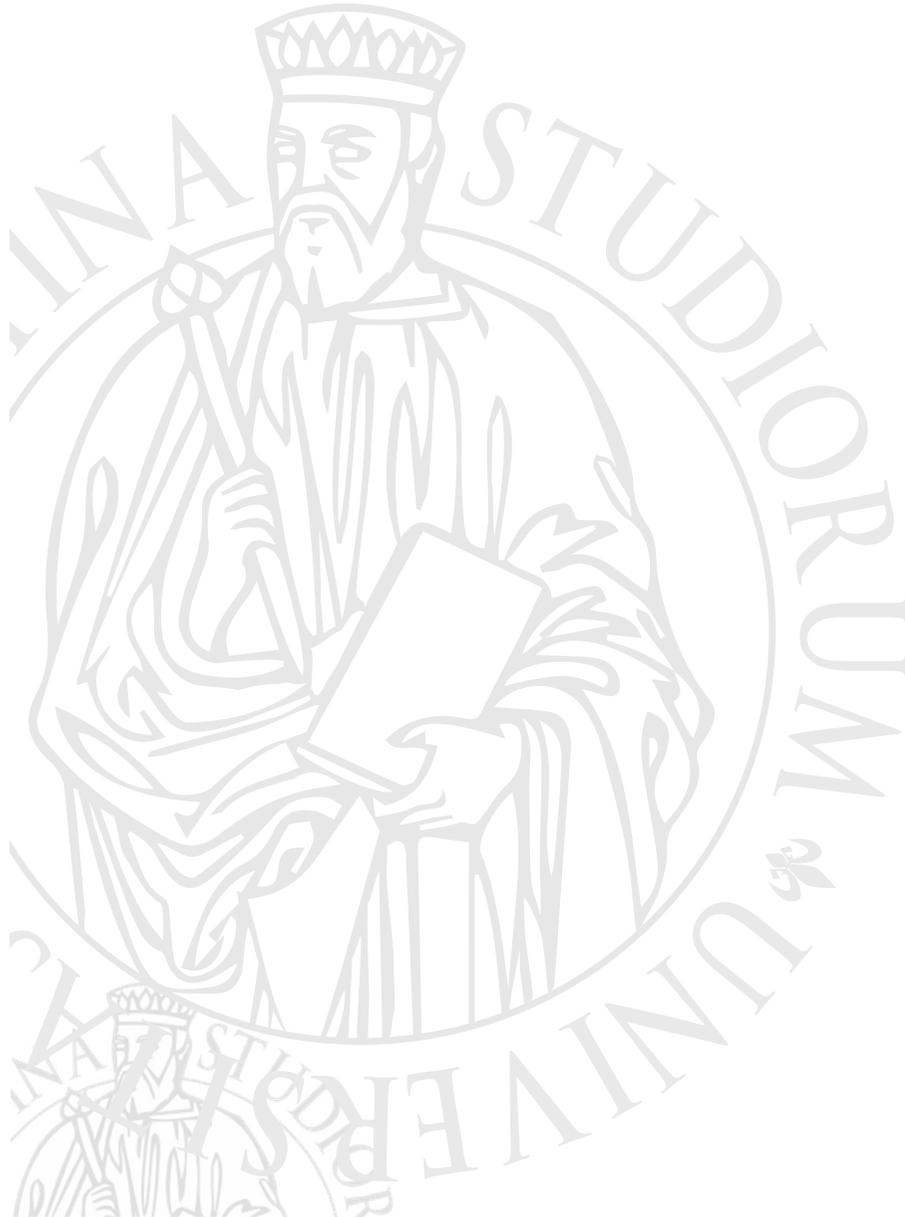




UNIVERSITÀ
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Dipartimento di
Ingegneria Industriale



Process Simulation using UNISIM Design

(Training Course - Basic level II)

