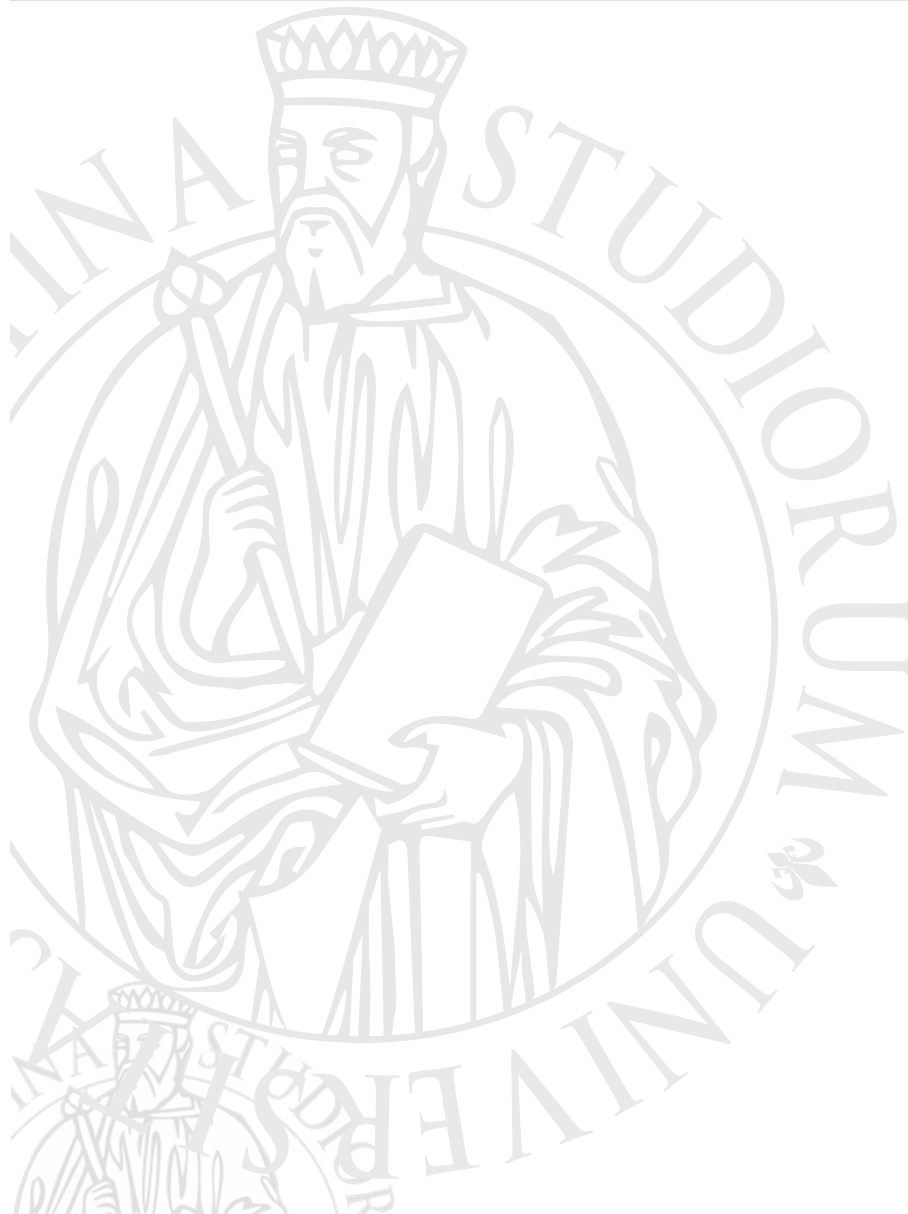




UNIVERSITÀ
DEGLI STUDI
FIRENZE

DIEF

Dipartimento di
Ingegneria Industriale



Process Simulation using UNISIM Design

(Training Course - Basic level)

