Temperature), O1 (Pressure), O2 (Pressure), and AC-100 (Fan design air flow (Fa)).

Object	Variable Description	Low Bound	Current Value	High Bound	Reset Value	Enabled
Wt	Power	3263	6992	1,305e+004	<empty>	<input type="checkbox"/>
Feed	Comp Mass Fra (CO2)	0,060000	0,080000	0,100000	<empty>	<input type="checkbox"/>
O1	Temperature	160,0	170,0	170,0	<empty>	<input checked="" type="checkbox"/>
O1	Pressure	2000	2450	2450	<empty>	<input checked="" type="checkbox"/>
O2	Pressure	200,0	200,0	1000	<empty>	<input checked="" type="checkbox"/>
AC-100	Fan design air flow (Fa)	2,500e+007	5,000e+007	1,000e+008	<empty>	<input checked="" type="checkbox"/>

Below the table are buttons for Add..., Edit..., and Delete. At the bottom, there are tabs for Configuration, Variables, Functions, Parameters, and Monitor. A green bar is visible under the Monitor tab.

Two smaller windows are overlaid on the main window, showing additional settings:

- Optimizer (Cell B4):** This window shows the current value of cell B4 as 0,163880963. It has radio buttons for Minimize and Maximize, with Maximize selected. Below this is a table of Constraint Functions:

Num	LHS Cell	Current Value	Cond	RHS Cell	Current Value
1	B6	295,11	>	B5	
2	B7	170,00	>	B9	

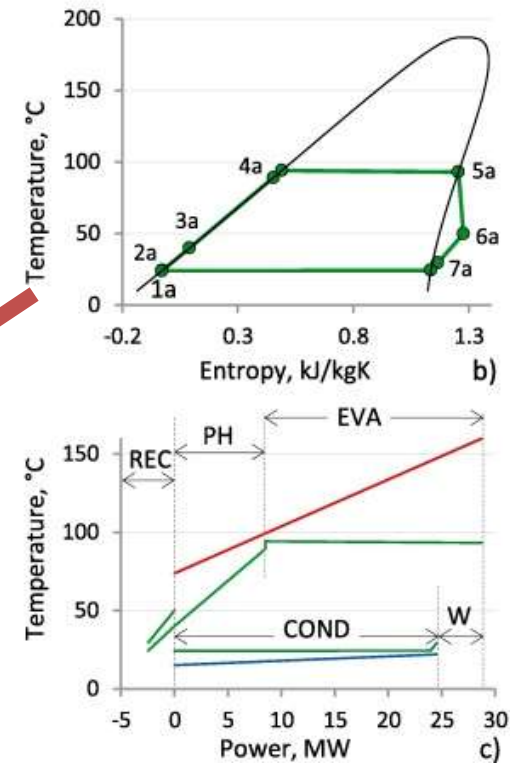
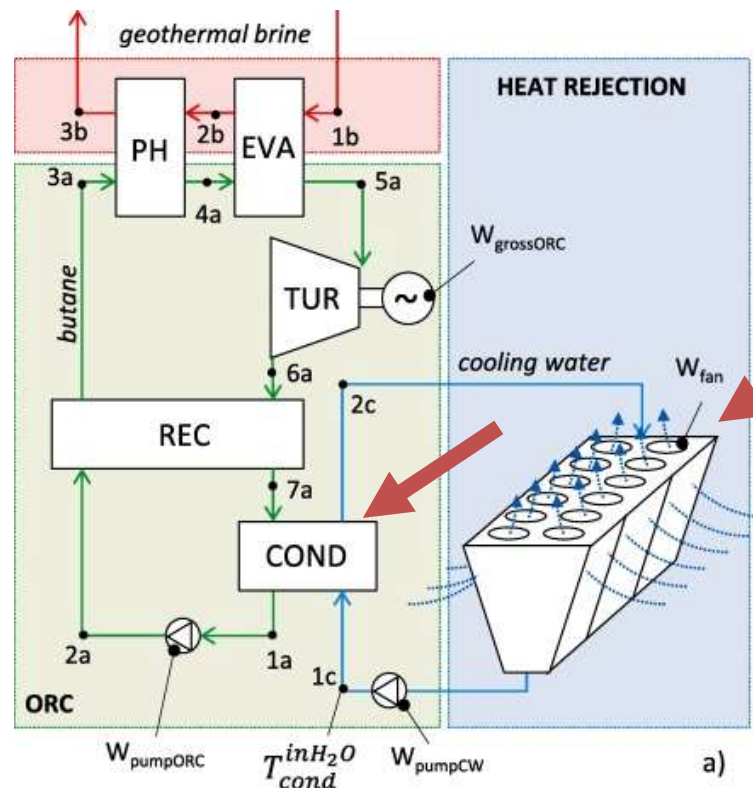
At the bottom of this window are tabs for Configuration, Variables, Functions, and Parameters.

- Optimizer (Parameters):** This window shows the Optimizer Parameters. The Scheme is set to Mixed. The Maximum Function Evaluation is 500000. The Tolerance is 1,000e-08. The Maximum Iterations is 20. The Maximum Change/Iteration is 0,3000. The Shift A is 5,000e-01. The Shift B is 1,000e-01.

At the bottom of this window are tabs for Configuration, Variables, Functions, and Parameters.