Dr. Pouriya H Niknam

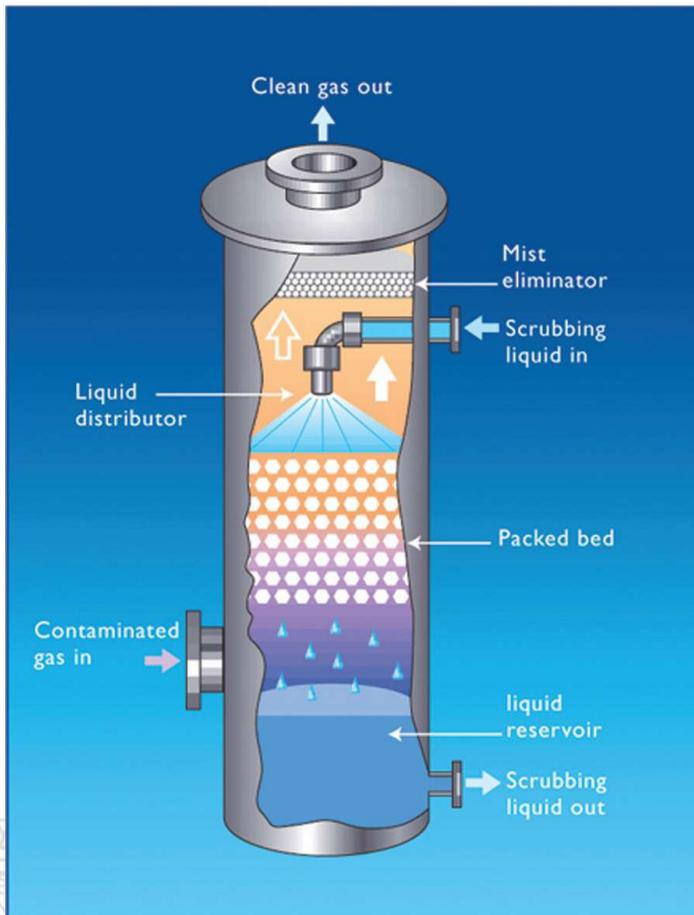
Nov,20, 2019



- 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

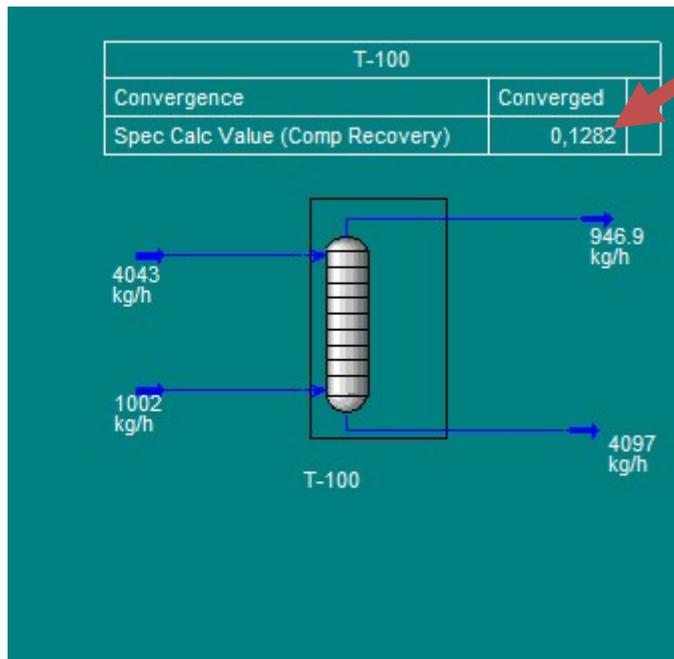
Example #2.1: absorber (Scrubber)

- 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



Column Name: T-100 Sub-Flowsheet Tag: COL1

Connections

Monitor

Specs

Specs Summary

Subcooling

Notes

Top Stage Inlet: Caustic

Optional Inlet Streams:

Stream	Inlet Stage
<< Stream	

Bottom Stage Inlet: Feed

Stage Numbering: Top Down Bottom Up

Edit Trays...

Num of Stages: n = 8

P1: 570,0 kPa

Pn: 650,0 kPa

Optional Side Draws:

Stream	Type	Draw Stage
<< Stream		

Ovhd Vapour Outlet: clean gas

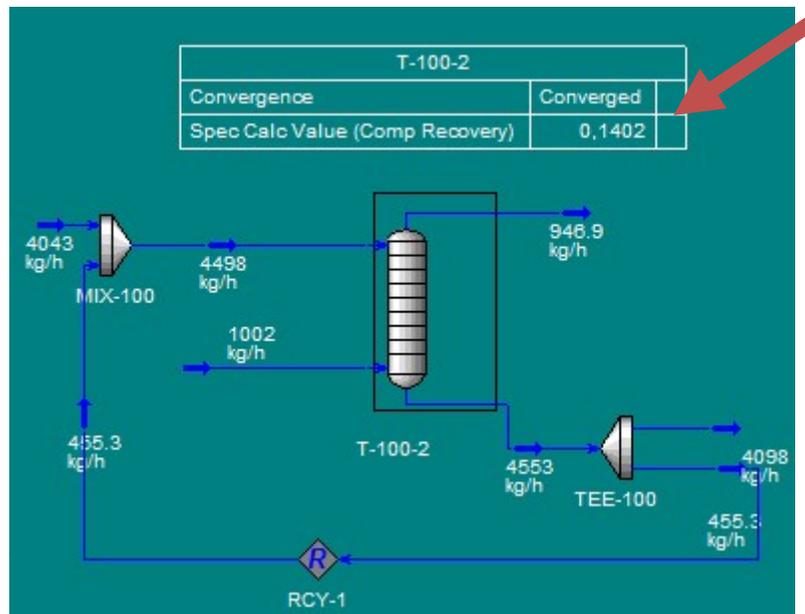
Bottoms Liquid Outlet: bot

Design Parameters Side Ops Rating Worksheet Performance Flowsheet Reactions Dynamics Cost