Dr. Pouriya H Niknam

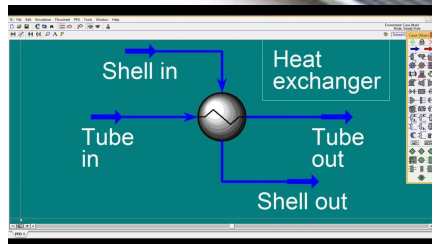
Nov,13, 2019



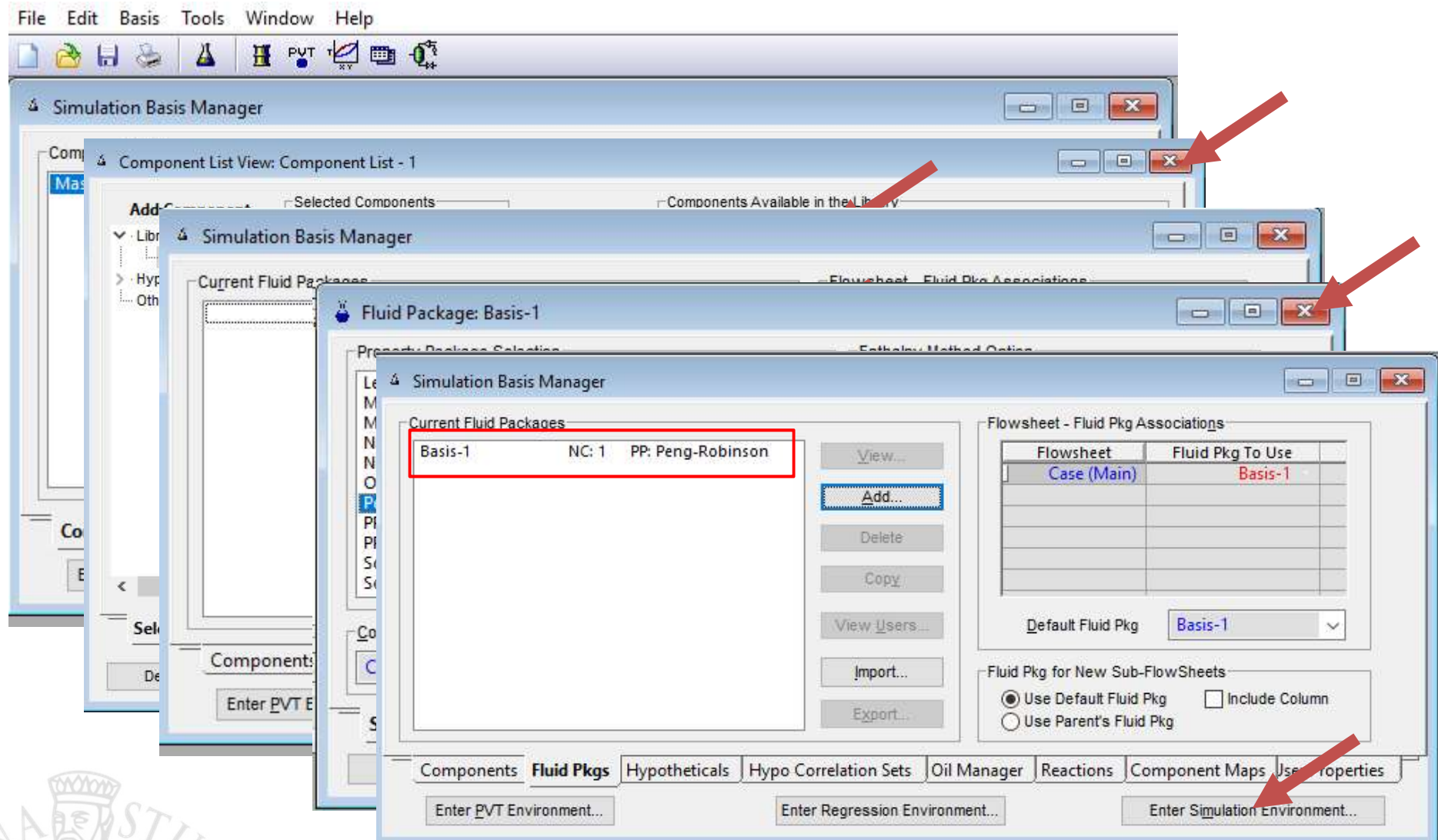
- Introduction to UniSim Design
- Define equipment, materials, utilities, and thermodynamic models
- Setting up a steady-state simulation case, flash calculations, utilities, and the workbook
- Extracting property tables and plots and phase envelope diagram

- Example #1.1: property calculation
- Example #1.2: property calculation
- Example #1.3: Simple vessel
- Example #1.4: Simple Heat Exchanger
- Example #1.5: Refrigeration Cycle

- You can simulate either simple cases or the most complicated plants



Starting the program



Ex. #1.1: property calculation

NoName.usc - UniSim Design R460.1

File Edit Simulation Flowsheet PFD Tools Window Help

PFD - Case (Main)

Default Colour Scheme

Environment: Case (Main)
Mode: Steady State

1
Temperature <empty>
Pressure <empty>
Molar Flow <empty>

Worksheet

- Conditions
- Properties
- Composition
- K Value
- User Variables
- Notes
- Cost Parameters

Stream Name	1
Vapour / Phase Fraction	<empty>
Temperature [C]	<empty>
Pressure [kPa]	<empty>
Molar Flow [kgmole/h]	<empty>
Mass Flow [kg/h]	<empty>
Std Ideal Liq Vol Flow [m3/h]	<empty>
Molar Enthalpy [kJ/kgmole]	<empty>
Molar Entropy [kJ/kgmole-C]	<empty>
Heat Flow [kJ/h]	<empty>
Liq Vol Flow @Std Cond [m3/h]	<empty>
Fluid Package	Basis-1
Phase Option	Multiphase

Worksheet Attachments Dynamics

Unknown Flow Rate

Delete Define from Other Stream...

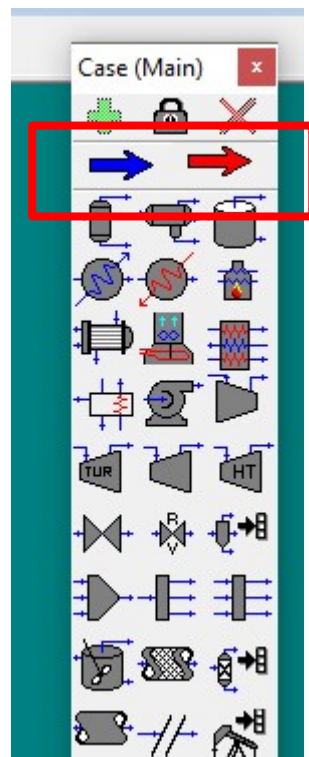
Balance Tool

Environment: Case (Main)
Mode: Steady State

Steams
vessels
Heat exchangers
Pressure Equip.
& turbine
Collector and
distributors
Special equipment
for chemical process
Logics

Ex. #1.1: Simple stream

Calculate Boiling temperature of water in Firenze?!



