

CH402 Chemical Engineering Process Design

Class Notes L9

Heat Exchanger Design – You are expected to know this!

Problem 14-15 using CHEMCAD

“3-Step” Heat Exchanger Design Method

(use desktop computer unless laptops have v8.1 on laptop)

Problem Statement 14-15

The overhead vapor from the C2 splitter in Figure 3-13 is partially condensed in E-601. The process conditions for the vapor entering the condenser are

Temperature, °C	-30.1
Pressure, kPa	1945*

* Value has been changed from the book value. The authors report 2944 kPa.

Species Flow rates, kg/s	
CH ₄	0.003
C ₂ H ₆	0.0626
C ₂ H ₄	64.53

A shell-and-tube heat exchanger is to be used to condense 73.5 % of the overhead vapor. Use an appropriate software package (based on TEMA guidelines) to obtain the overall heat transfer coefficient and the area required for the condensation if the tubes have an outside diameter of 0.0127 m and an inside diameter of 0.0094 m. Assuming that the maximum length of the tubes is 3.05 m long, **how many tubes** will be required and what **shell diameter** is recommended? Propylene at -46 °C and 125 kPa serves as the coolant for the condensation process.

Additional Questions: (1) Identify the **largest resistance** to heat transfer in the exchanger and, (2) determine the **total purchase cost** of the exchanger in Feb. 2025.

Process Background - Conventional Ethylene Process – Fig. 3-7.

page 91

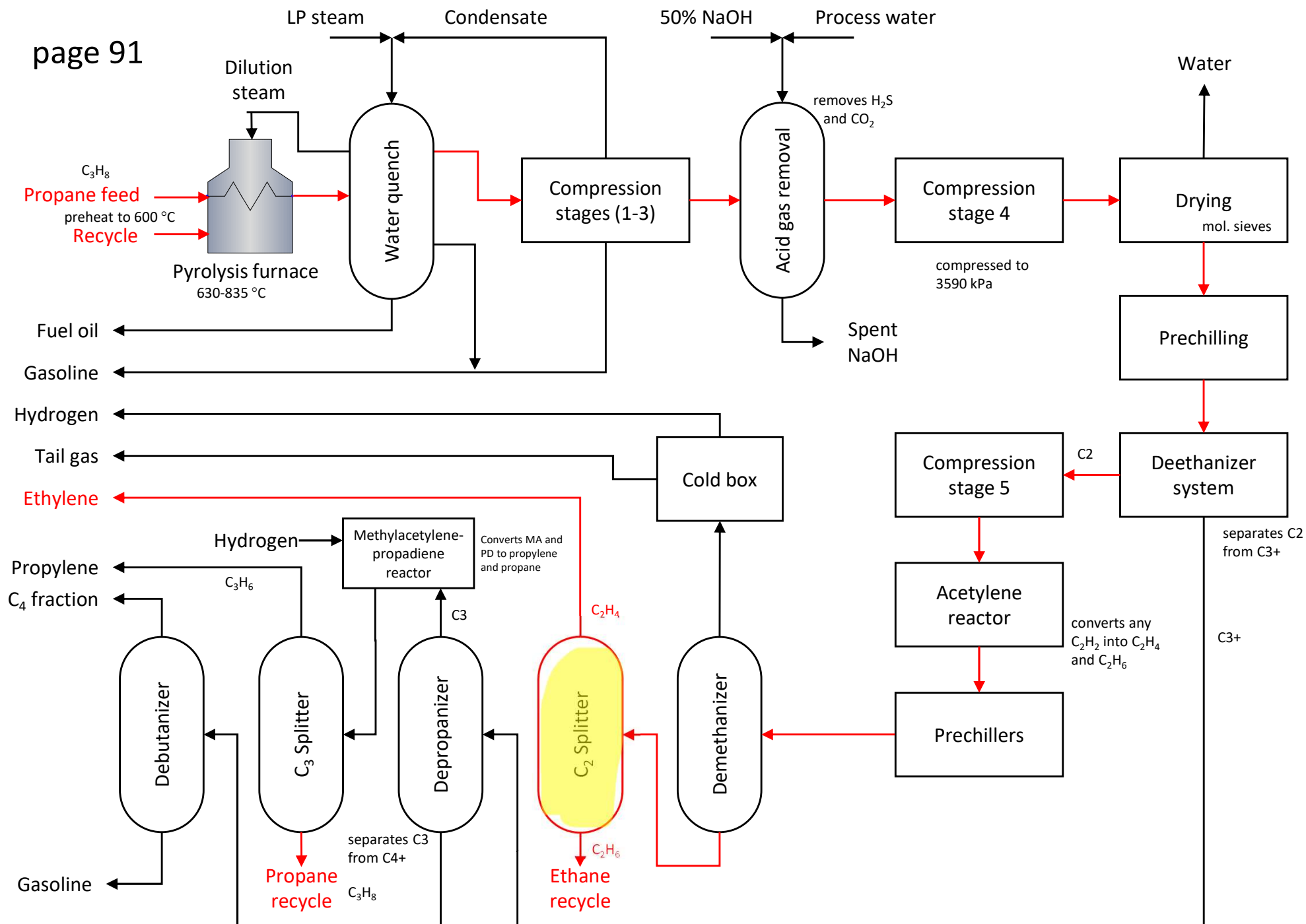


Figure 3-13. Product Separation Section

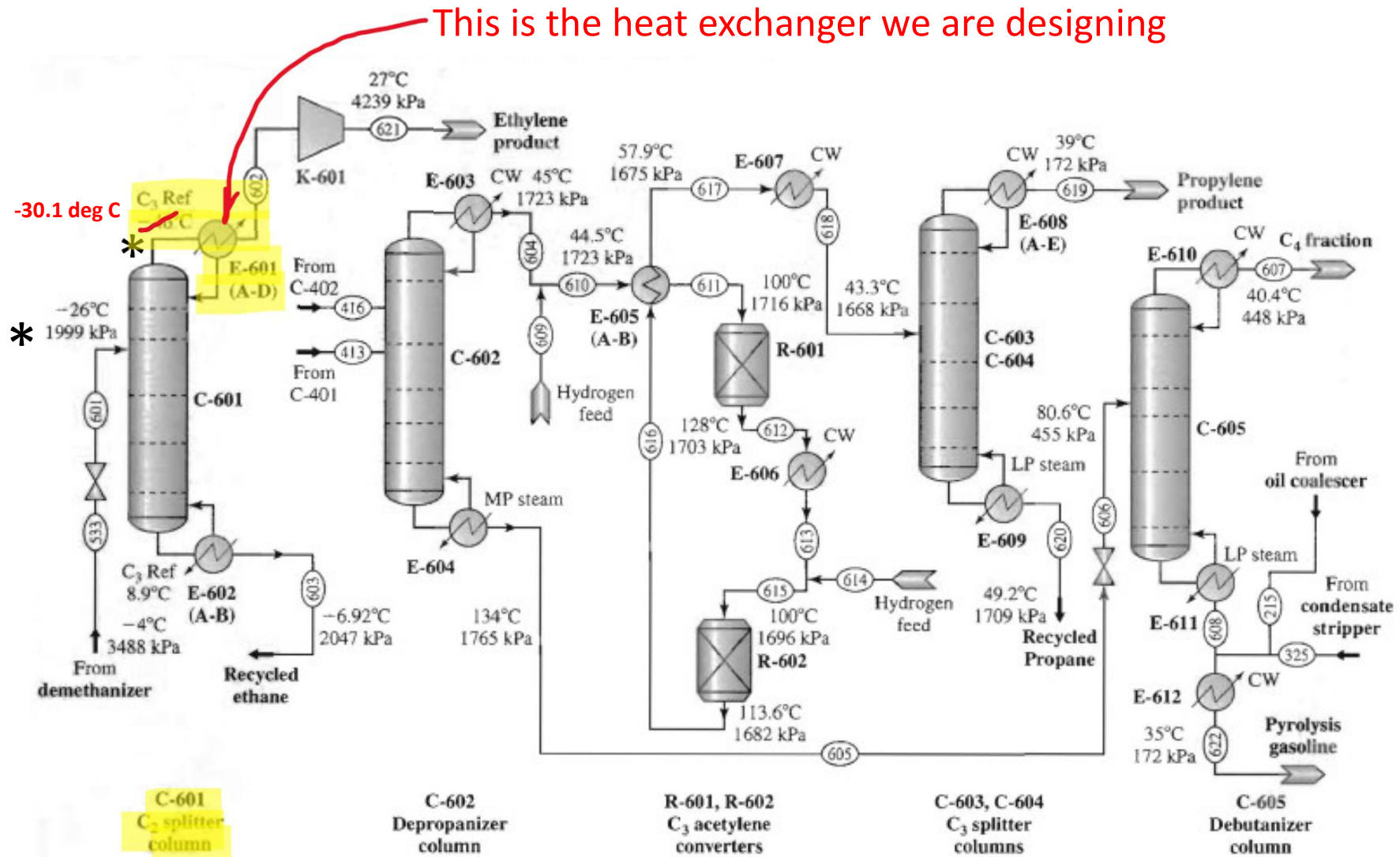


Figure 3-13. Product separation section.

