

# 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 to 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 <sub>4</sub>	0.003
C <sub>2</sub> H <sub>6</sub>	0.0626
C <sub>2</sub> H <sub>4</sub>	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. 2024.

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

page 91

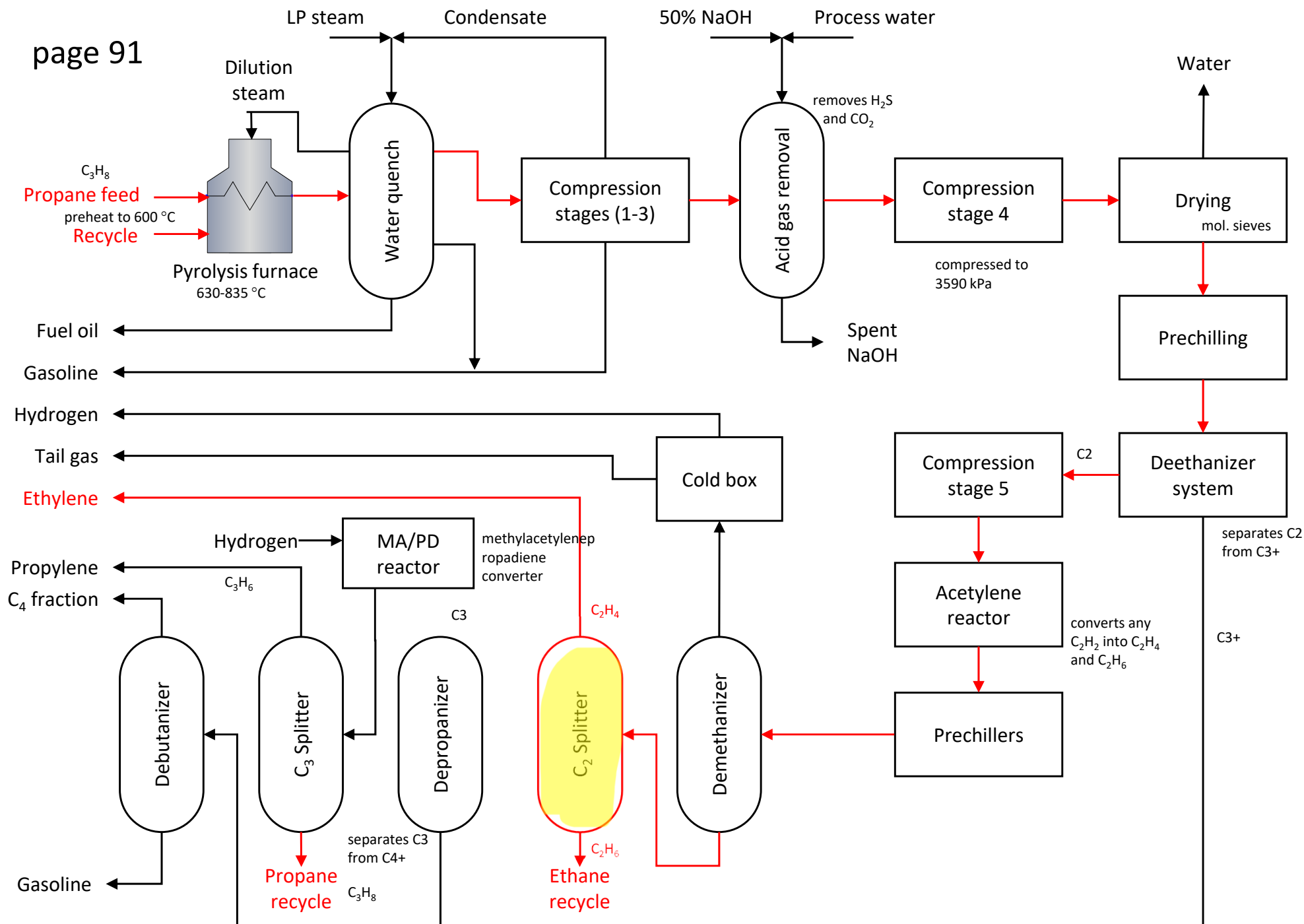


Figure 3-13. Product Separation Section

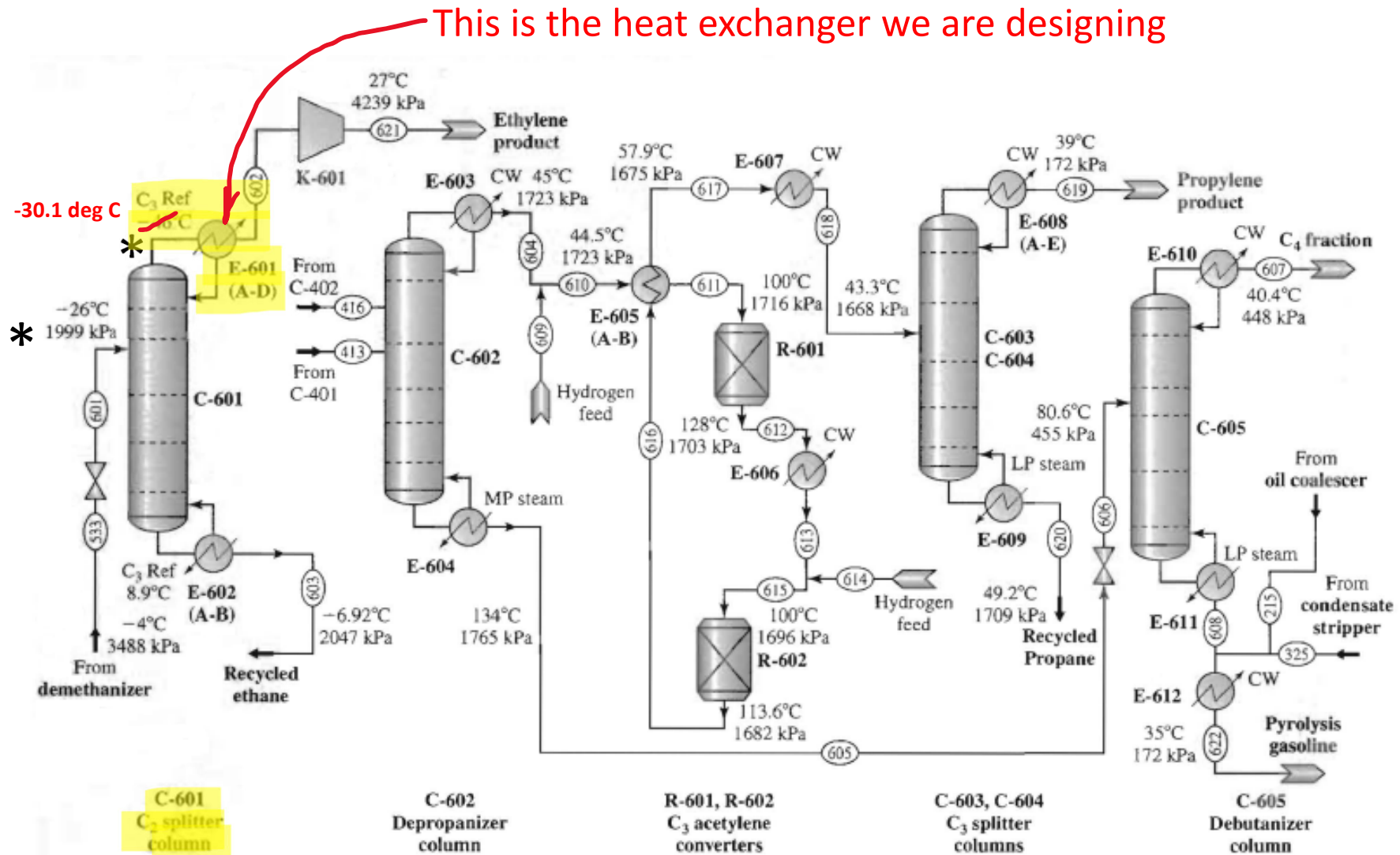


Figure 3-13. Product separation section.