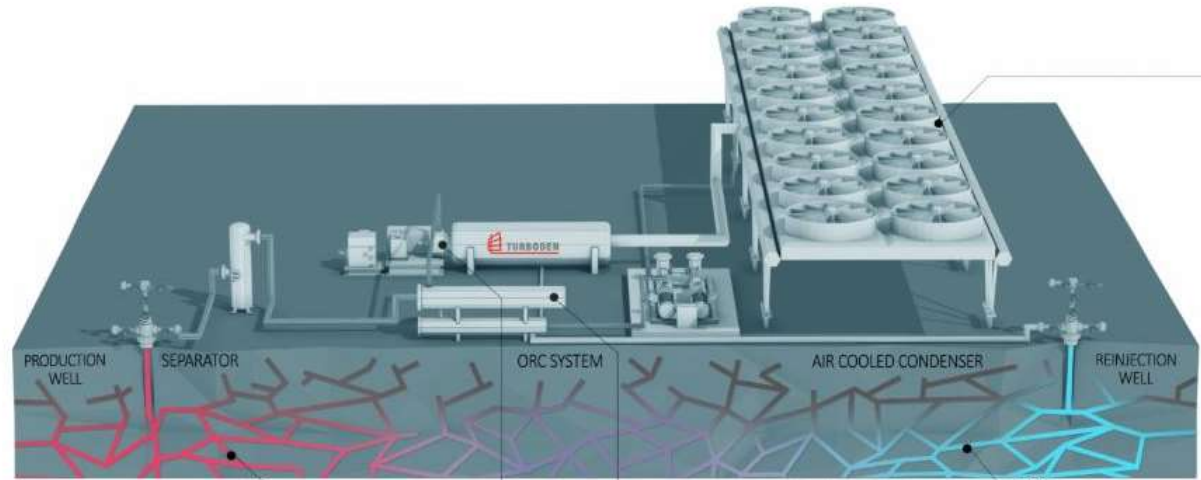
Ex. #2.2: ORC cycle

- Adding air cooler
- Adjust the air flow

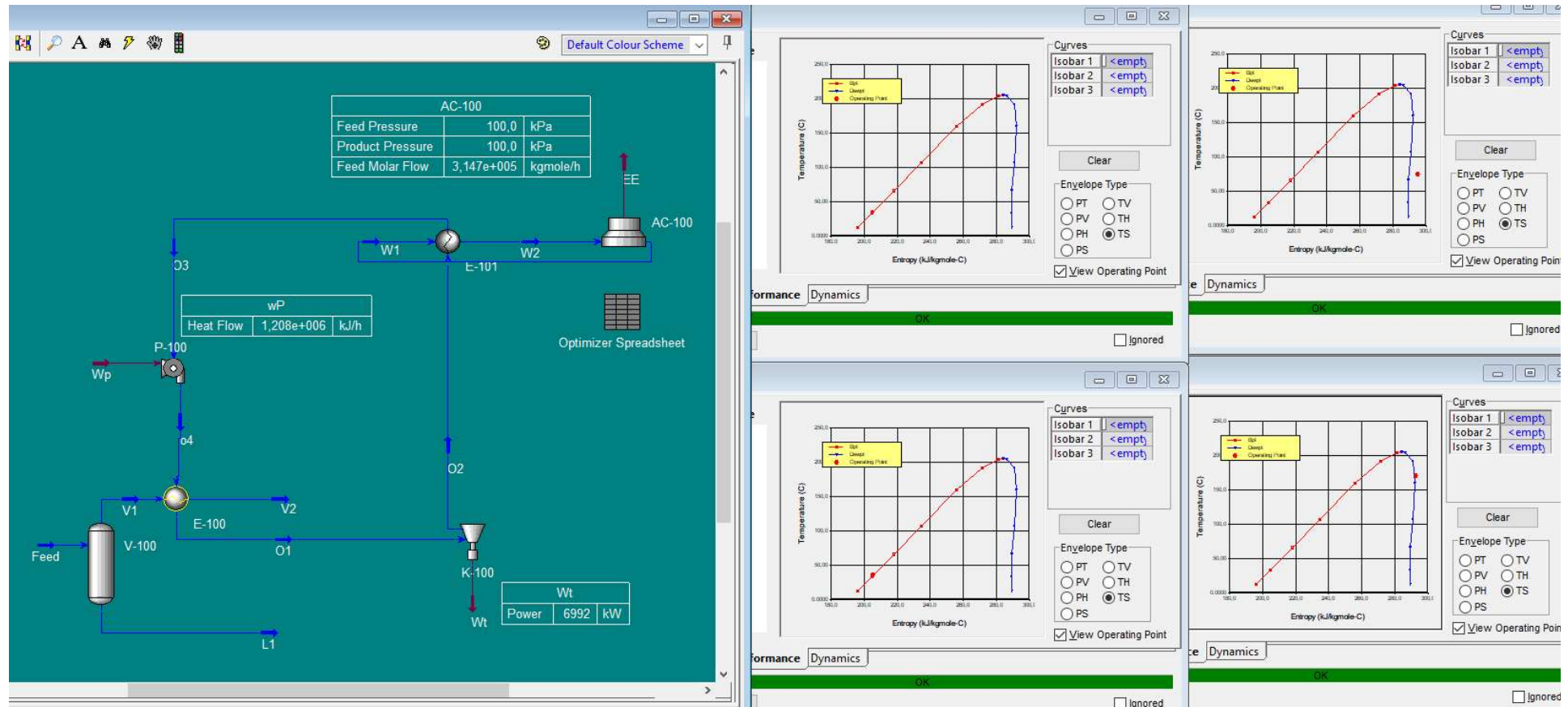


Ex. #1.5: Refrigeration Cycle

- Adding air cooler
- Adjust the air flow



- Also we can optimize the air flow of air coolers...





- <http://tiny.cc/0dokgz>
- or
- <https://bit.ly/2r9KUiR>