Firenze Current weather

FIRENZE / PERETOLA



Rain: 0 %

Humidity: 67%

Pressure: 993 mb

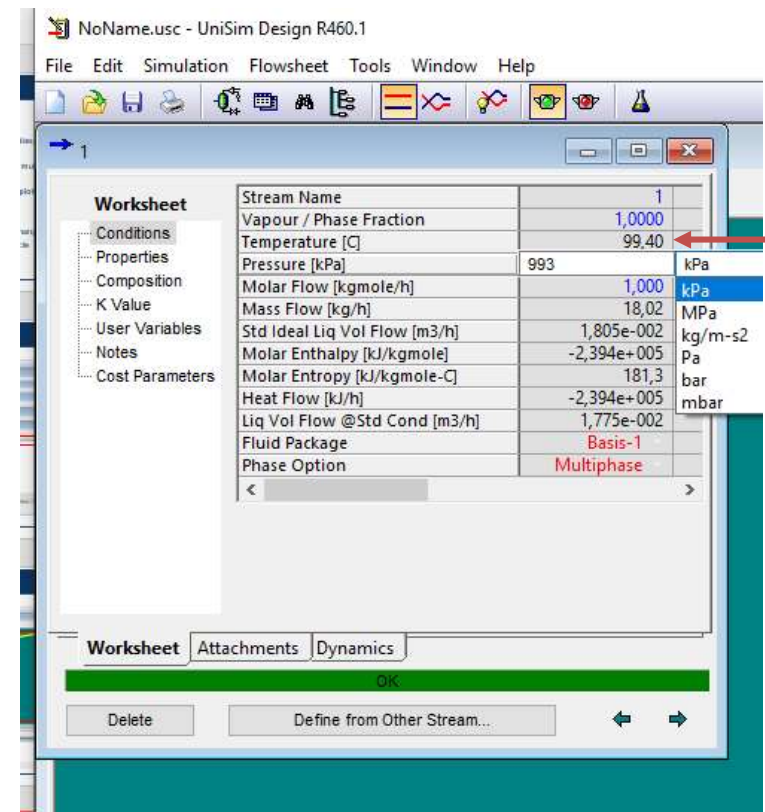
Cloud: 75%

Visibility: 10 km

Inputs:

- Water stream
- Pressure: 993mbar / Flow : 1 (not important) / ?