Change CEPCI to Feb 2024 for PS4

Change engineering units

The screenshot shows the CHEMCAD 8.1.0 software interface. The 'Tools' menu is highlighted in the top ribbon. The 'Engineering Units' dialog box is open, showing the 'System Profiles' section with 'Common SI' selected. The 'Fundamental' units section shows 'Time' as 'sec', 'Mole/Mass' as 'kg', 'Temperature' as 'C', 'Pressure' as 'kPa', 'Enthalpy' as 'J', and 'Work' as 'kJ'. The 'Fluid Flow' section shows 'Liquid Volume Rate' as 'm3/h', 'Vapor Volume Rate' as 'm3/h', 'Vapor Density' as 'kg/m3', 'Liquid Density/Con...' as 'kg/m3', 'Crude Flow Rate' as 'm3/h', and 'Velocity' as 'm/sec'. The 'Fluid Properties' section shows 'Heat Capacity' as 'kJ/kg-K', 'Specific Heat' as 'kJ/kg', 'Heat Transfer Coef...' as 'W/m2-K', 'Thermal Conductivity' as 'W/m-K', 'Viscosity' as 'N-s/m2', and 'Surface Tension' as 'N/m'. The 'Stream Flow Units' section shows 'Total Flow' as 'Default mole/r', 'Component Flow' as 'Default mole/r', and 'Stream Edit' as 'Automatic con'. The 'VBA Flow Units' section shows 'Flow unit option for some VBA functions' as 