Change engineering units

Change CEPCI to Feb 2025 for PS4

CHEMCAD 8.1.0 - [Untitled]

File Home Drawing View Thermophysic Component D Specification Analysis Sizing **Tools** CC-THERM

Steady State Dynamic

Run All Run from Initial State

Charts Reports

Property Set Stream Property Report Viewer

MS Excel

Style Help

Results

Engineering Units

System Profiles

English Default Profile

Common SI

Formal SI

Metric

User Profiles

ALT SI

Research

Current Flowsheet Settings: Custom Save As

Fundamental

Time **sec**

Mole/Mass kg

Temperature C

Pressure **kPa**

Enthalpy J

Work **kJ**

Fluid Flow

Liquid Volume Rate m3/h

Vapor Volume Rate m3/h

Vapor Density kg/m3

Liquid Density/Con... kg/m3

Crude Flow Rate m3/h

Velocity m/sec

Fluid Properties

Heat Capacity kJ/kg-K

Specific Heat kJ/kg

Heat Transfer Coef... W/m2-K

Thermal Conductivity W/m-K

Viscosity N-s/m2

Surface Tension N/m

Stream Flow Units

Total Flow Default mole/r

Component Flow Default mole/r

Stream Edit Automatic con

VBA Flow Units

Flow unit option for some VBA functions.

Mole

Vapor Reference Temperature

This is the reference for determining standard vapor volume flow rate.

Default 0.00 C

Custom

Atmospheric Pressure Reference

This is the reference for determining gauge pressure.

Default 101.3249817 kPa

Custom

Pipe Table Selection

Default pipe table for Pipe, Onifice, and line sizing tool.

ASME (B36.10M-2015, B36.19M-2004)

Set Default Delete

Help

Cancel Apply

Palette

All UnitOps : Grayscale

Heat Exchangers **Gray**

Feed Product

Fired Heater Heat Exchanger

Multi-Stream Exchanger

Miscellaneous : Grayscale

Piping and Flow : Grayscale

Reactors : Grayscale

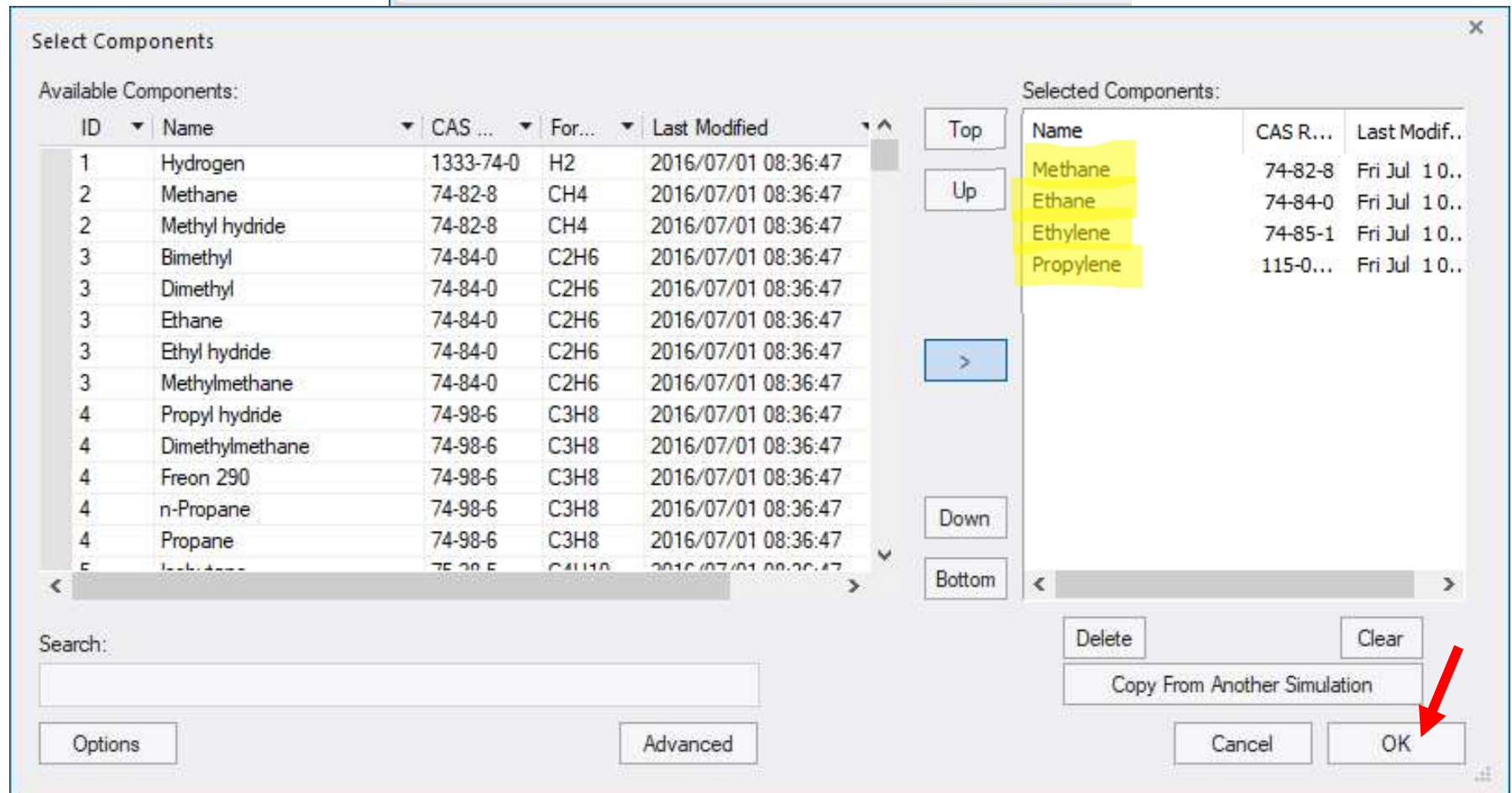
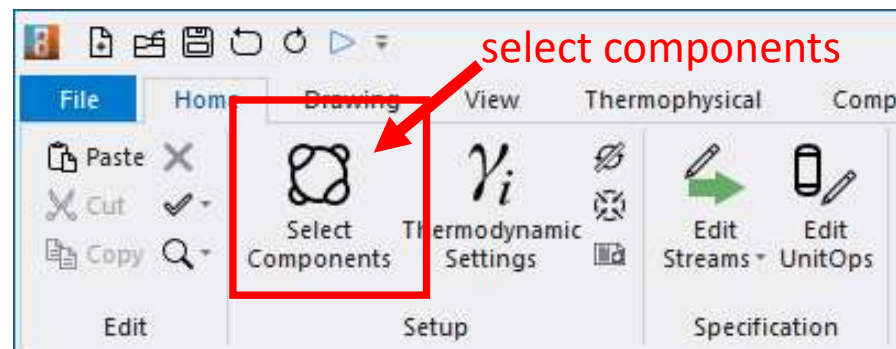
Separators : Grayscale

Solids handling : Grayscale

Steady State



100.0%

On my computer, I have Common SI set as the default.









“Thermodynamic Suggestions” window launches automatically when you click OK.

Thermodynamic Suggestions

 - Thermodynamic Suggestions - 

The selection of thermodynamic models is based on the component class data availability as well as the T/P operation range of the process. Use the suggestions of the expert system as a guide only.

Select components to ignore (e.g., non process utilities)

<None> 	<None> 
<None> 	<None> 
<None> 	<None> 

Please enter the temperature/pressure range of the process:


Temperature Min C

Temperature Max C

Pressure Min kPa

Pressure Max kPa

BIP data threshold

CHEMCAD 8.1.0 

Selected K = SRK, H = SRK

SRK is good!

Thermodynamic suggestions: Check defaults in both tabs and click OK.

The image displays two overlapping 'Thermodynamic Settings' dialog boxes. The background dialog is on the 'K-value Models' tab, showing the 'Global K-value Model' set to 'SRK'. The foreground dialog is on the 'Enthalpy Models' tab, showing the 'Global Enthalpy Model' set to 'SRK'. It also includes options for 'Ideal gas heat capacity' (DIPPR), 'Steam table' (IAPWS-IF97), and several checkboxes for heat of solution, electrolyte enthalpy, heat of mixing, and compressed water pressure correction. A red arrow points to the 'OK' button in the foreground dialog.

Thermodynamic Settings -

K-value Models | **Enthalpy Models** | Transport Properties

Global Enthalpy Model:
SRK

Ethane/Ethylene, Propane
☐ Regular SRK/PR BIPs
☒ Special SRK/PR BIPs

Vapor Phase Association
No association

Vapor Fugacity/Poynting
☐ Correction using
☒ No Correction

SRK/PR Alpha function
☒ Standard SRK/PR
☐ Boston-Mathias extra
☐ Special PSRK Gas/Liquid

Help

Ideal gas heat capacity:
DIPPR

Steam table
IAPWS-IF97

☐ Use heat of solution file
☐ Use electrolyte enthalpy
☐ Heat of Mixing by Gamma
☐ Compressed water pressure correction for steam table

Note: The BIPs from VLE data may not be suitable for heat of mixing by gamma. Use this option carefully.