Delete Column Environment... Run Reset Converged Update Outlets Ignored

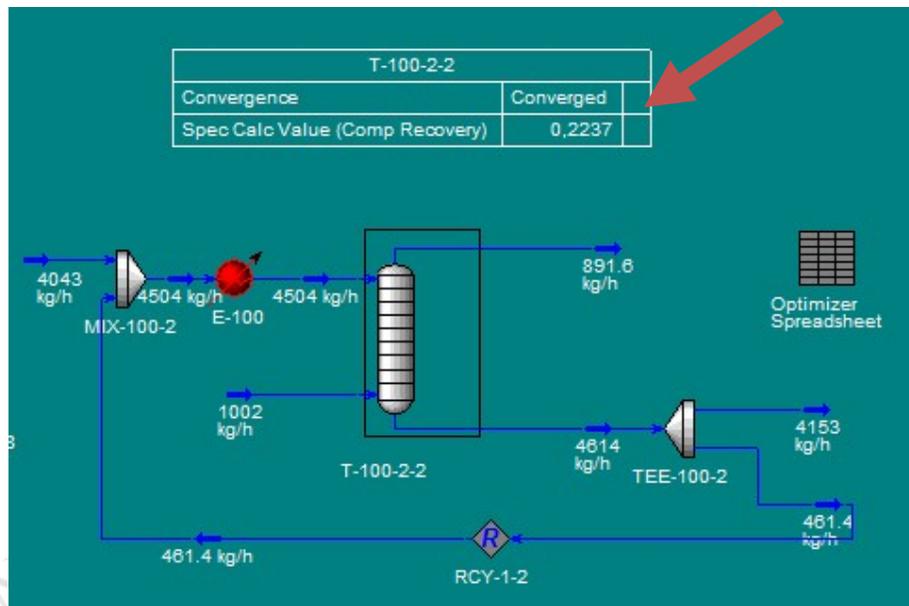
Example #2.2: absorber (Scrubber)

- 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

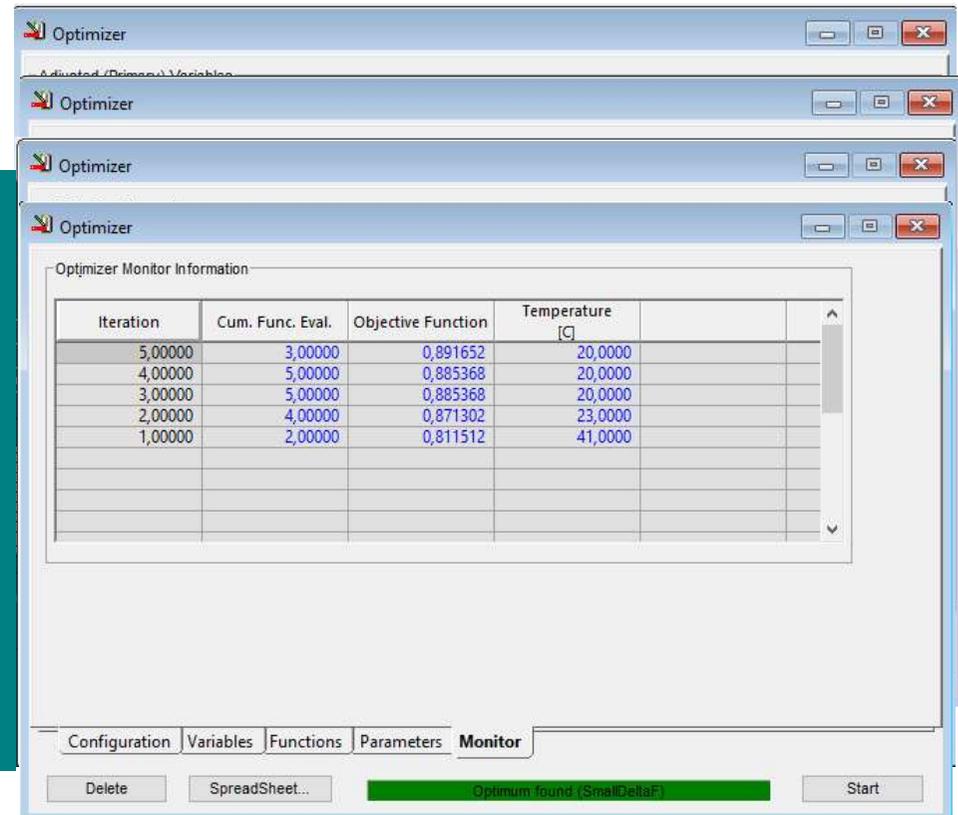


Example #2.3: absorber (Scrubber)