'Mole'. The 'Pipe Table Selection' section shows 'Default pipe table for Pipe, Orifice, and line sizing tool' as 'ASME (B36.10M-2015, B36.19M-2004)'. The 'Atmospheric Pressure Reference' section shows 'Default' as '101.3249817 kPa'. The 'Vapor Reference Temperature' section shows 'Default' as '0.00 C'. The 'Apply' button is highlighted.

Change engineering units

Change CEPCI to Feb 2024 for PS4

Tools

Steady State

Dynamic

Run All

Run from Initial State

Charts

Reports

Property Set

Stream Property

Report Viewer

MS Excel

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

Pipe Table Selection

Default pipe table for Pipe, Orifice, and line sizing tool: ASME (B36.10M-2015, B36.19M-2004)

Atmospheric Pressure Reference

This is the reference for determining gauge pressure: Default 101.3249817 kPa

Vapor Reference Temperature

This is the reference for determining standard vapor volume flow rate: Default 0.00 C

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

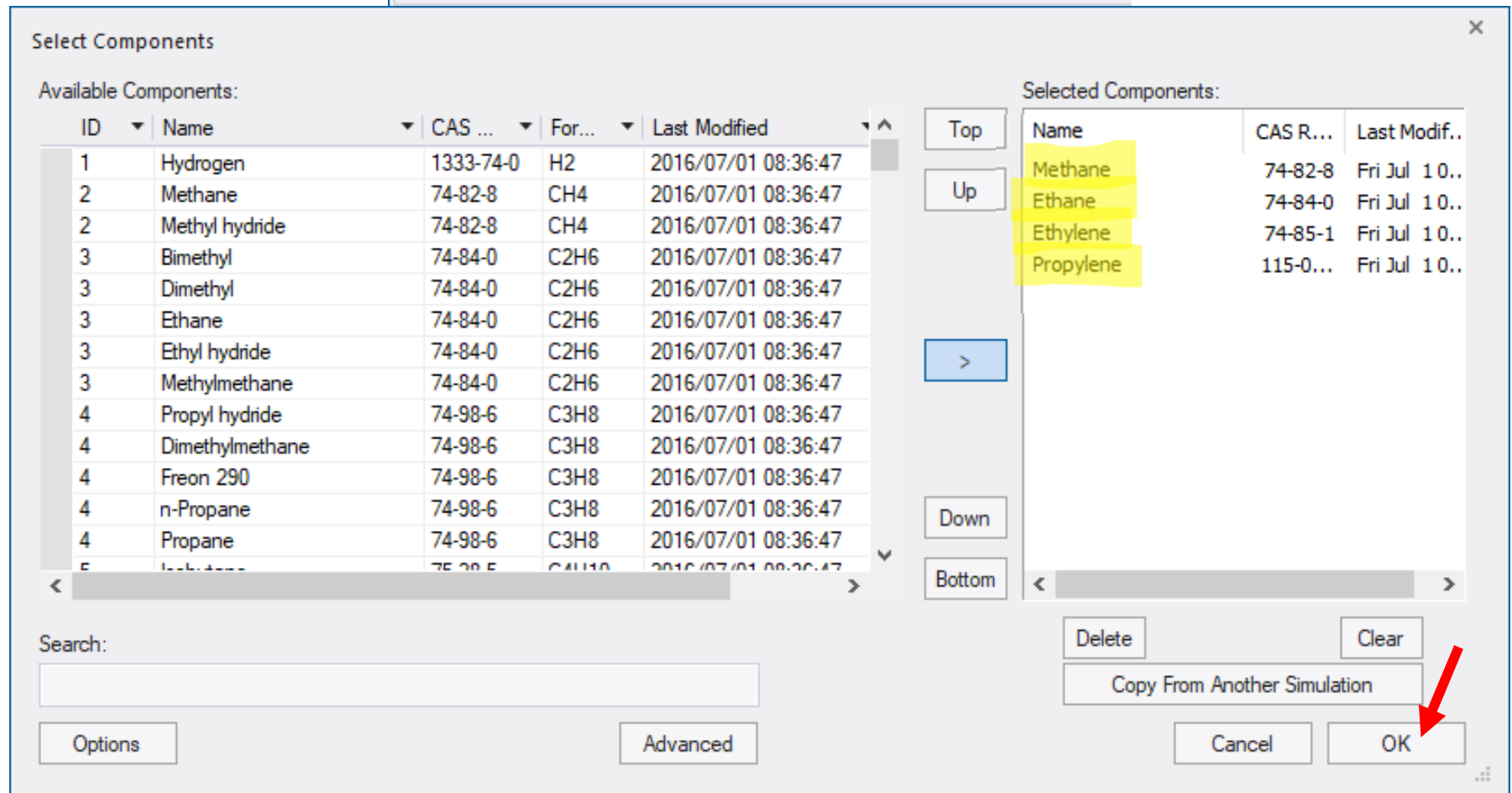
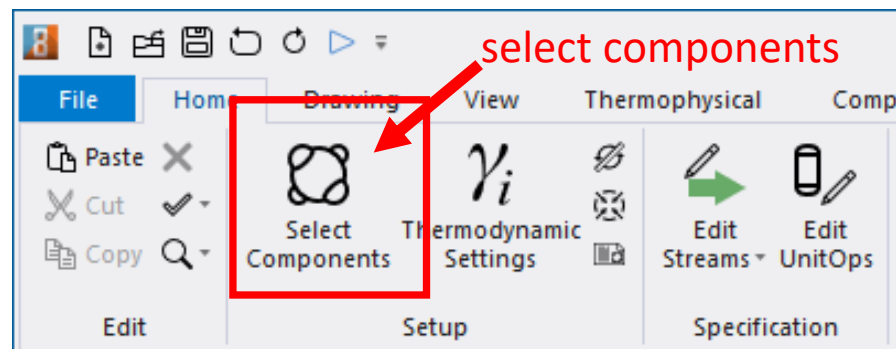
Separators : Grayscale