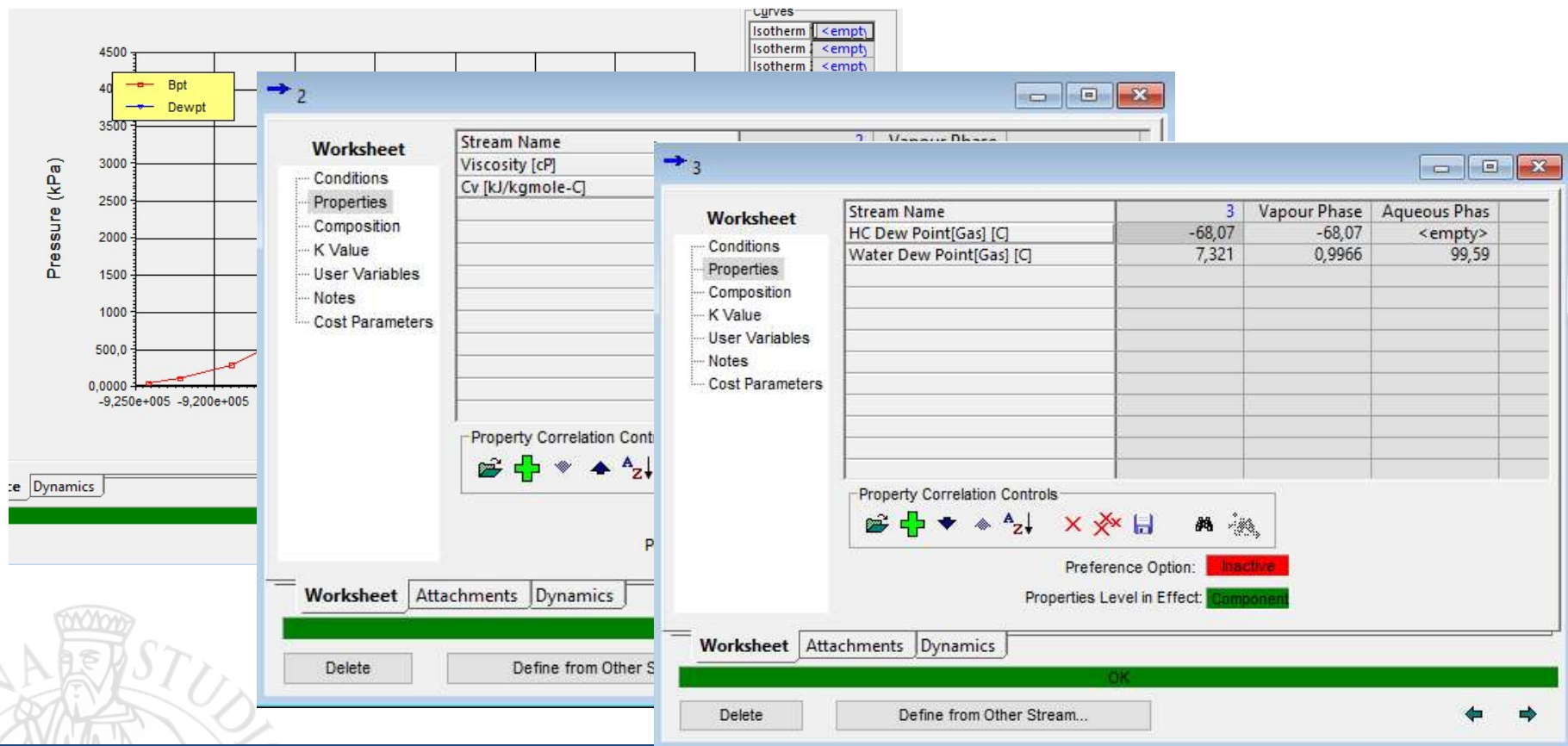
Output: Temperature



Ex. #1.2: property calculation

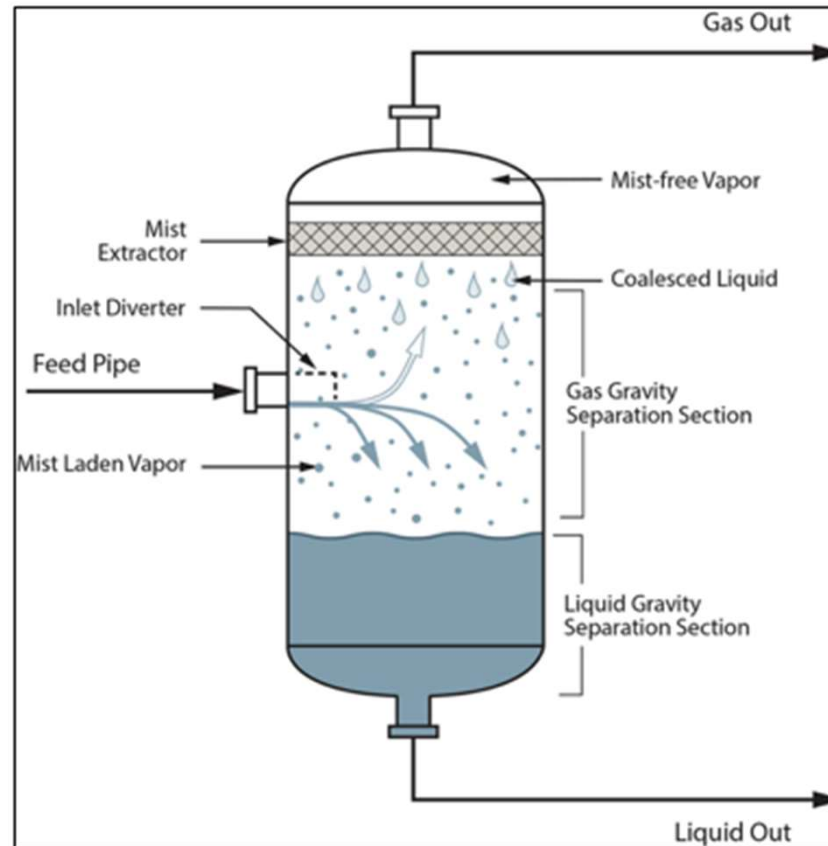
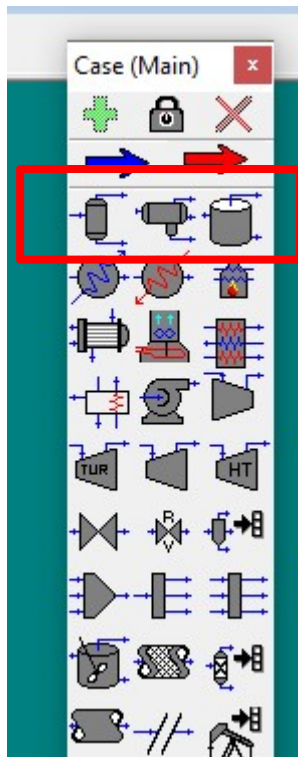
Calculate property of pure or mixture streams

1. P-H diagram and T-S diagram of R134a?
2. Viscosity & C_v of air? (O₂ 21% N₂ 79%)
3. Water Dew point and hydrocarbon dew point of natural gas (C₁ 96% C₄ 3% water 1%)