Help Cancel **OK**

CHEMCAD 8.1.0 - [Untitled*]

File Home Drawing View Thermophys Component Specification Analysis Sizing Tools CC-THERM Style Help

Flowsheet Data Boxes Explorer Zoom to Fit TP Box Visible Mark Error with Color Mark Cut Streams Show Stream IDs Show UnitOp IDs Show Stream Names Show UnitOp Names Cascade Tile Horizontally Tile Vertically

Refresh Show Zoom Flowsheet Window

Draw flowchart and solve m/e balances.

Step 1 – Lesson 8, slide 3.

Overhead vapor

Coolant – tube side

Heat Exchanger #4

Pro tip: default fonts can be set in the “drawing” tab by clicking “font”

Font

Palette

All UnitOps : Grayscale

Heat Exchangers Gray

Feed Product

Fired Heater Heat Exchanger

Multi-Stream Exchanger

Miscellaneous : Grayscale

Piping and Flow : Grayscale

Reactors : Grayscale

Separators : Grayscale

Solids handling : Grayscale

Steady State

124.0%

Set Feed Stream 1: Propylene

(Propylene at -46 °C and 125 kPa is available as a coolant.)

Place propylene coolant tubeside (Stream 1)

Tube-side coolant in a condenser is a good idea.

Stream No.	1	3
Stream Name		
Temp C	-46	-30.1
Pres kPa	125	1945.806
Vapor Fraction	0	1
Enthalpy J/sec	-77463.29	1.114613e+08
Total flow	1	64.5956
Total flow unit	kg/sec	kg/sec
Comp unit	kg/sec	kg/sec
Methane	0	0.003
Ethane	0	0.0626
Ethylene	0	64.53
Propylene	1	0

Two specs needed:
Set temperature and
vapor fraction.

We don't know the
propylene flow rate.
Set it to 1 kg/s.

CHEMCAD will solve for the
actual flow rate later.

Complete Specs on Heat Exchanger and Coolant Flow Rate

The screenshot shows the 'Heat Exchanger (HTXR)' dialog box with three tabs: 'Specifications', 'Misc. Settings', and 'Cost Estimations'. The 'Specifications' tab is active. The 'Simulation mode' is set to '0 Enter specifications (CHEMCAD simulation)'. The 'Utility option' is set to '3 Calculate flow of stream 1'. The 'Pressure drop' is set to '(default = 0)'. The 'ID' is '1'. The 'Stream 1' and 'Stream 3' pressure fields are empty. The 'Delta temperature specifications' section includes fields for 'Minimum delta temperature', 'Hot outlet - cold inlet', 'Hot inlet - cold outlet', 'Stream 2 - stream 4', 'Stream 2 - stream 1', and 'Stream 4 - stream 3'. The 'Heat transfer coefficient and area specification' section includes fields for 'Heat transfer coefficient (U)' and 'Area (per shell)'. The 'Heat duty (specified)' field is highlighted in gray. Red arrows point from annotations to the 'Utility option' dropdown, the 'Vapor fraction stream 2' and 'Vapor fraction stream 4' fields, and the 'Heat duty (specified)' field.

Heat Exchanger (HTXR) -

Specifications Misc. Settings Cost Estimations

Simulation mode: 0 Enter specifications (CHEMCAD simulation)

Utility option: 3 Calculate flow of stream 1

Pressure drop: (default = 0)

Stream 1 kPa

Stream 3 kPa

ID: 1

Switch this to "3"

Assume! (see note 1)

Given (see slide 2)

Temperature stream 4 C

Vapor fraction stream 2 0.995

Vapor fraction stream 4 0.265

Subcooling stream 2 C

Superheat stream 4 C

Heat duty (specified) J/sec

Delta temperature specifications:

Minimum delta temperature C

Hot outlet - cold inlet C

Hot inlet - cold outlet C

Stream 2 - stream 4 C

Stream 2 - stream 1 C

Stream 4 - stream 3 C

Heat transfer coefficient and area specification:

Specifying both U and A counts as a single thermal specification.

Heat transfer coefficient (U) W/m²-K

Area (per shell) m²

Help Cancel OK

Note 1: The largest "thermal reservoir" in the coolant is the latent heat of the phase transition. Any further warming of the coolant beyond the phase change will involve relatively small enthalpy changes.

Click OK, then Run

Run the Simulation and Confirm Results (1/3)

The screenshot displays the CHEMCAD 8.1.0 interface. The main window shows a process flow diagram with four streams (1, 2, 3, 4) and a unit operation (a circle with a triangle). Stream 1 is highlighted in green. The 'Steady State' button is highlighted in blue, and a red arrow points to it. The 'Edit Streams' dialog box is open, showing the properties for Stream 1. The 'Flash' tab is selected. The 'Propylene' row is highlighted in yellow, and a red arrow points to the value 35.29116. A text box at the bottom right of the dialog box says 'Double-click stream 1 to check results'.

Steady State

Stream No.	1
Stream Name	
Temp C	-46
Pres kPa	125
Vapor Fraction	0
Enthalpy J/sec	-2733769
Total flow	35.29116
Total flow unit	kg/sec
Comp unit	kg/sec
Methane	0
Ethane	0
Ethylene	0
Propylene	35.29116

Double-click stream 1 to check results

Confirm Results (2/3)

Heat Exchanger (HTXR) -

Specifications | Misc. Settings | Cost Estimations

Simulation mode: 0 Enter specifications (CHEMCAD simulation)

Utility option: 3 Calculate flow of stream 1

Pressure drop: (default = 0)

Stream 1 kPa

Stream 3 kPa

Enter two specifications, the flowrate of stream 1 will be recalculated

Temperature stream 2		C
Temperature stream 4		C
Vapor fraction stream 2	0.995	
Vapor fraction stream 4	0.265	
Subcooling stream 2		C
Subcooling stream 4		C
Superheat stream 2		C
Superheat stream 4		C
Heat duty (specified)		J/sec

Delta temperature specification

Minimum delta temperature

Hot outlet - cold inlet

Hot inlet - cold outlet

Stream 2 - stream 4

Stream 2 - stream 1

Stream 4 - stream 3

Heat transfer coefficient and area specification:

Specifying both U and A count

Heat transfer coefficient (U) W/m²-K

Area (per shell) m²

Help Cancel OK

Given

Note: there is no P-drop

Note: there is no A or U

Double-click heat exchanger
to confirm results

Confirm Results (3/3)

Heat Exchanger (HTXR) -

Specifications | Misc. Settings | Cost Estimations

ID: 1

Type: 0 Countercurrent

No. of Zones

Max. Percent of Pressure Drop

For evaporator utility side operating temp:

Utility operating T

Shells in Series

No. of SS Passes

No. of TS Passes

☐ Include holdup in dynamic calculation

Stream 1-2 holdup

Stream 3-4 holdup

Backcalc mode (for Autocalc): 0 No back calculation

Calculated Results

Calc Ht Duty	1.56566e+07	J/sec	Pinch Flag	
LMTD (End points)	14.2801	C	Wt. LMTD	
LMTD Corr Factor	1		Area Zone analysis	
Calc U				
Calc Area (Total)				
Tube fouling		m2-K/W		
Shell fouling		m2-K/W		

For more comprehensive heat exchanger design and rating, please contact us regarding our CC-THERM program.

Help Cancel OK

$$\ln[52] = \frac{(-30.1084 - (-46)) - (-30.1000 - (-42.8813))}{\log\left[\frac{(-30.1084 - (-46))}{(-30.1000 - (-42.8813))}\right]}$$