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 shows two overlapping 'Thermodynamic Settings' dialog boxes. The background box is on the 'K-value Models' tab, and the foreground box is on the 'Enthalpy Models' tab. A red arrow points to the 'OK' button in the foreground box.

**Thermodynamic Settings - (Background)**

- K-value Models**
- Global K-value 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**

**Thermodynamic Settings - (Foreground)**

- Enthalpy Models**
- Global Enthalpy Model: **SRK**
- Use heat of solution file: ☐
- Use electrolyte enthalpy: ☐
- Heat of Mixing by Gamma: ☐
- Ideal gas heat capacity: **DIPPR**
- Steam table: **IAPWS-IF97**
- 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 5.

Heat Exchanger #4

Feed Product

Fired Heater Heat Exchanger

Multi-Stream Exchanger

Miscellaneous : Grayscale

Piping and Flow : Grayscale

Reactors : Grayscale

Separators : Grayscale

Solids handling : Grayscale

Untitled\* x

Steady State

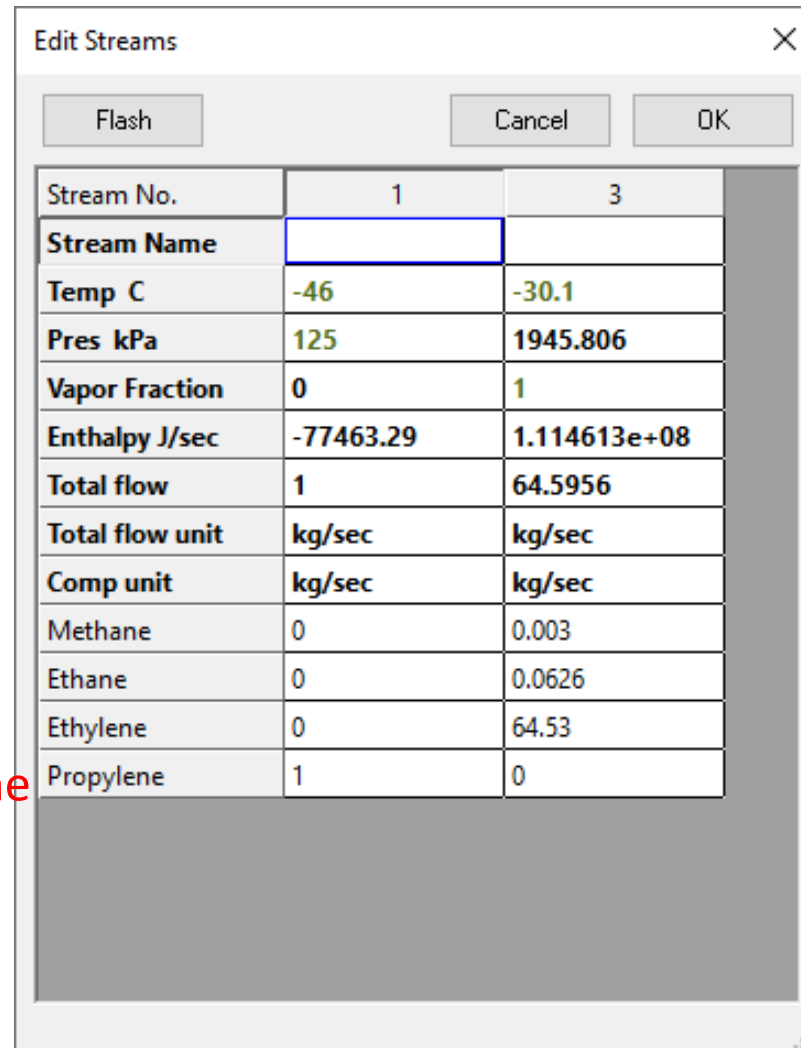
124.0%

# 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 the 'Specifications' tab selected. The 'Simulation mode' is set to '0 Enter specifications (CHEMCAD simulation)'. The 'Utility option' is set to '3 Calculate flow of stream 1', which is highlighted by a red box with the text 'Switch this to "3"'. The 'Pressure drop' is set to '(default = 0)'. 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 by a red box with the text 'Given (see slide 2)'. The 'Temperature stream 4' field is highlighted by a red box with the text 'Assume! (see note 1)'. The 'Vapor fraction stream 2' and 'Vapor fraction stream 4' fields are set to 0.995 and 0.265, respectively. The 'Subcooling stream 2' field is empty. The 'Superheat stream 4' field is empty. The 'Heat duty (specified)' field is highlighted by a red box with the text 'Given (see slide 2)'. The 'Help', 'Cancel', and 'OK' buttons are at the bottom.

Heat Exchanger (HTXR) -

Specifications | Misc. Settings | Cost Estimations

Simulation mode: 0 Enter specifications (CHEMCAD simulation) ID: 1

Utility option: 3 Calculate flow of stream 1

Pressure drop: (default = 0)

Stream 1 kPa

Stream 3 kPa

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/m<sup>2</sup>-K

Area (per shell) m<sup>2</sup>

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

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 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 software interface. The main window shows a process flow diagram with four streams (1, 2, 3, 4) and a central unit. Stream 1 is highlighted in the 'Edit Streams' dialog box. A red arrow points to the 'Steady State' button in the top toolbar, and another red arrow points to the 'Propylene' row in the 'Edit Streams' dialog box.

**Steady State**

**Edit Streams**

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

Steady State

## 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 counts as a single thermal specification.

Heat transfer coefficient (U) W/m<sup>2</sup>-K

Area (per shell) m<sup>2</sup>

Help Cancel OK

Given

Note: there is no P-drop

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		W/m2-K	Pressure stream 2	125
Calc Area (Total)		m2	Pressure stream 4	1945.81
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