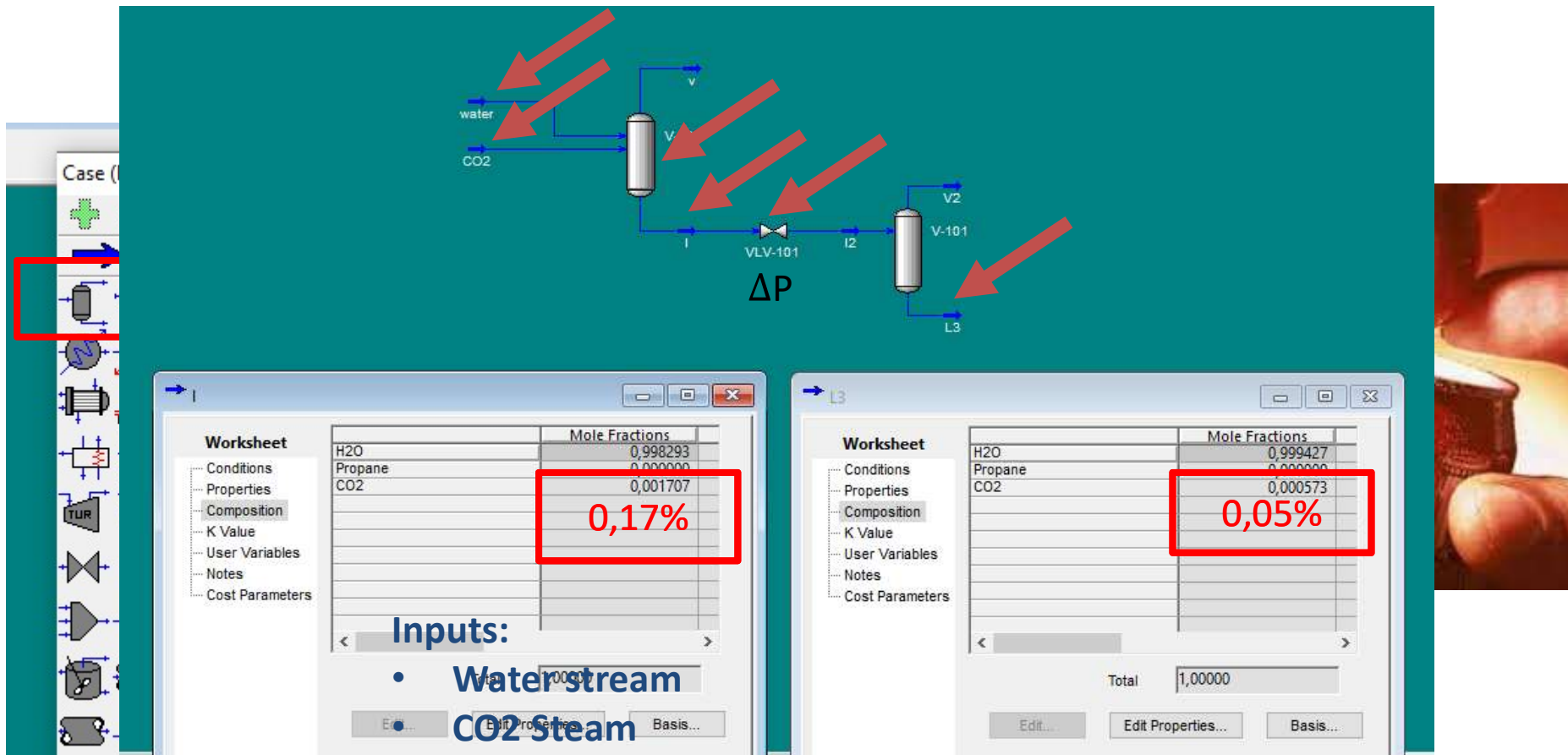


Ex. #1.3: Simple vessel

- (flash calculation, phase separator)



Ex. #1.2: Simple vessel



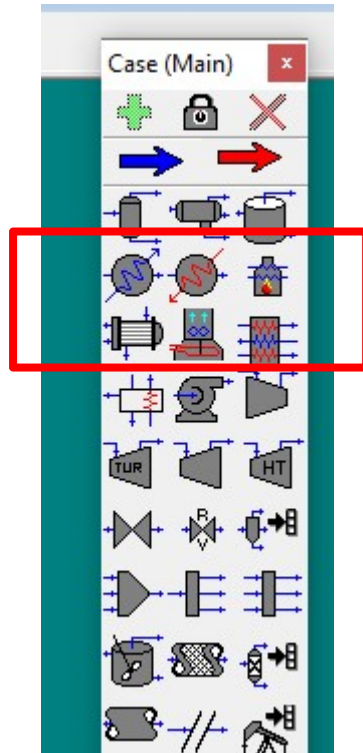
Inputs:

- Water stream
- CO2 Stream
- Pressure: 300kPa / Flow : 1 / Temperatur: 20°C

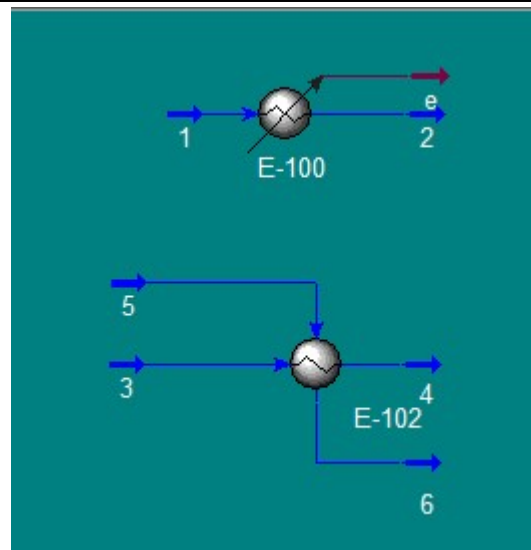
Output

- solubility (CO2 composition in the liquid phase)

Ex. #1.4: Heat Exchanger



Cooler	<ul style="list-style-type: none"> Stream input Stream output Energy
Heater	<ul style="list-style-type: none"> Stream input Stream output Energy
exchanger	<ul style="list-style-type: none"> Stream1 input Stream1 output Stream2 input Stream2 output Energy



Ex. #1.4: Heat Exchanger

Solar water heater

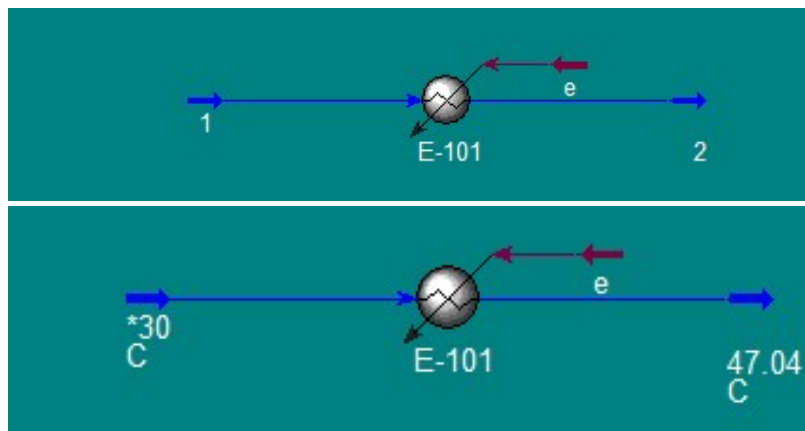
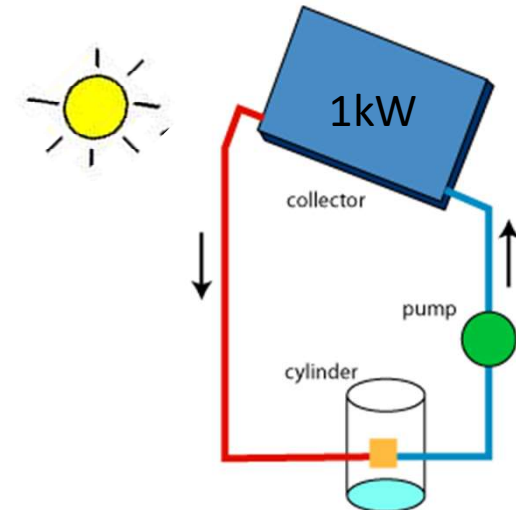
- active