- 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



T-100-2-2	
Convergence	Converged
Spec Calc Value (Comp Recovery)	0,2237



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

Tray Sizing: Tray Sizing-1

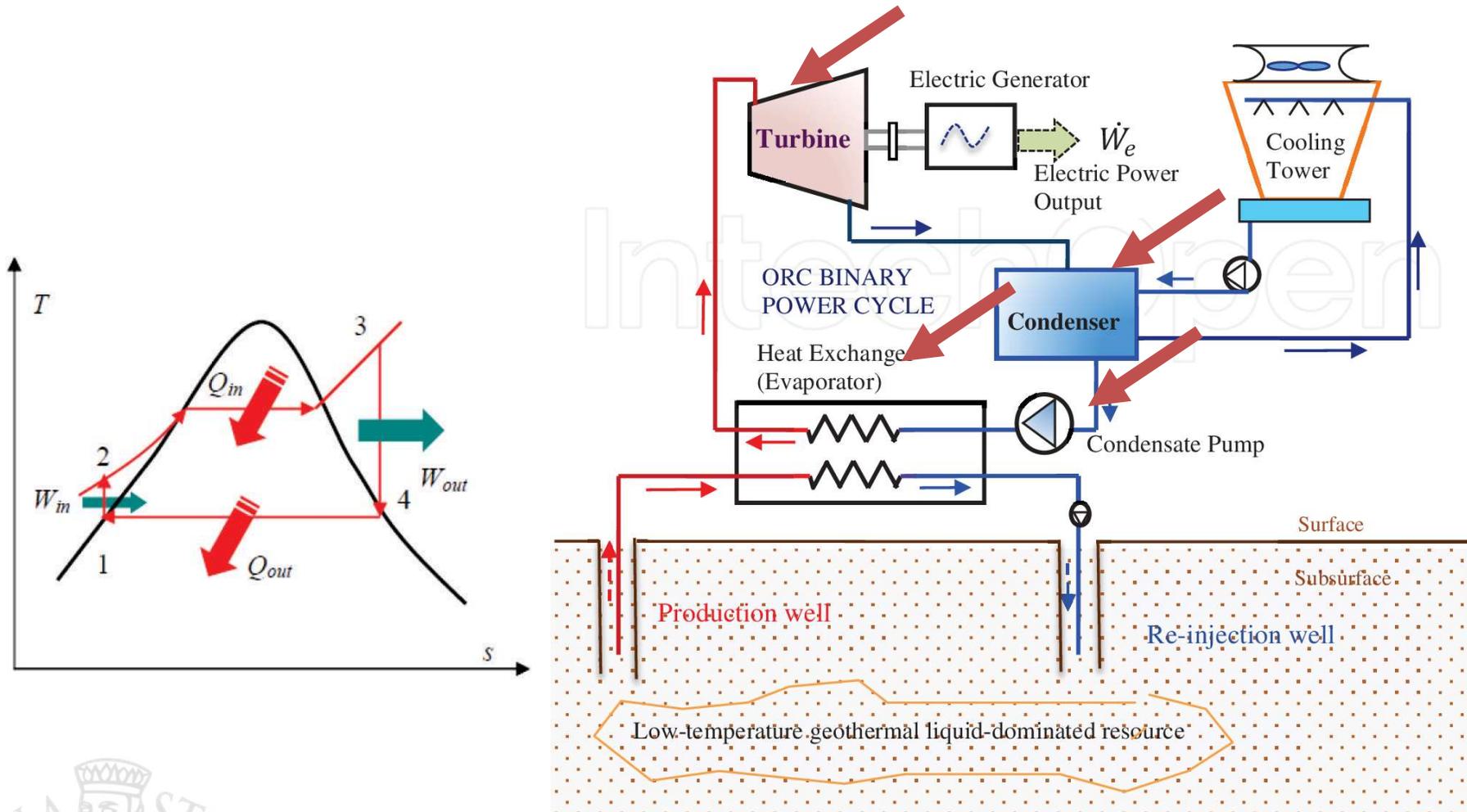