$$\text{Out}[52] = 14.28004$$

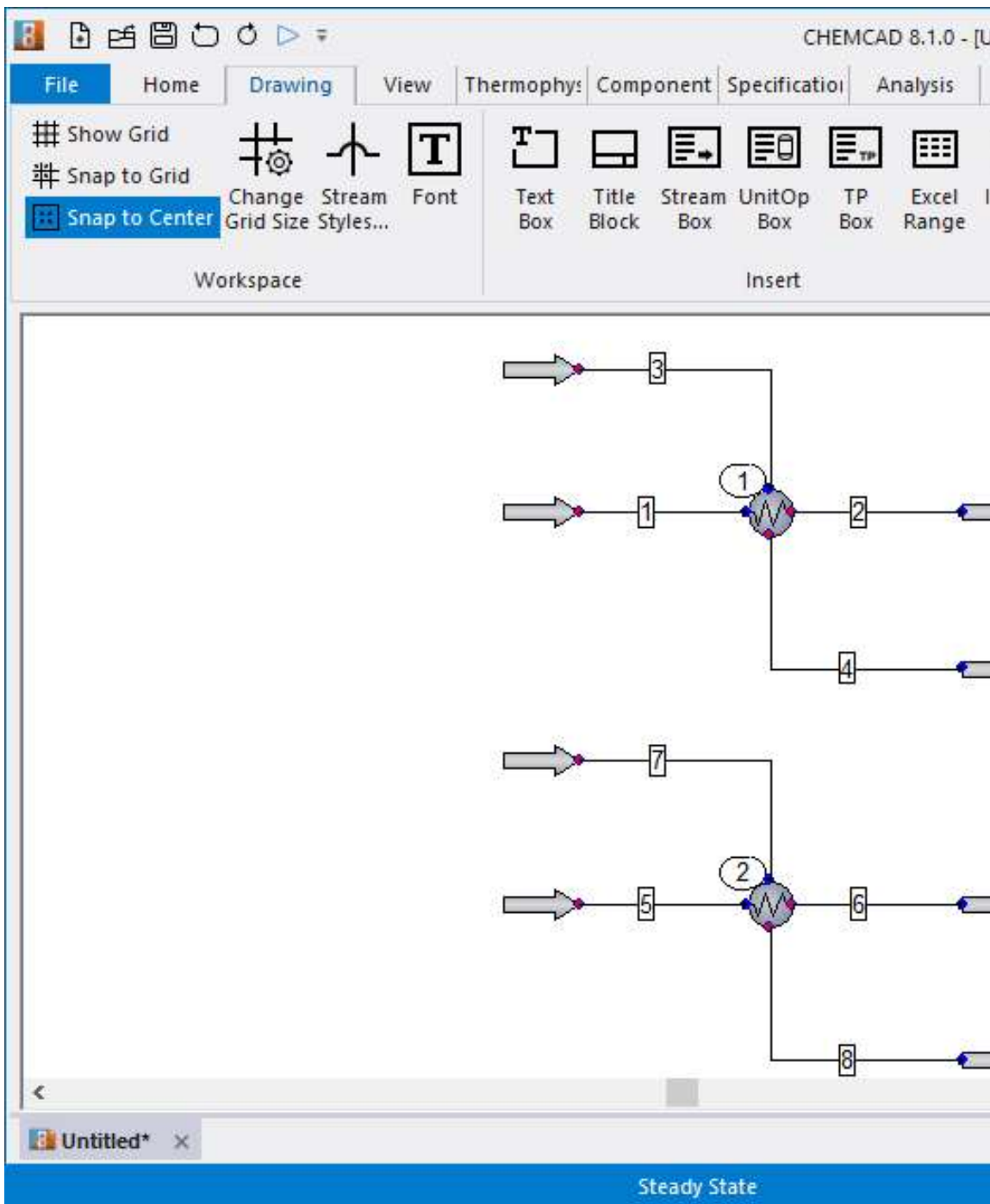
Numbers in gray fields were calculated by CHEMCAD

STOP HERE

Confirm results in slides 12 to 14 before proceeding

Step 1 (L8 Slide 3) is complete:

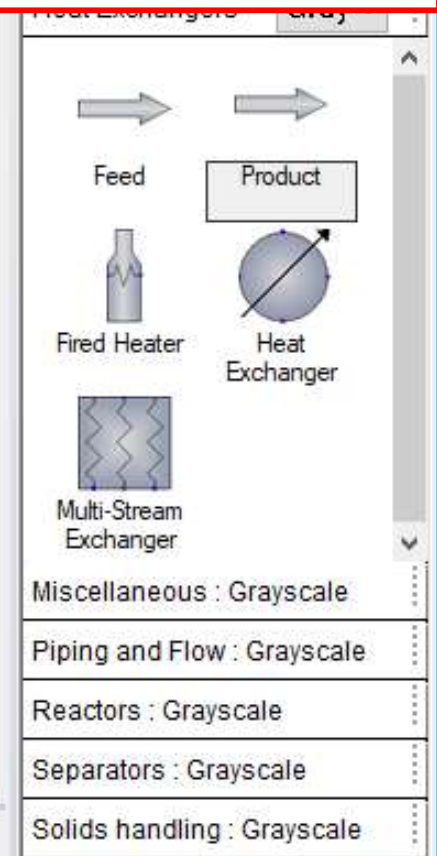
Determined the flow rates and heat transfer rates
necessary to meet the given conditions.

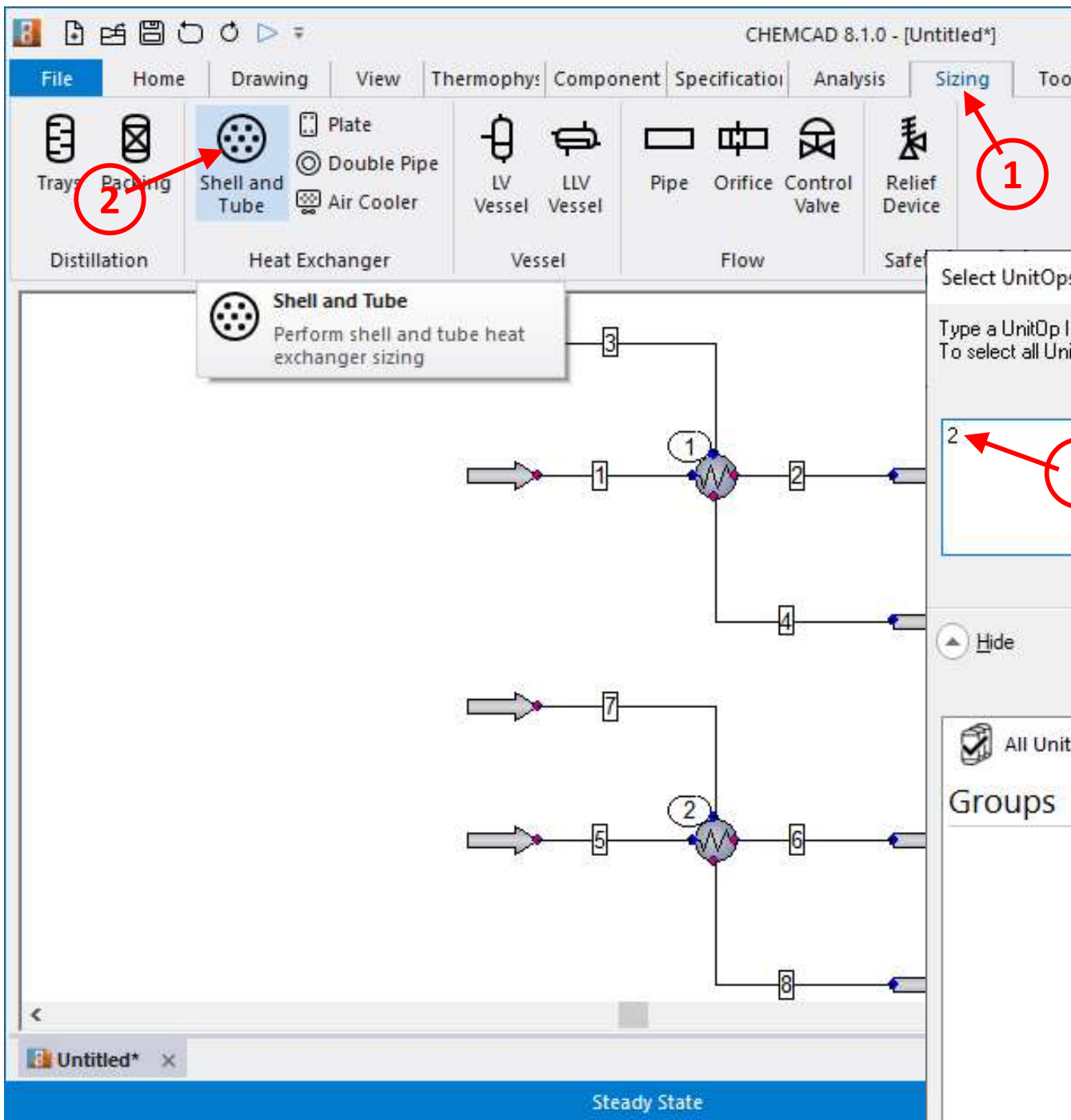


Save your simulation at this point.

Make a copy of the first exchanger and paste it to make a second exchanger. This is REQUIRED.