Inputs:

- Water stream input
- Pressure: 150kPa / Flow : 50 kg/h / Temperature: 30°C
- Energy stream : 1kW

Output

- Water Output temperature



E-101

Worksheet	Name	1	2	e
Conditions	Vapour	0,0000	0,0000	<empty>
Properties	Temperature [C]	30,00	47,04	<empty>
Composition	Pressure [kPa]	150,0	150,0	<empty>
PF Specs	Molar Flow [kgmole/h]	2,775	2,775	<empty>
	Mass Flow [kg/h]	50,00	50,00	<empty>
	Std Ideal Liq Vol Flow [m3/h]	0,0501	0,0501	<empty>
	Molar Enthalpy [kJ/kgmole]	-2,845e+005	-2,832e+005	<empty>
	Molar Entropy [kJ/kgmole-C]	-36,92	-32,78	<empty>
	Heat Flow [kJ/h]	-7,897e+005	-7,861e+005	3600

Design Rating **Worksheet** Performance Dynamics Cost

Delete OK Ignored

Ex. #1.4: Heat Exchanger

Solar water heater

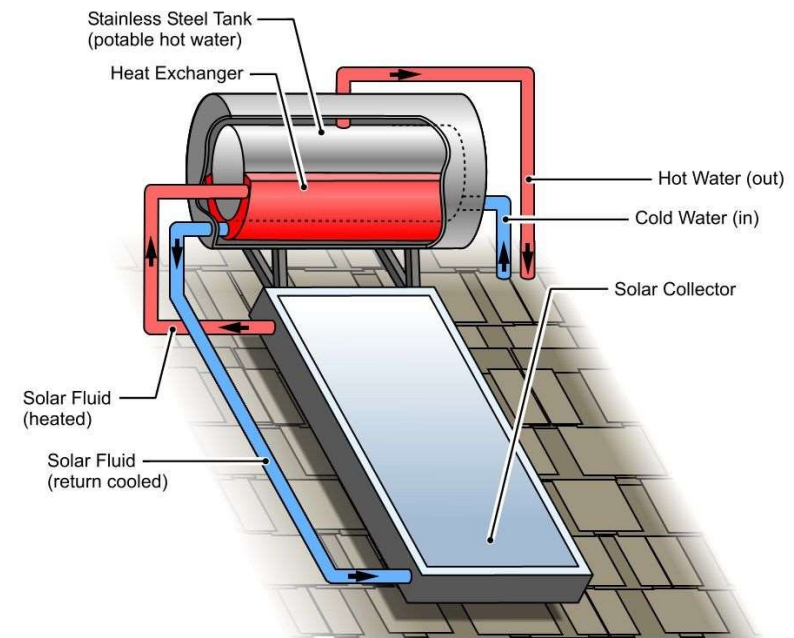
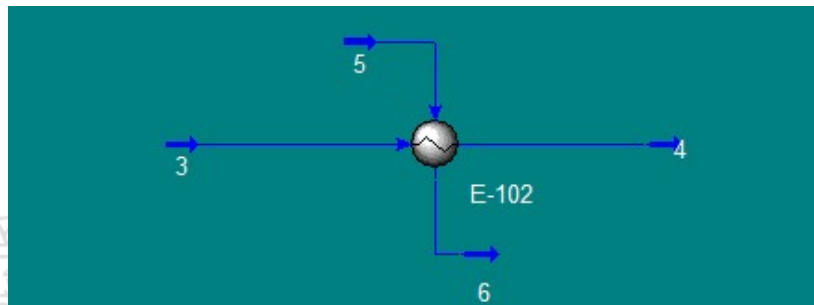
- Passive by using Solar fluid : Ethylene glycol

Inputs:

- Water stream input
- Pressure: 150kPa / Flow : 50 kg/h / Temperature:30°C
- Water stream input
- Pressure: 150kPa / Flow : " / **Temperature: ? °C**
- Propylene Glycol
- Pressure: 150kPa / / Temperatuer:30°C
- Pressure: 150kPa / / Temperatuer:30°C