Performance: Trayed Packed

Results: Trayed, 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

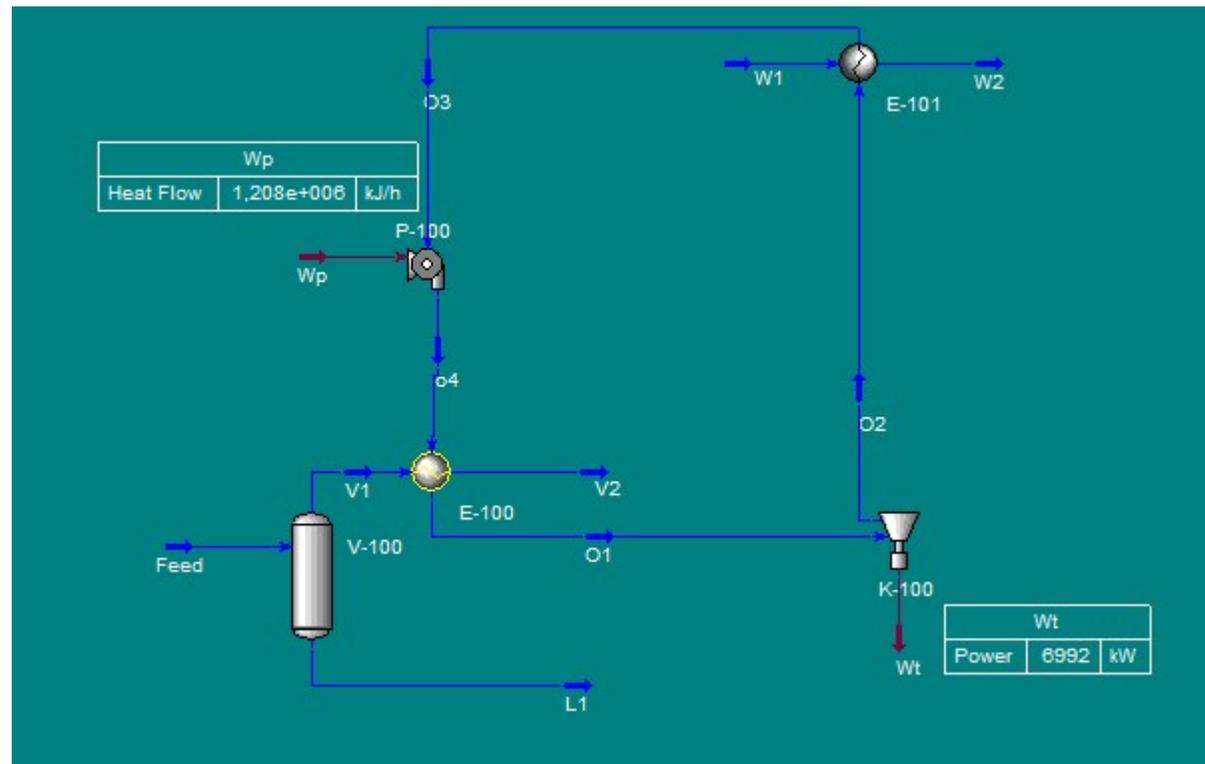


- ORC cycle-Basic

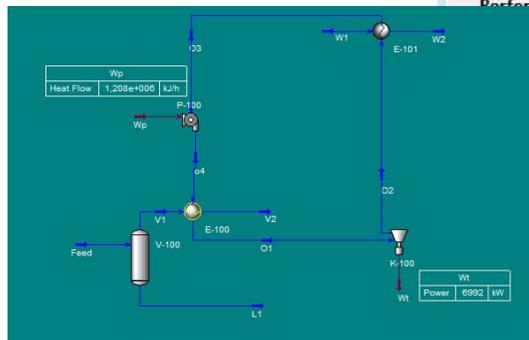
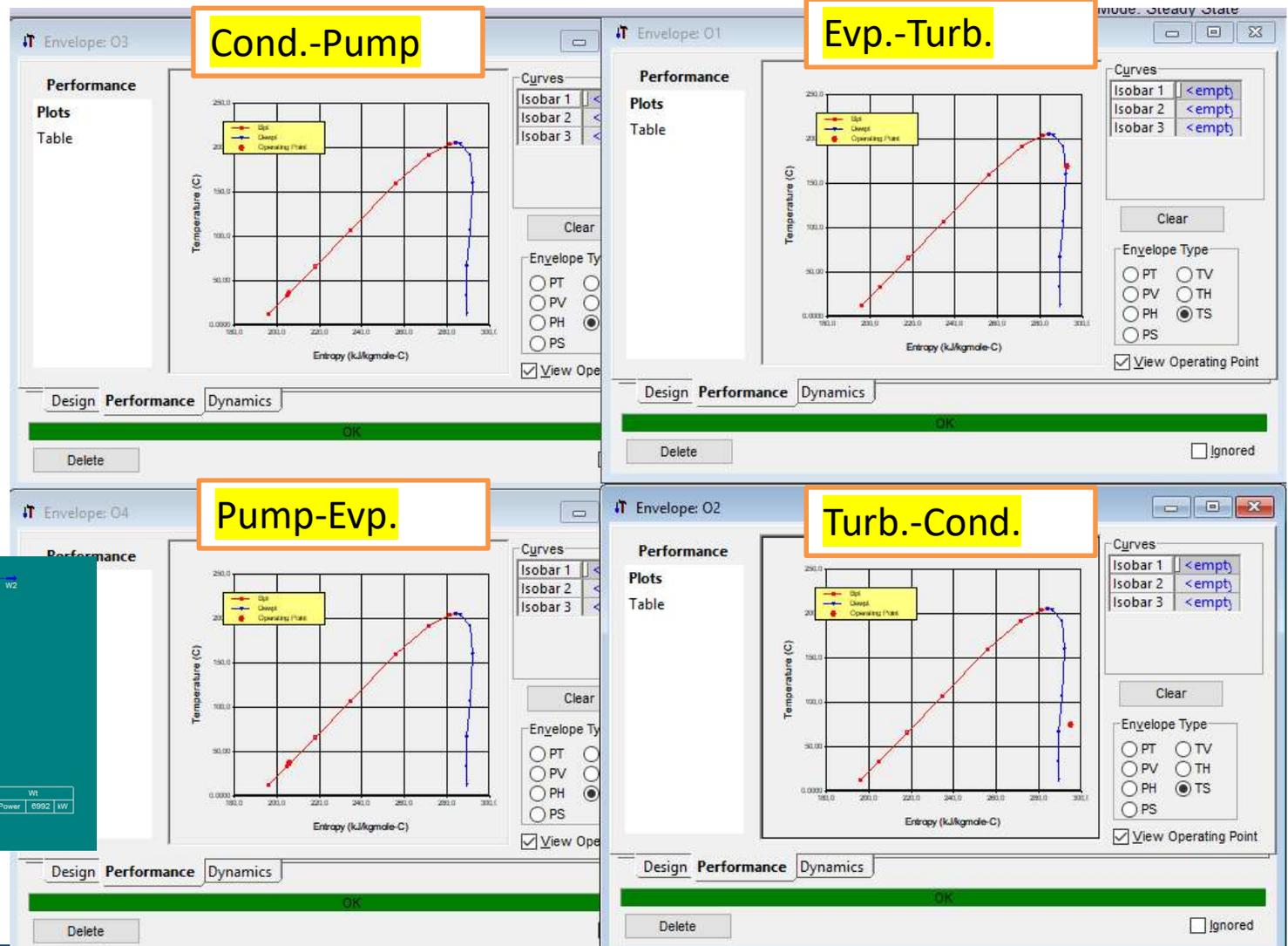