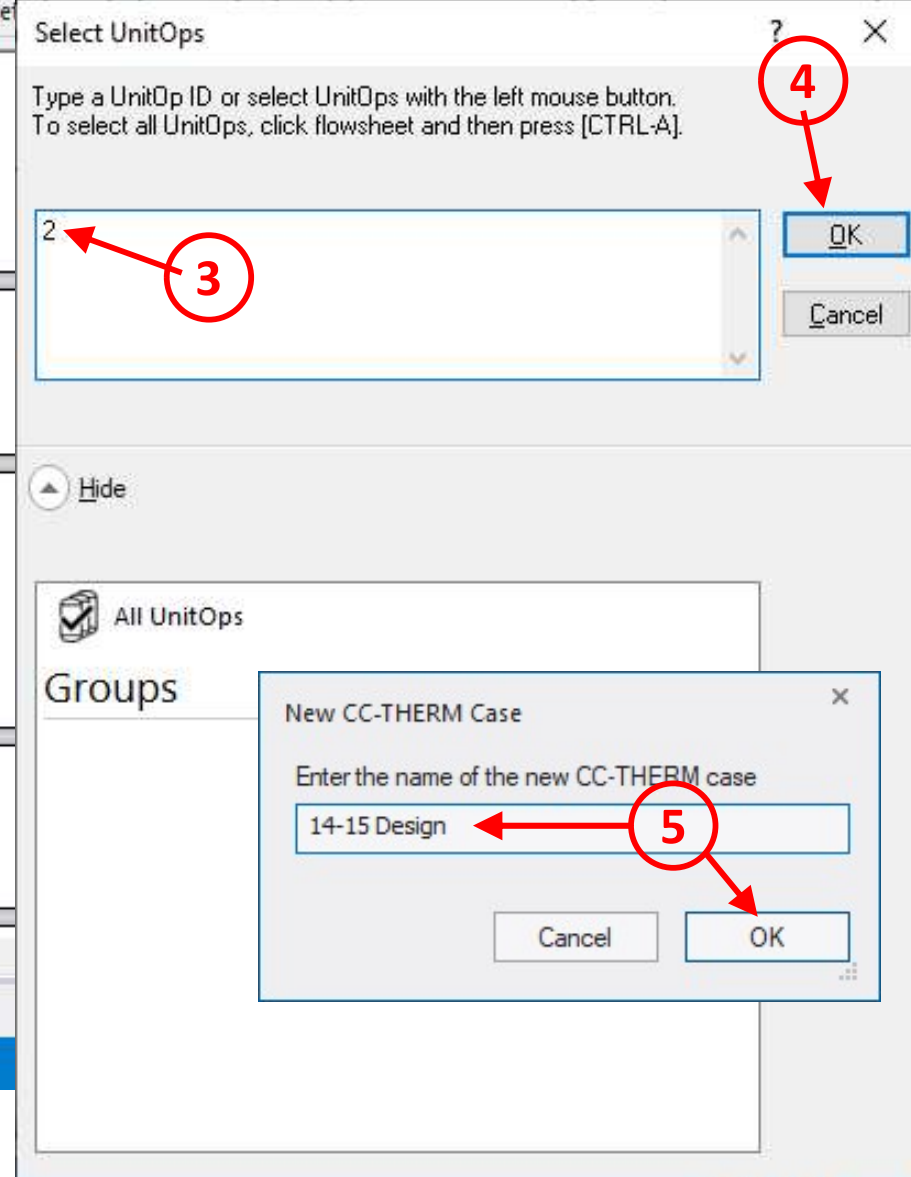
This is a backup of your work to safeguard against mistakes.





Click "Sizing," then "Shell-and-tube."

This initiates steps 2-5 of the design process (L8 slide 5).



123456

FileHomeDrawingViewThermophysicComponent DSpecificationAnalysisSizingToolsCC-THERM

UnitOp ID 2Type Shell and Tube

Case 14-15 Design

General

Enter Stream InformationMaterialsTubeNozzleShellClearance

Heat Curve SpecificationLabel

Edit Heat Curve

Configuration

4

7

5

2

6

8

Steady State

K:SRK H:SRK

Select Tube-side Inlet Stream

Please select the stream entering the exchanger tube side.

5

OK

Cancel

Hide

All Streams

Feed Streams

Product Streams

Cut Streams

Groups

TEMA Type AEL Exchanger. Take all defaults.

General Specifications

General Information Modeling Methods

TEMA class/ standard: TEMA R

Orientation: Horizontal

TEMA front end head: A - Channel Removable Cover

TEMA shell type: E - One Pass

TEMA rear end head type: L - Fixed Tubesheet (A head)

Tube Side

Stream name:

Process type: Forced Evaporation

Fouling factor: 0.0001761094 m²-K/W

Optional h Coeff.: W/m²-K

Shell Side

Horiz Condensation

0.0001761094 m²-K/W

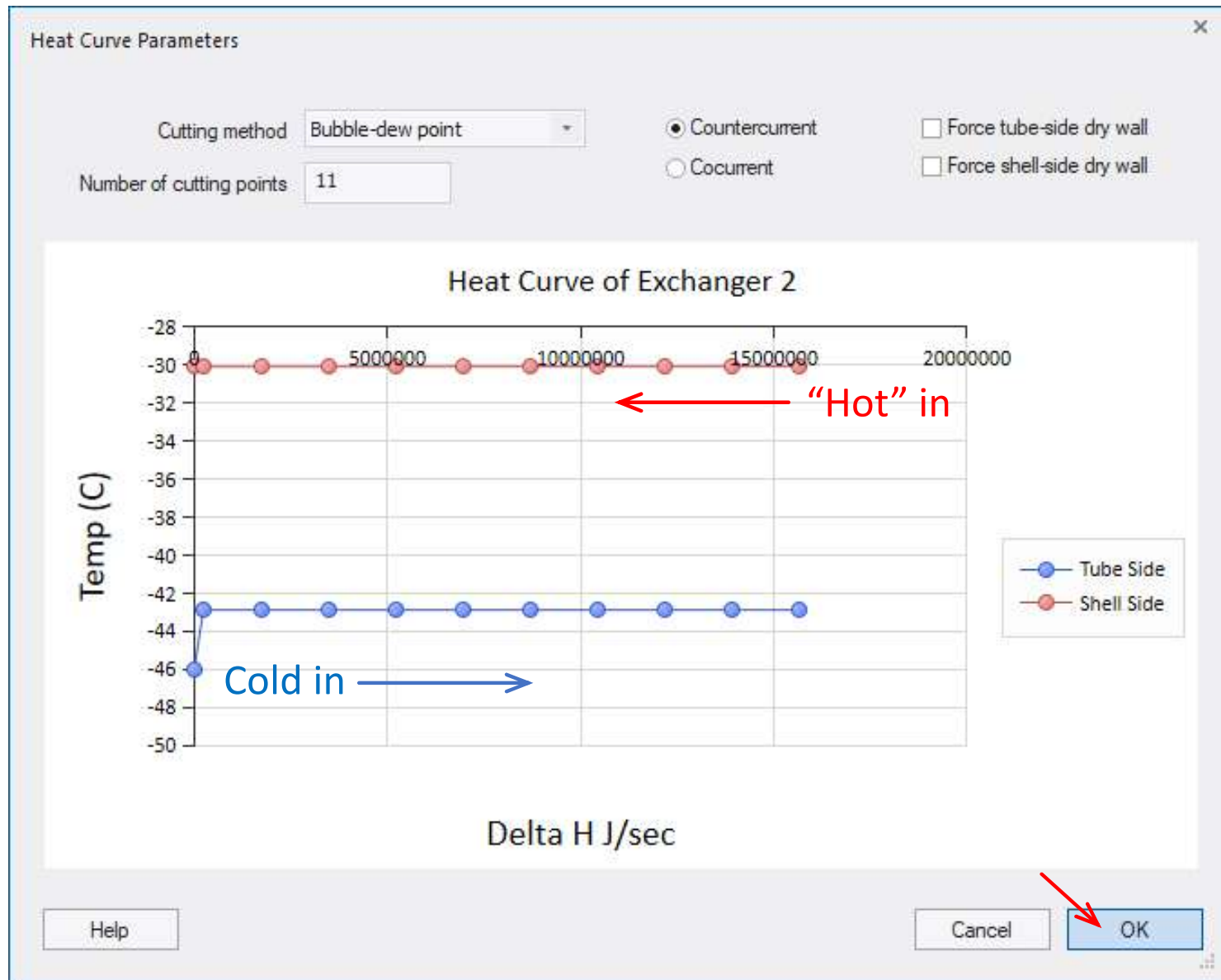
W/m²-K

For fouling rating calculations: Calculate tube-side fouling only

Help Cancel OK

3

Heating-cooling curve can be seen by clicking “Heat Curve Specification.”