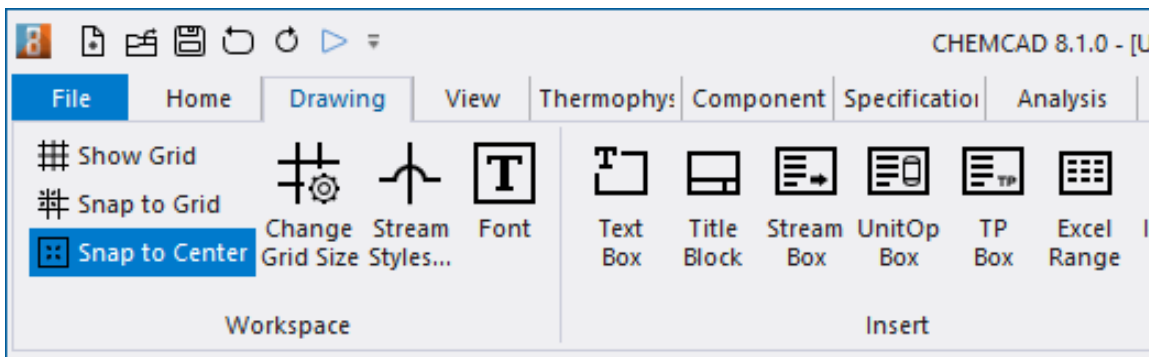
Numbers in gray fields were calculated by CHEMCAD

# STOP HERE

Confirm results in slides 12 to 14 before proceeding

Step 1 (L8 Slide 5) is complete:

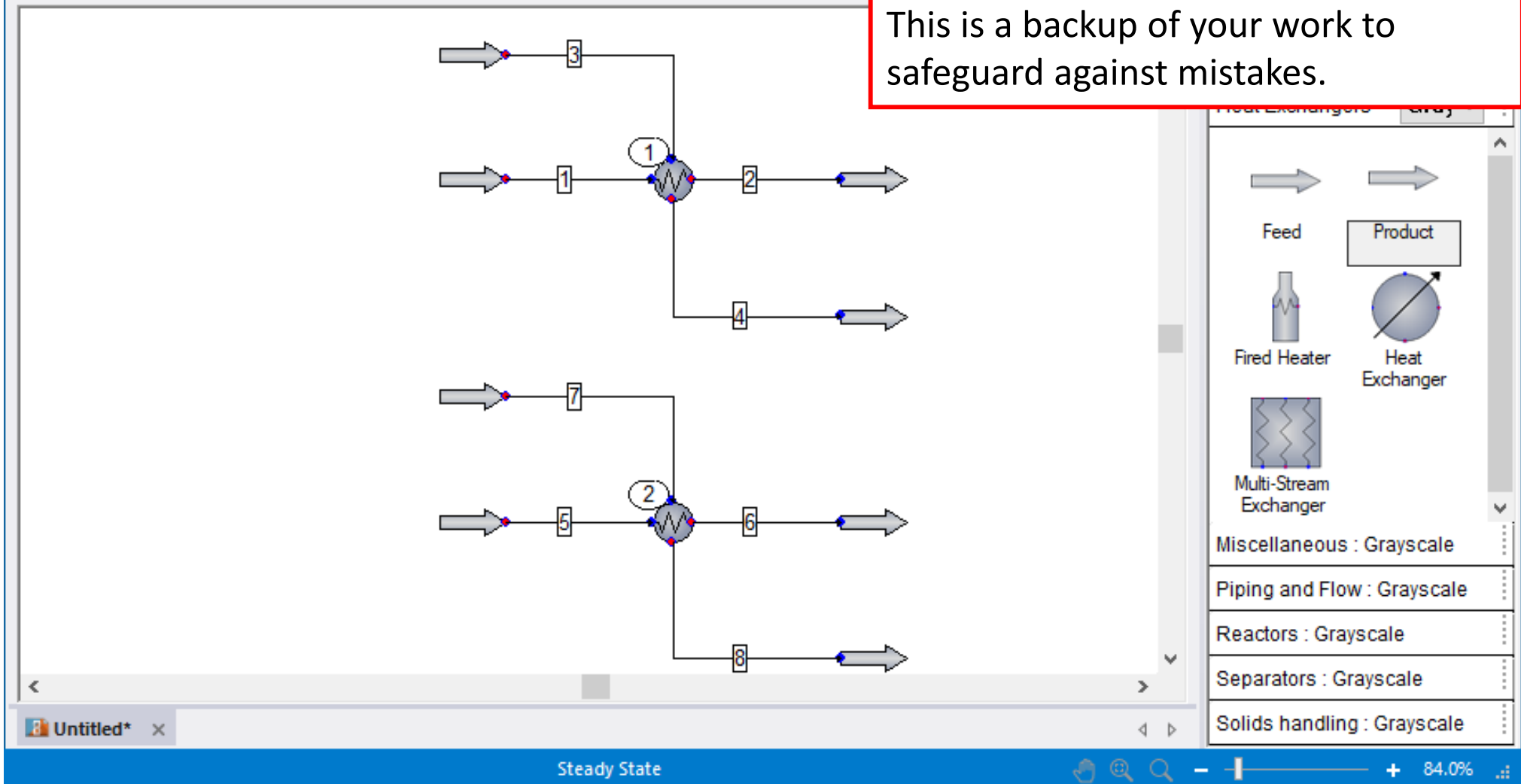
Determined the flow rates and heat transfer rates  
necessary to meet the given conditions.