• Simulating ORC

- 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. $\Delta P_{shell} = 0$



- Simulating ORC

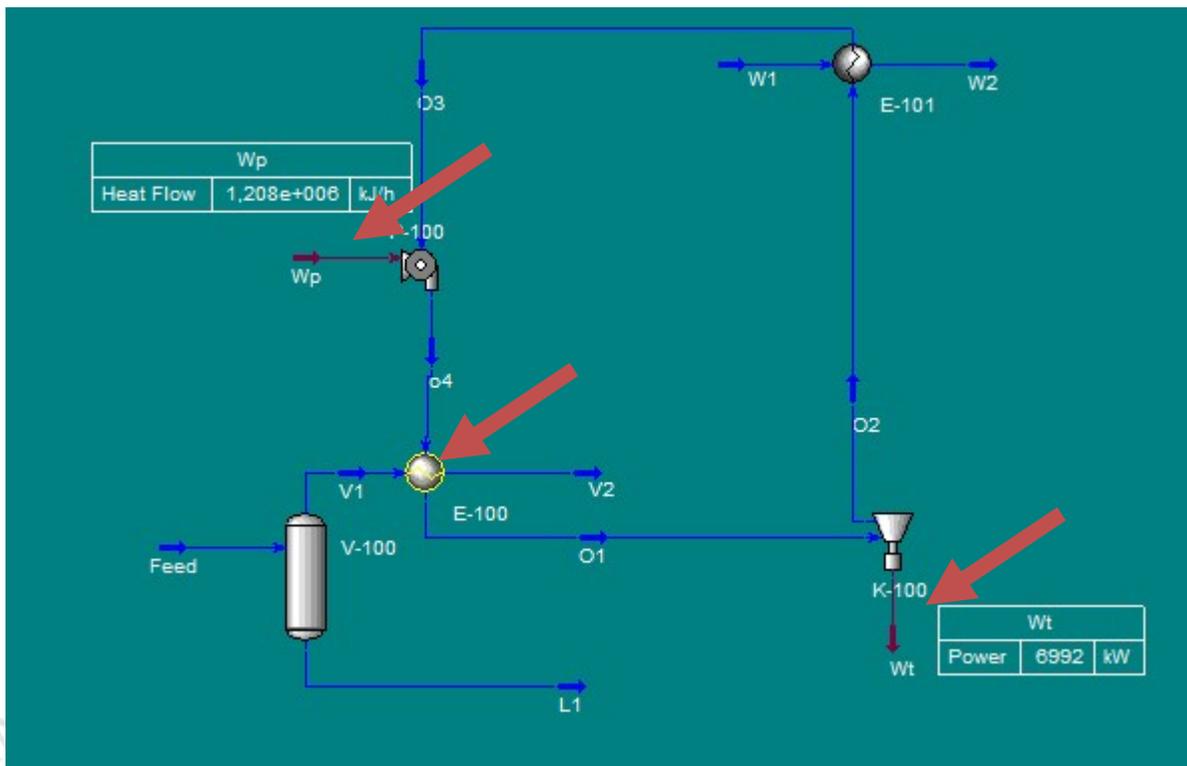


Ex. #2.6: ORC optimization

- Calculate efficiency of ORC
- Optimizing the cycle

Optimizer Spreadsheet

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



Optimizer Spreadsheet

Current Cell: B4
Variable Type: [dropdown]
Variable: B4
Formula: $=(B1-B2)/B3$

	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

OK

Function Help... Spreadsheet O

Ex. #2.6: ORC optimization

- Calculate efficiency of ORC
- Optimizing the cycle

The image shows three overlapping windows of the 'Optimizer' software. The largest window displays the 'Adjusted (Primary) Variables' table, which is highlighted with a red box. The table lists various variables and their current values and bounds.