CHEMCAD 8.1.0 - [Lesson9_AY232_Trial1*]

File Home Drawing View Thermophysic Component D Specification Analysis Sizing Tools CC-THERM Style Help

UnitOp ID 2 Type Shell and Tube Case 14-15 Design Select

General Enter Stream Information Materials Heat Curve Specification Label Simulation Mode Design Constraints Reboiler Specifications

Tube Nozzle Shell Clearance Baffle Miscellaneous Geometry Run Results

Design Constraints

Design Criteria

Allowable tube pressure drop	34.473801	kPa
Allowable shell pressure drop	34.473801	kPa
Allowable tube velocity	76.199997	m/sec
Allowable shell velocity	76.199997	m/sec
Prefer tube length/shell diameter ratio	12	
Minimum excess %		

Sizing nozzle

- ☒ Tube, inlet
- ☒ Tube, outlet
- ☒ Shell, inlet
- ☒ Shell, outlet

Limits of Design Variables

	Lower Limits	Upper Limits	
Tube Length	3	3.1	m
Shell Diameter	0.1524	6	m
Baffle Cut	15	45	Percent of diameter
Baffle Spacing	0.050799999	3.175	m

☐ Optimize number of tube passes

Help Cancel OK

Steady State

Lesson9_AY232_Trial1* Lesson9_AY232_Trial1_1

1 dropdown

2

3

4

5

CHEMCAD 8.1.0 - [Lesson9_AY232_Trial1*]

File Home Drawing View Thermophysic Component D Specification Analysis Sizing Tools CC-THERM Style Help

UnitOp ID 2 Type Shell and Tube Case 14-15 Design

General Enter Stream Information Materials Heat Curve Specification Label Simulation Mode

Configuration

Tube Nozzle Shell Clearance Baffle Miscellaneous Geometry Run Results

Tube Access tube specifications

Heat Exchangers Gray

Feed Product

Fired Heater Heat Exchanger

Multi-Stream Exchanger

Miscellaneous : Grayscale

Piping and Flow : Grayscale

Reactors : Grayscale

Separators : Grayscale

Solids handling : Grayscale

Steady State K:SRK H:SRK 128.0%

Tube Specifications

Number of tubes * 1396

Number of tube passes * 1

Tube outer diameter .0127 m

Tube wall thickness 0.00165 m

Tube length * m

Roughness factor 1.5748e-06 m

Tube pattern Rotated Triangular (60) m

Tube pitch 0.023812501 m

Trufin tube code Plain tube

Turbulator No Turbulator

Tubesheet thickness 0.01905 m

Number of tubesheets 2

* Field may be recalculated when design calculation is run

Help Cancel OK

1

2

3

4

5

CHEMCAD 8.1.0 - [Lesson9_AY232_Trial1b*]

File Home Drawing View Thermophysi Component Specification Analysis Sizing Tools CC-THERM Style Help

UnitOp ID 2 Type Shell and Tube

Case 14-15 Design

Select

General

Enter Stream Information

Heat Curve Specification

Edit Heat Curve

Materials

Label

Simulation Mode

Configuration

Tube

Shell

Baffle

Geometry

Calculate

Charts

Reports

Design

Rating

Fouling Rating

1

dropdown

4

7

5

2

6

8

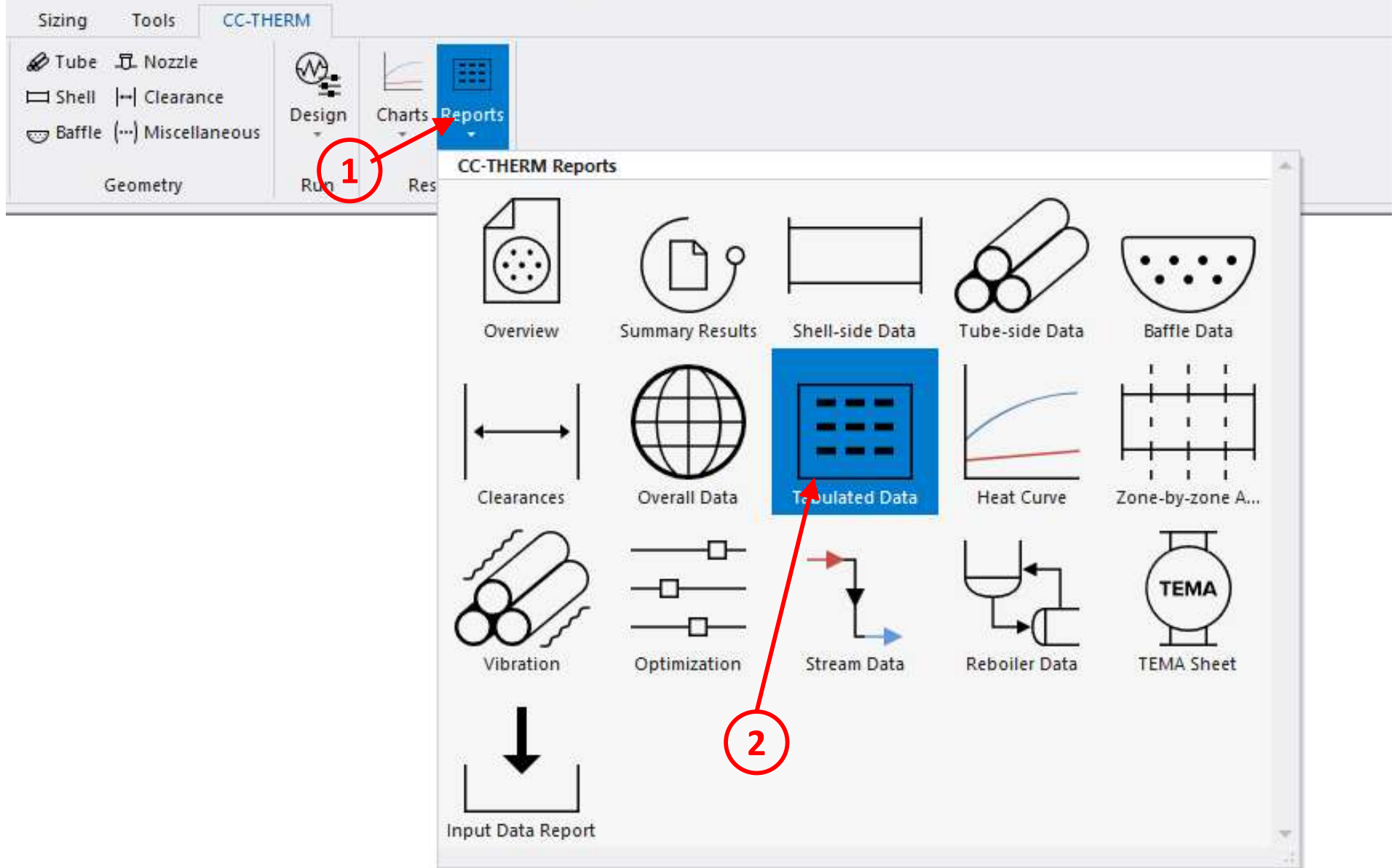
should see 46 iterations after running (44 in NXT)

Lesson9_AY232_Trial1b*

Iteration 46

Steady State

100.0%



Design Results – CHEMCAD 8.1.2

TABULATED ANALYSIS

Overall Data:

Area Total	m2	2758.72	% Excess	8.57
Area Required	m2	2482.72	U Calc. W/m2-K	492.75
Area Effective	m2	2695.50	U Service W/m2-K	453.85
Area Per Shell	m2	2695.50	Heat Duty J/sec	1.57E+07
Weight LMTD C	12.80	LMTD CORR Factor	1.0000	CORR LMTD C 12.80

Shell:

Shell O.D.	m	3.99	Orientation	H
Shell I.D.	m	3.96	Shell in Series	1
Bonnet I.D.	m	3.96	Shell in Parallel	1
Type		AEL	Max. Heat Flux Btu/ft2-hr	0.00
Imping. Plate		Impingement Plate	Sealing Strip	5

Tubes:

Number		22685	Tube Type	Bare
Length	m	3.05	Free Int. Fl Area m2	0.00
Tube O.D.	m	0.013	Fin Efficiency	0.000
Tube I.D.	m	0.009	Tube Pattern	TRI60
Tube Wall Thk.	m	0.002	Tube Pitch m	0.024
No. Tube Pass		1		
Inner Roughness	m	0.0000016		
Number of tubesheets		2	Tubesheet thickness, m	0.019

Resistances:

Shell-side Film	m2-K/W	0.00091
Shell-side Fouling	m2-K/W	0.00018
Tube Wall	m2-K/W	0.00004
Tube-side Fouling	m2-K/W	0.00018
Tube-side Film	m2-K/W	0.00050

Answers to first three questions are found here. How many tubes? Shell diameter? Largest resistance?

Design Results – CHEMCAD NXT 1.1.3

TABULATED ANALYSIS

Overall Data:

Area Total	m2	2348.77	% Excess	6.13
Area Required	m2	2157.83	U Calc. W/m2-K	566.94
Area Effective	m2	2290.05	U Service W/m2-K	534.21
Area Per Shell	m2	2290.05	Heat Duty J/sec	1.57E+07
Weight LMTD C	12.80	LMTD CORR Factor	1.0000	CORR LMTD C 12.80

Shell:

Shell O.D.	m	3.68	Orientation	H
Shell I.D.	m	3.66	Shell in Series	1
Bonnet I.D.	m	3.66	Shell in Parallel	1
Type		AEL	Max. Heat Flux Btu/ft2-hr	0.00
Imping. Plate		Impingement Plate	Sealing Strip	5

Tubes:

Number		19314	Tube Type	Bar
Length	m	3.05	Free Int. Fl Area m2	0.00
Tube O.D.	m	0.013	Fin Efficiency	0.000
Tube I.D.	m	0.009	Tube Pattern	TRI60
Tube Wall Thk.	m	0.002	Tube Pitch m	0.024
No. Tube Pass		1		
Inner Roughness	m	0.0000016		
Number of tubesheets		2	Tubesheet thickness, m	0.019

Resistances:

Shell-side Film	m2-K/W	0.00068
Shell-side Fouling	m2-K/W	0.00018
Tube Wall	m2-K/W	0.00004
Tube-side Fouling	m2-K/W	0.00018
Tube-side Film	m2-K/W	0.00047
Reference Factor (Total outside area/inside area based on tube ID)		1.351

Answers to first three questions are found here. How many tubes? Shell diameter? Largest resistance?