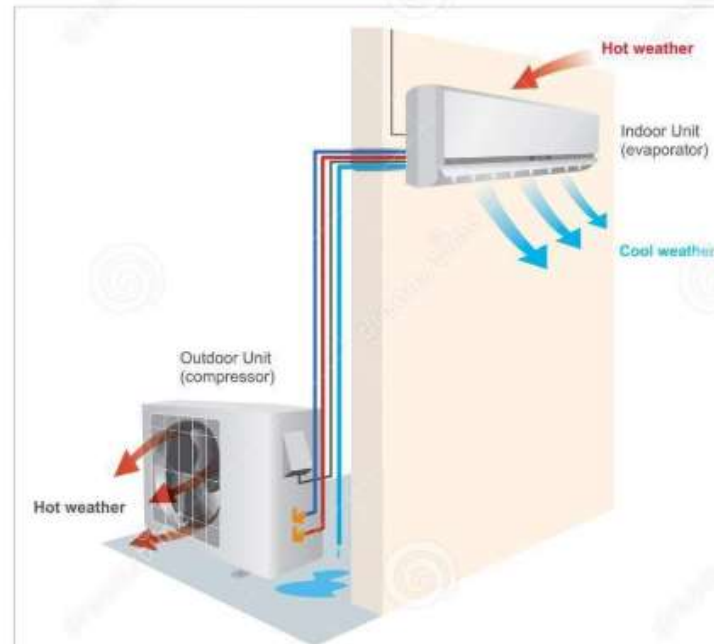
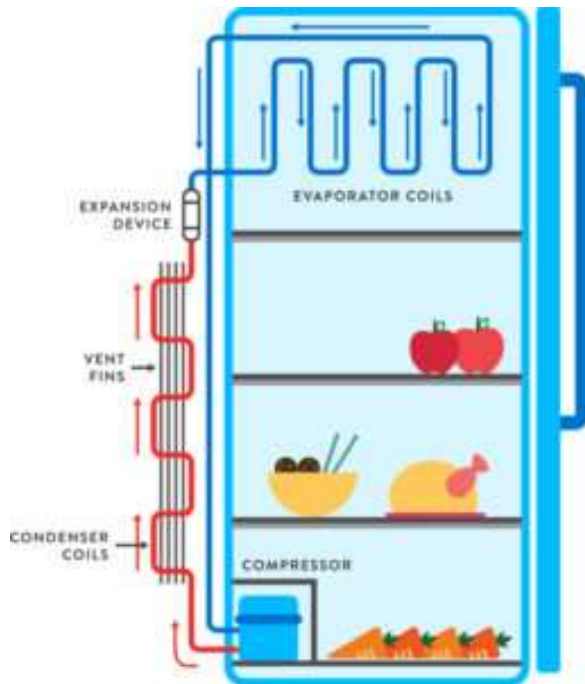
Output