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. Frac. (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 'Delete' button and a 'SpreadSheet...' button are also visible.

The middle window shows the 'Optimizer' interface with the 'Cell' dropdown set to 'B4' and the 'Current Value' as '0,163880963'. The 'Maximize' radio button is selected. Below this is the 'Constraint Functions' table:

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

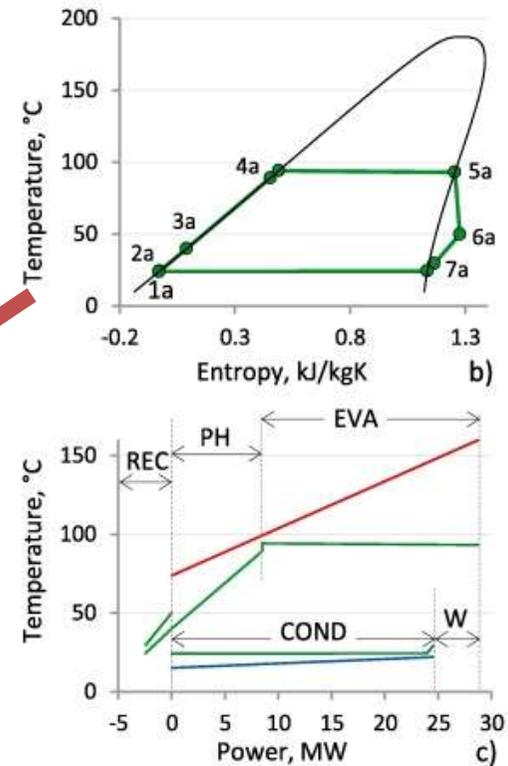
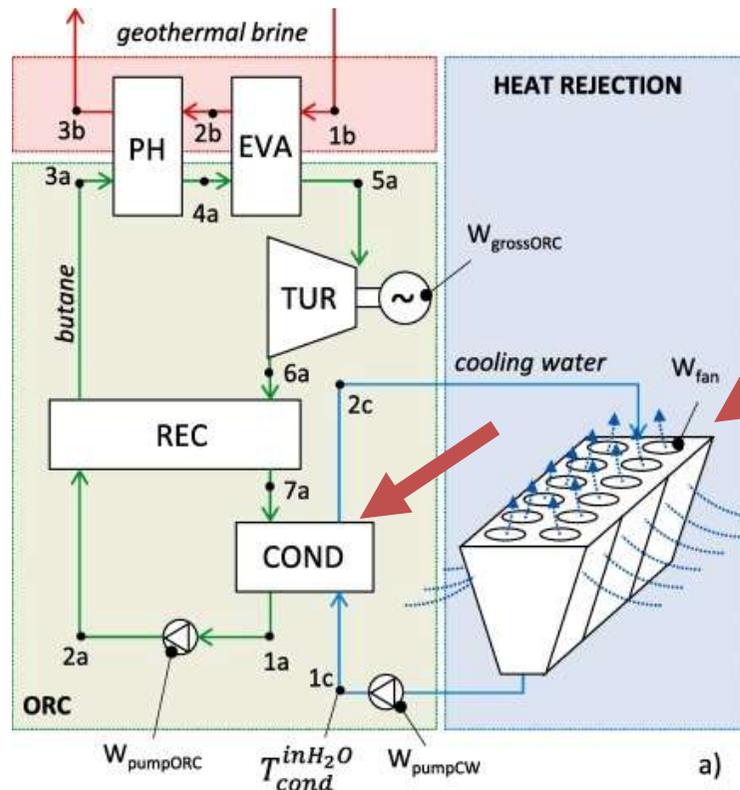
The bottom window shows the 'Optimizer Parameters' dialog box with the following settings:

Parameter	Value
Scheme	Mixed
Maximum Function Evaluation	500000
Tolerance	1,000e-08
Maximum Iterations	20
Maximum Change/Iteration	0,3000
Shift A	5,000e-01
Shift B	1,000e-01

Red arrows point from the middle and bottom windows to the main window, indicating the flow of information or configuration changes.