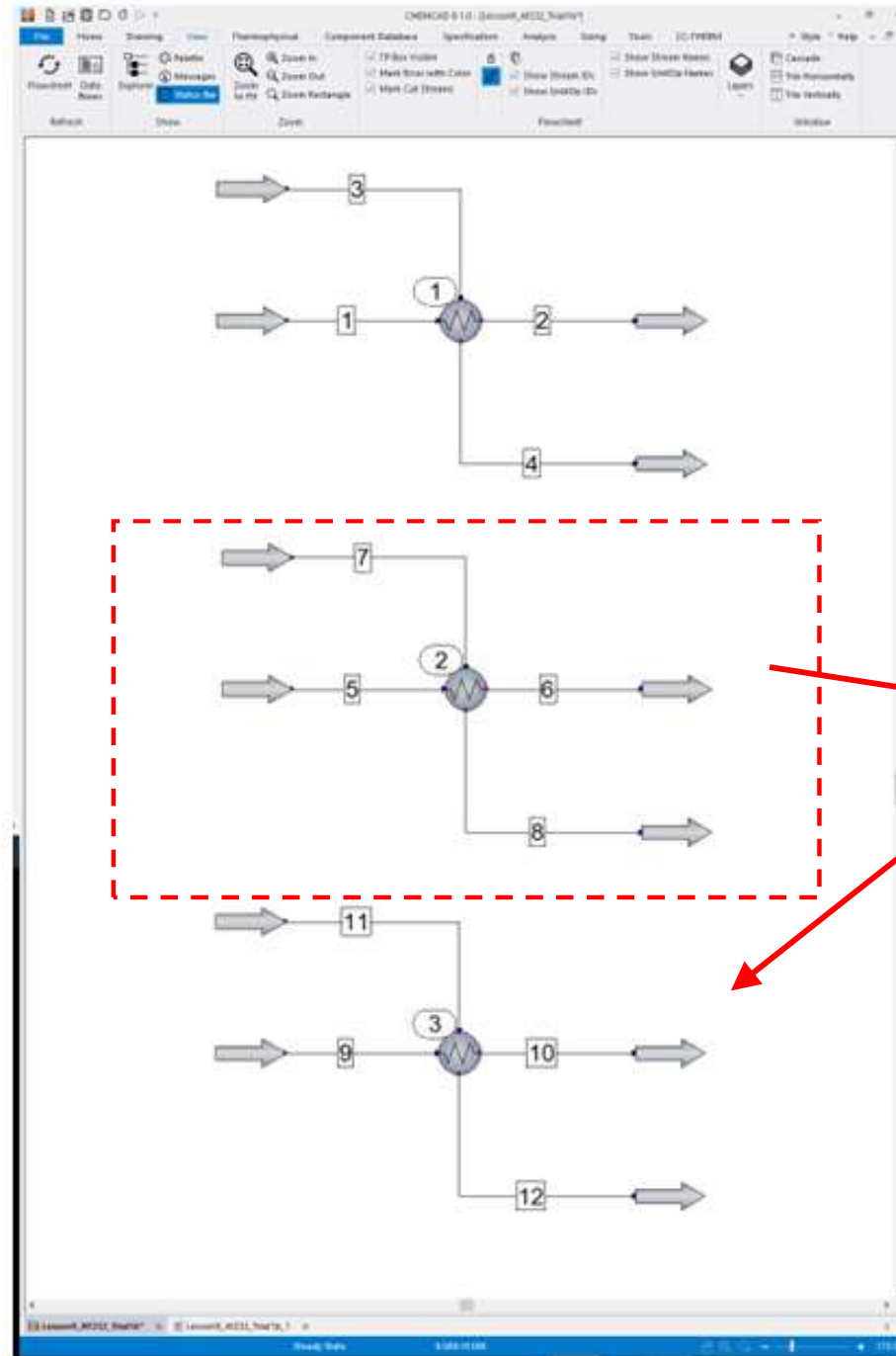
STOP HERE

Confirm results in slide 25 and save your simulation before proceeding

Steps 2-5 of L8 Slide 3 are now complete:

Type of exchanger, geometric details, overall U, thermal driving force, area, and P-drops.

Exchanger Simulation



Copying and pasting is an important step.

It preserves the design work down in exchanger 2 as a backup.

copy this and paste here

Setting the "Simulation Mode" to "1 Shell & tube simulation" initiates step 6 of the design process (L8 slide 3).

The screenshot displays the CHEMCAD 8.1.0 software interface. The main window shows a process flowsheet with a heat exchanger unit operation (HTXR) labeled '3'. The unit is connected to streams 9, 10, 11, and 12. A red arrow labeled '1' points to the heat exchanger icon, with the text 'double-click' above it. The 'Heat Exchanger (HTXR)' dialog box is open, showing the 'Specifications' tab. The 'Simulation mode' dropdown is set to '1 Shell & tube simulation', indicated by a red arrow labeled '2'. Below this, green text states: 'Click OK to proceed to CC-THERM data entry. Outlet conditions will be rigorously calculated by CC-THERM. Change simulation mode to "Enter specifications" to use the specifications below'. The dialog also lists various temperature and vapor fraction specifications for streams 10 and 12, along with subcooling, superheat, and heat duty options. A 'Pressure drop' section on the right lists 'Stream 9' and 'Stream 11'. At the bottom, a 'Select Simulation Case' dialog box is open, prompting the user to choose a case for the exchanger unit operation in simulation mode. It includes an information icon, a message, and 'OK' and 'Cancel' buttons. A red arrow labeled '4' points to the 'OK' button. Another red arrow labeled '3' points to the 'OK' button in the 'Heat Exchanger (HTXR)' dialog box.

File Home Drawing View Thermophys Component Specification Analysis Sizing To

Flowsheet Data Boxes Explorer Palette Messages Status Bar

Refresh Show Zoom

TP Box Visible Mark Error with Color Mark Cut Streams

Show Stream IDs Show UnitOp IDs

Flowsheet Window

Heat Exchanger (HTXR)

Specifications Misc. Settings Cost Estimations

Simulation mode: 1 Shell & tube simulation

Click OK to proceed to CC-THERM data entry.
Outlet conditions will be rigorously calculated by CC-THERM.
Change simulation mode to "Enter specifications" to use the specifications below

Temperature stream 10 C
Temperature stream 12 C
Vapor fraction stream 10
Vapor fraction stream 12
Subcooling stream 10 C
Subcooling stream 12 C
Superheat stream 10 C
Superheat stream 12 C
Heat duty (specified) J/sec

Delta temperature specification
Minimum delta temperature
Hot outlet - cold inlet
Hot inlet - cold outlet
Stream 10 - stream 12
Stream 10 - stream 9
Stream 12 - stream 11
Heat transfer coefficient and a
Specifying both U and A count
Heat transfer coefficient (U)
Area (per shell)

Select Simulation Case

Please choose from the options below to continue, or click Cancel to exit without changes

Choose the case to use for this exchanger UnitOp in simulation mode.

14-15 Design

OK Cancel

Heat Exchanger Before Running

8 - Heat Exchanger (HTXR) -

Specifications | Misc. Settings | Cost Estimations

Simulation mode: 1 Shell & tube simulation

Pressure drop: (default = 0)

Stream 5 kPa

Stream 7 kPa

ID: 2

Click OK to proceed to CC-THERM data entry.
Outlet conditions will be rigorously calculated by CC-THERM.
Change simulation mode to "Enter specifications" to use the specifications below

Temperature stream 6		C
Temperature stream 8		C
Vapor fraction stream 6		
Vapor fraction stream 8		
Subcooling stream 6		C
Subcooling stream 8		C
Superheat stream 6		C
Superheat stream 8		C
Heat duty (specified)		J/sec

Delta temperature specifications:

Minimum delta temperature		C
Hot outlet - cold inlet		C
Hot inlet - cold outlet		C
Stream 6 - stream 8		C
Stream 6 - stream 5		C
Stream 8 - stream 7		C

Heat transfer coefficient and area specification:
Specifying both U and A counts as a single thermal specification.

Heat transfer coefficient (U)		W/m ² -K
Area (per shell)		m ²

Help Cancel OK

Heat Exchanger After Running

The screenshot displays the 'Heat Exchanger (HTXR)' dialog box with the 'Specifications' tab selected. The simulation mode is set to '1 Shell & tube simulation'. The pressure drop for Stream 5 is 3.18865 kPa and for Stream 7 is 3.92201 kPa. The heat transfer coefficient (U) is 452.164 W/m²-K and the area (per shell) is 2699.65 m². A 'CHEMCAD Message Box' is open in the foreground, displaying a warning: 'Warning: CC-THERM has detected possible vibration.' The 'OK' button in the message box is highlighted with a red arrow. Red circles and arrows labeled '1' and '2' point to the pressure drop and heat transfer coefficient/area fields, respectively. The text 'CC NXT 1.1.3' is visible in the bottom right corner of the dialog box.