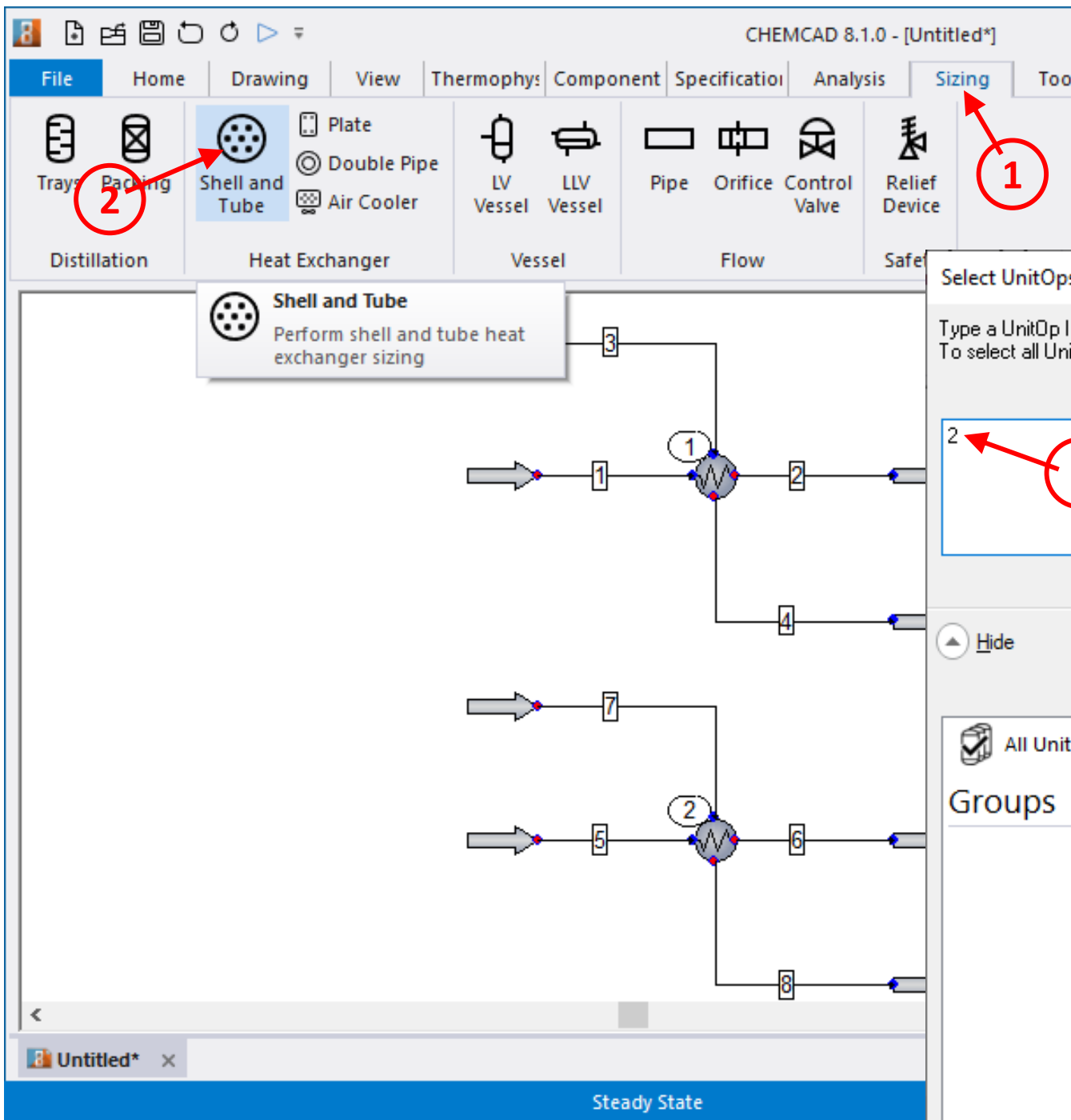
Save your simulation at this point.