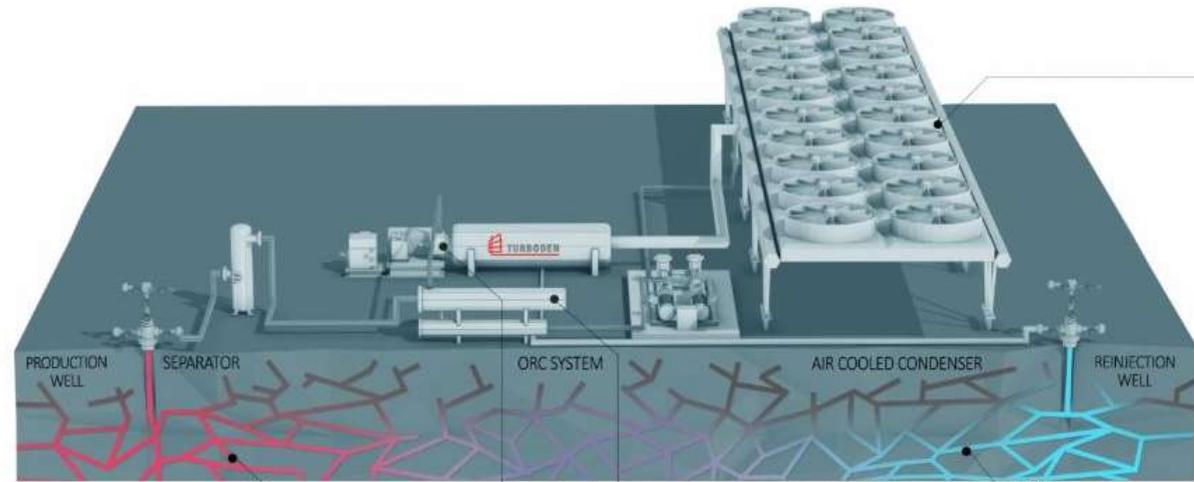
Ex. #2.2: ORC cycle

- Adding air cooler
- Adjust the air flow



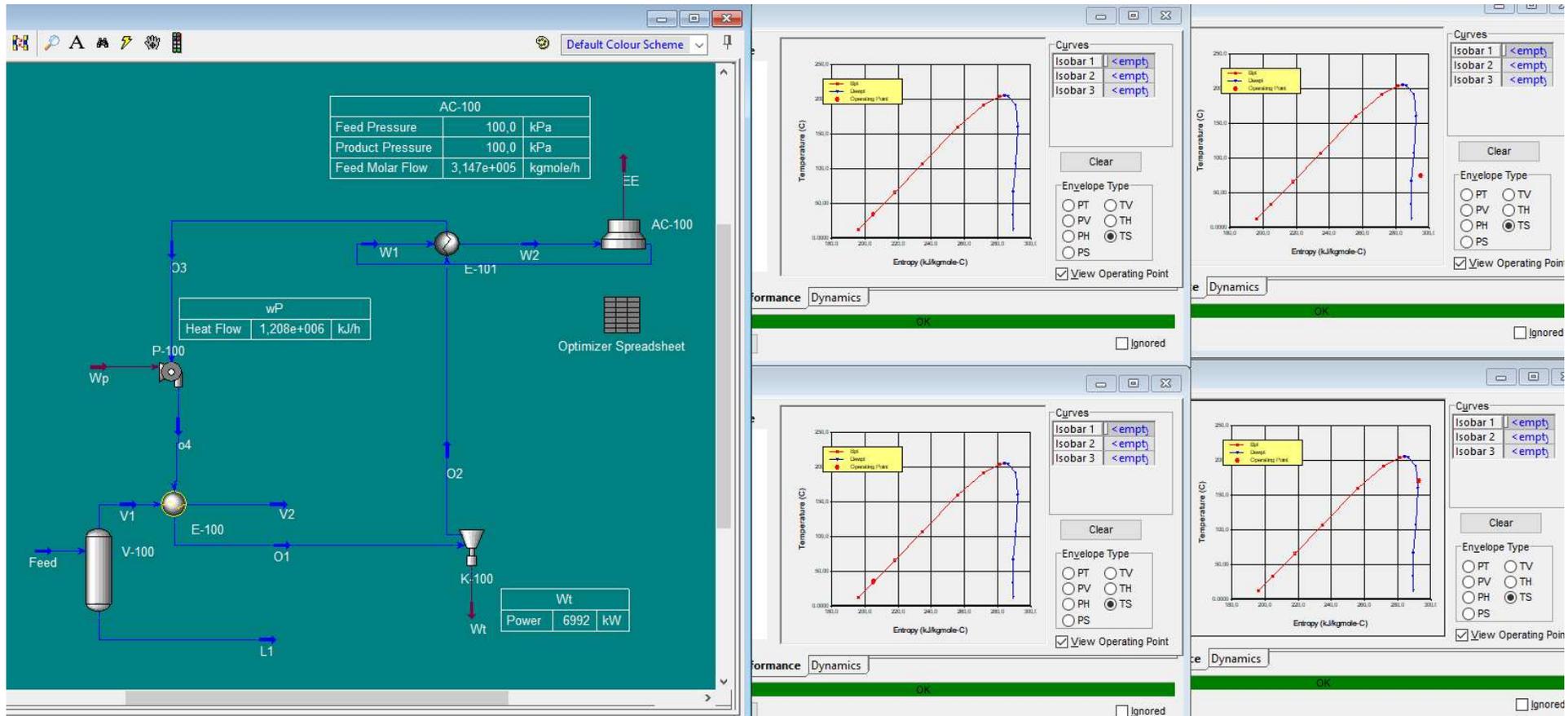
Ex. #1.5: Refrigeration Cycle

- 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>