Heat Exchanger (HTXR) -

Specifications | Misc. Settings | Cost Estimations

Simulation mode: 1 Shell & tube simulation

Pressure drop: (default = 0)

Stream 5: 3.18865 kPa

Stream 7: 3.92201 kPa

Stream 6: 3.31996 kPa

Stream 8: 1.63408 kPa

Click OK to proceed to CC-THERM data entry.
Outlet conditions will be rigorously calculated by CC-THERM.
Change simulation mode to "Enter specifications" to use the specifications below

Temperature stream 6: [] C

Temperature stream 8: [] C

Vapor fraction stream 6: []

Vapor fraction stream 8: []

Subcooling stream 6: [] C

Subcooling stream 8: [] C

Delta temperature specifications:

Minimum delta temperature: [] C

Hot outlet - cold inlet: [] C

Hot inlet - cold outlet: [] C

Stream 6 - stream 8: [] C

Stream 6 - stream 5: [] C

Stream 8 - stream 7: [] C

Heat transfer coefficient and area specification:

Specifying both U and A counts as a single thermal specification.

U and A are specified. $Q = U \cdot A \cdot \text{LMTD}$ constraint applied.

Heat transfer coefficient (U): 452.164 W/m²-K

Area (per shell): 2699.65 m²

527.247 W/m²-K

2299.84 m²

CC NXT 1.1.3

CHEMCAD Message Box -

Run Time Error and Warning Messages:

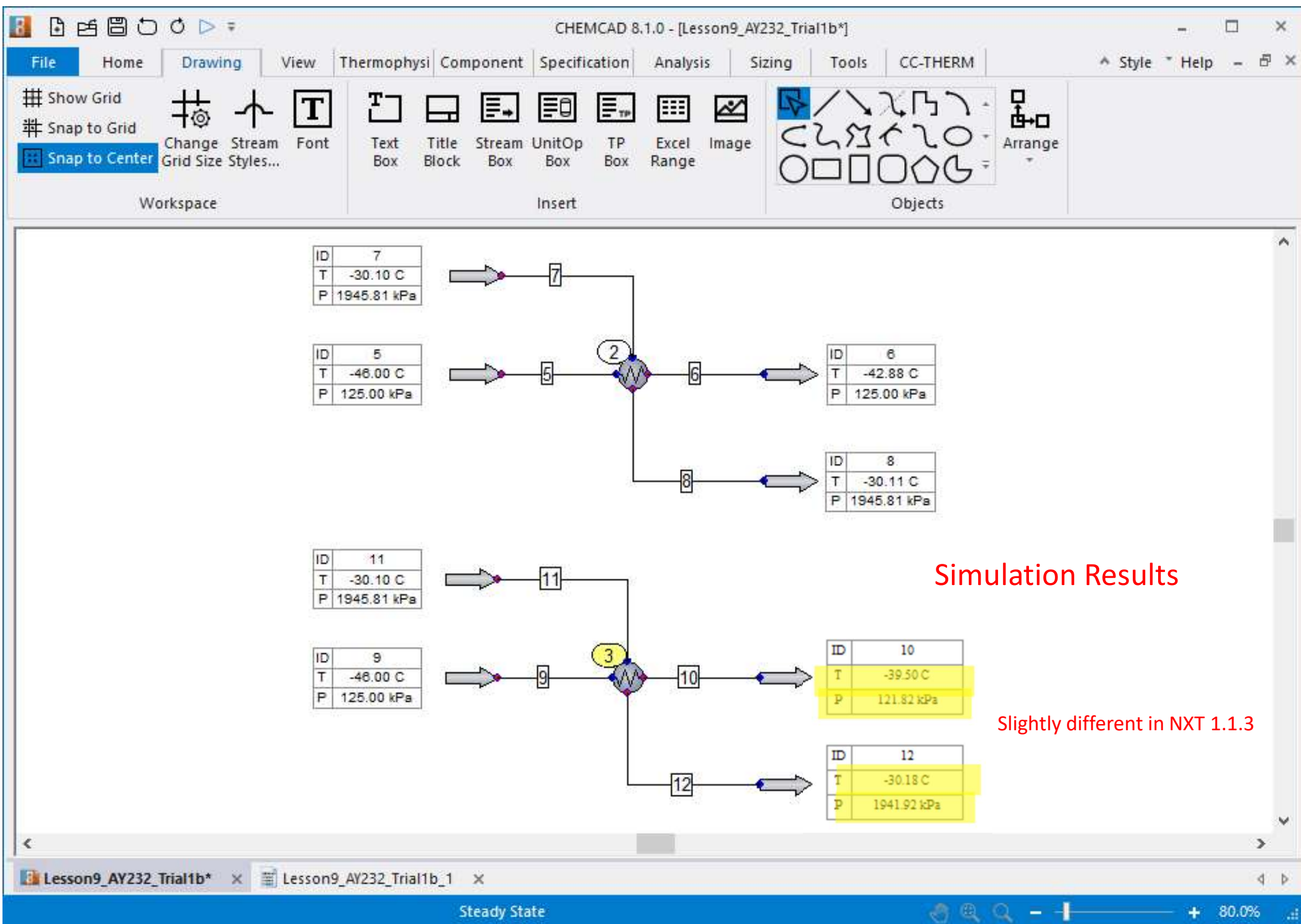
*** Equip. 3 ***

Warning: CC-THERM has detected possible vibration.

OK

Cancel OK

Click "Run All" in the Home tab



CHEMCAD 8.1.0 - [Lesson9_AY232_Trial1b*]

File Home Drawing View Thermophysical **Component** Specification Analysis Sizing **Tools** CC-THERM

Save Data Map Save Data Map As View/Edit Execution Rules New Import... Select Costing Edit Costing Index Economics Execute Parser Units Converter CO2 Solid Title Block Designer UnitOp Designer

Data Map

ID	11
T	-30.10 C
P	1945.81 kPa

ID	9
T	-46.00 C
P	125.00 kPa

Chemical Engineering Plant Cost Index

Year/Month Selection for the Cost Index

Year 2025 Source Database

Month February } make sure to set this to February 2025

Type	Cost Index
CE Index	787.30
Equipment	983.20
Heat exchangers and tanks	772.60
Process machinery	1011.40
Pipes, valves, and fittings	1324.20
Process instruments	578.90
Pumps and compressors	1581.40
Electrical equipment	834.10
Structural supports and misc.	1069.00
Construction labor	388.90
Buildings	798.70
Engineering and supervision	313.50

1945.81 kPa

10
-39.34 C
121.81 kPa

12
-30.18 C
1941.89 kPa

Lesson9_AY232_Trial1b* x

CEINDEX.my

Help Cancel OK

132.0%

CHEMCAD 8.1.0 - [Lesson9_AY232_Trial1b*]

File Home Drawing View Thermophys Component Specification Analysis Sizing Tools CC-THERM Style Help

Save Data Map Save Data Map As View/Edit Execution Rules New Import... Select Costing Edit Costing Index Economics Execute Parser Units Converter CO2 Solid Title Block Designer UnitOp Designer

Data Map Costing General Environmental Flowsheet

P 1945.81 kPa

ID	11
T	-30.10 C
P	1945.81 kPa

ID	9
T	-46.00 C
P	125.00 kPa

ID	10
T	-39.34 C
P	121.81 kPa

ID	12
T	-30.18 C
P	1941.89 kPa

double-click

Lesson9_AY232_Trial1b* Lesson9_AY232_Trial1b_1

Steady State

132.0%

Heat Exchanger (HTXR) -

Specifications | Misc. Settings | Cost Estimations

ID: 3

☒ Run the costing report after running the unit

Cost model: Shell and tube

Exchanger type: Fixed head

Evaporator type: Forced circulation

Design pressure: kPa

Install factor:

Material factor:

Pressure factor:

Type factor:

Material selection for this model:

Shell and tube

Carbon steel

Calculated Results:

Basic cost		\$
Total purchase cost		\$
Total installed cost		\$
Utility Cost		\$
Purchase Cost Override		\$

Costs show up here after running.

Help Cancel OK

Click OK then run the simulation.

Cost Results

Heat Exchanger (HTXR) -

Specifications | Misc. Settings | Cost Estimations

ID: 3

☒ Run the costing report after running the unit

Cost model: Shell and tube

Exchanger type: Fixed head

Evaporator type: Forced circulation

Design pressure: kPa

Install factor: 2

Material factor: 1

Pressure factor: 1.28892

Type factor: 0.831407

Material selection for this model

Shell and tube

Carbon steel

Calculated Results

Basic cost	377042	\$
Total purchase cost	930449	\$
Total installed cost	1.8609e+06	\$
Utility cost		\$/sec
Purchase cost override		\$

317634 \$

767912 \$

1.53582e+06 \$

CC NXT 1.1.3

Help Cancel OK

Answer to last question is found here (total purchase cost in Feb 2025).

STOP HERE

Finished.

Submit CHEMCAD file, tabulated results report,
and answers to the four (4) questions