- Glycol flowrate**





Ex. #1.5: Refrigeration Cycle

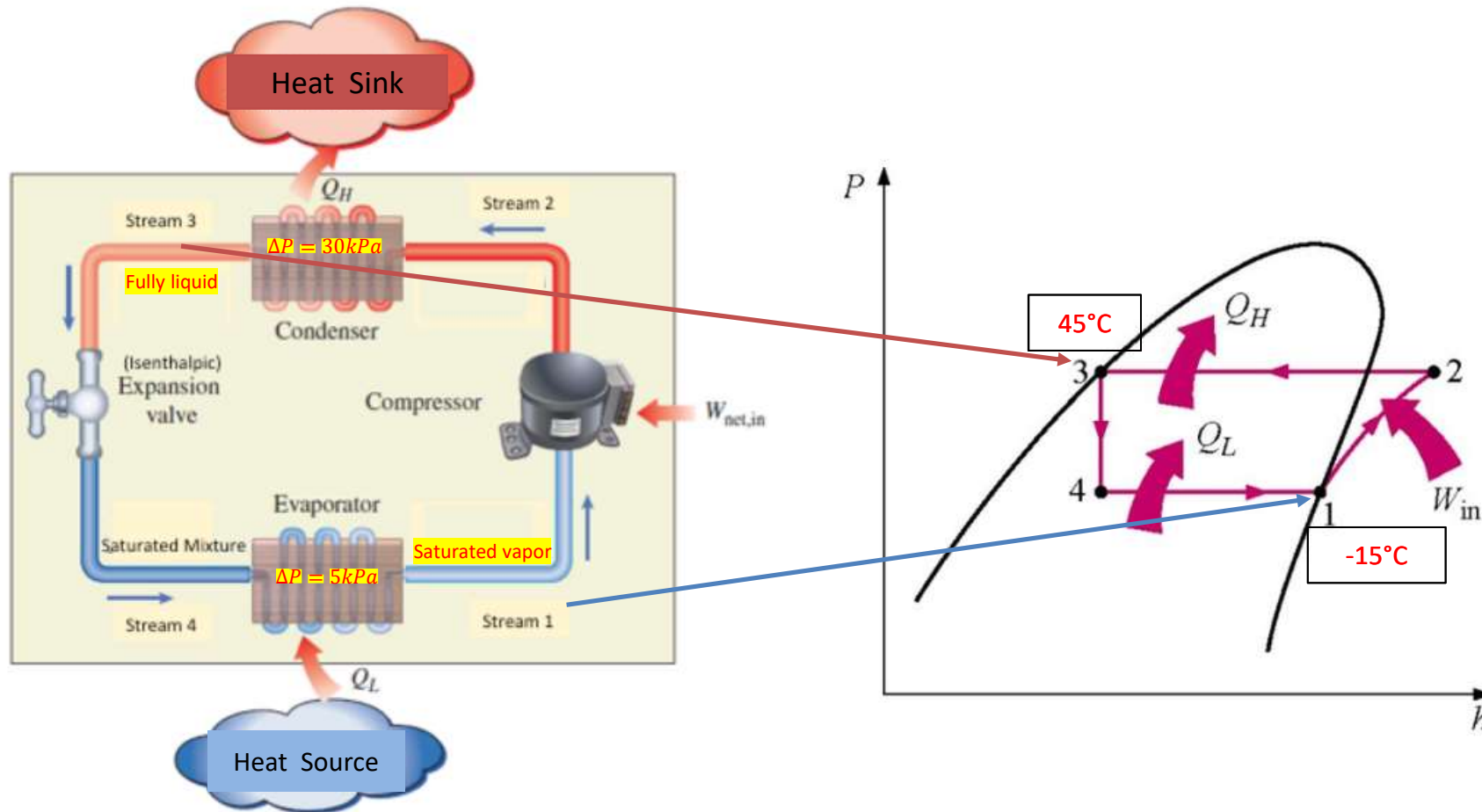


Example setup showing the simple connection for home air conditioner system unit

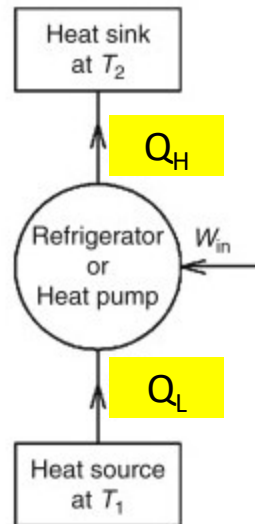
- Copper pipe from Evaporator indoor to Compressor outdoor
- Copper pipe from Compressor outdoor to Evaporator indoor
- Sewer (Condensation)
- Electric wire



Ex. #1.5: Refrigeration Cycle



Ex. #1.5: Refrigeration Cycle



COP= Evaporator Duty/ Compressor Power

$$\text{COP} = Q_L / W_c$$

Example:

A Refrigeration cycle utilizes propane as the working fluid is used in the liquefaction of the NG. Propane is fed to an evaporator (Heater) the pressure drop=5 kPa, where it absorbed 1.50e+6 kJ/hr from the NG and leaves at the dew point (Vapor Fraction=1.0) at T= -15°C. The output of the evaporator is then compressed adiabatically with efficiency of 75%, and then it's condensed to reject heat. Inside the Condenser there is a pressure drop of 30 kPa, and leaves as saturated liquid at 45°C. Finally, the propane passes through a valve to return the pressure of the Evaporator.

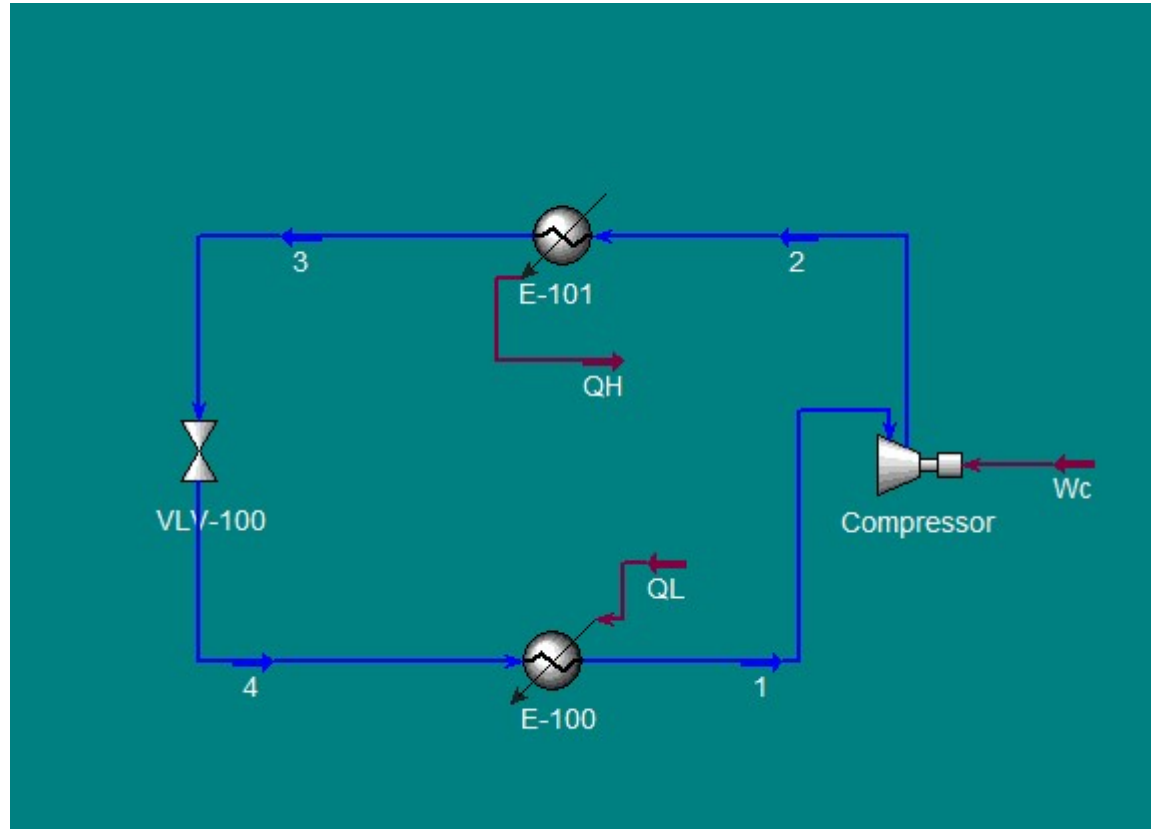
Fluid Pkg: Peng Robinson

Calculate:

Pressure of the evaporator fed in kPa.	
Flow rate of propane in kmol/hr.	
Valve pressure drop in kPa.	
Temperature of the valve outlet in °C.	
Compressor duty in hp.	
Condenser duty in kJ/hr.	

Ex. #1.4: Refrigeration Cycle

- Final Solution is:



Ex. #1.4: Refrigeration Cycle

- Calculate Coefficient of performance (COP)
- Adjust the configuration to have COP of 2.