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.

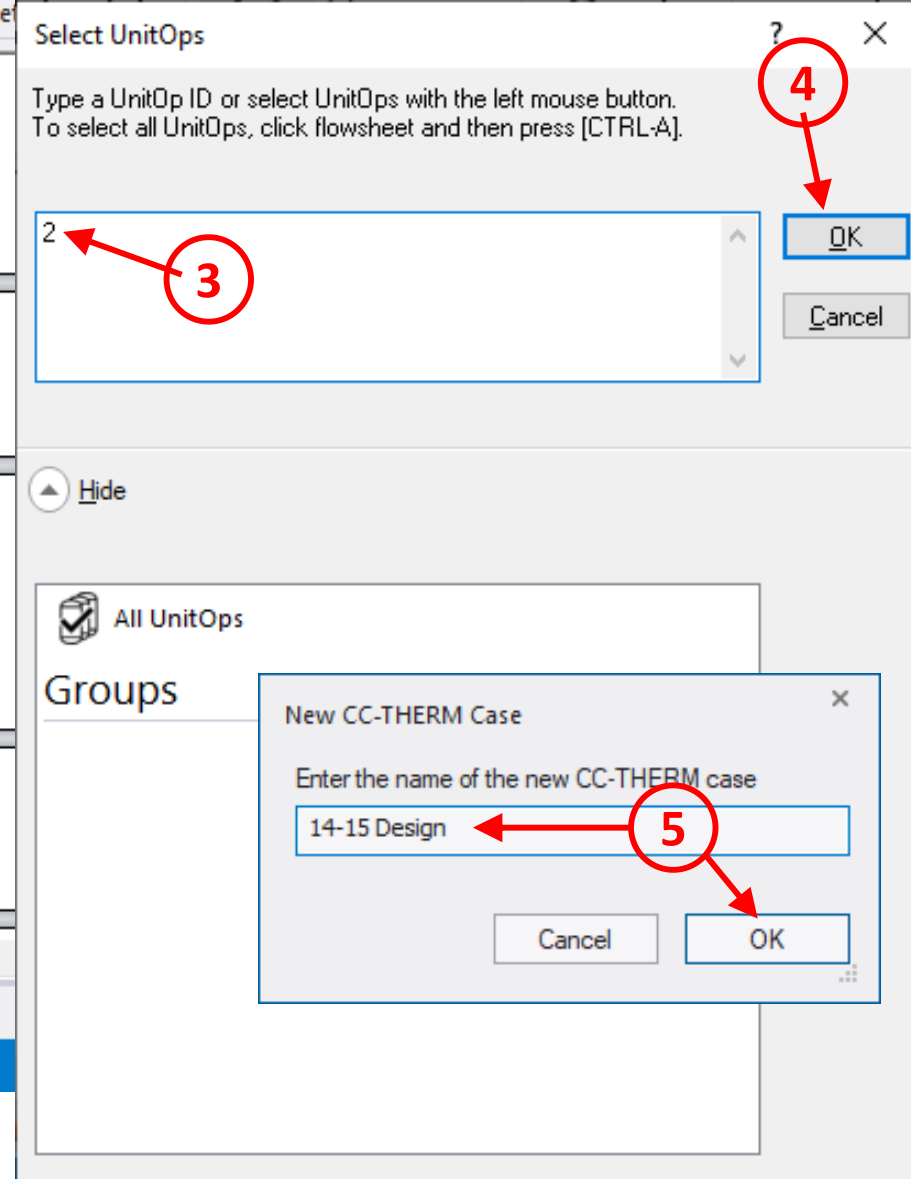






Click "Sizing," then "Shell-and-tube."

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 InformationMaterialsHeat Curve SpecificationLabelEdit Heat Curve

Configuration

4

7

5

2

6

8

1

Select Tube-side Inlet Stream

Please select the stream entering the exchanger tube side.

5

2

3

OK

Cancel

Hide

All Streams

Feed Streams

Product Streams

Cut Streams

Groups

Lesson9\_AY232\_Trial1\*Lesson9\_AY232\_Trial1\_1

Steady StateK:SRK H:SRK



## 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 m<sup>2</sup>-K/W

Optional h Coeff.: W/m<sup>2</sup>-K

Shell Side

Stream name:

Process type: Horiz Condensation

Fouling factor: 0.0001761094 m<sup>2</sup>-K/W

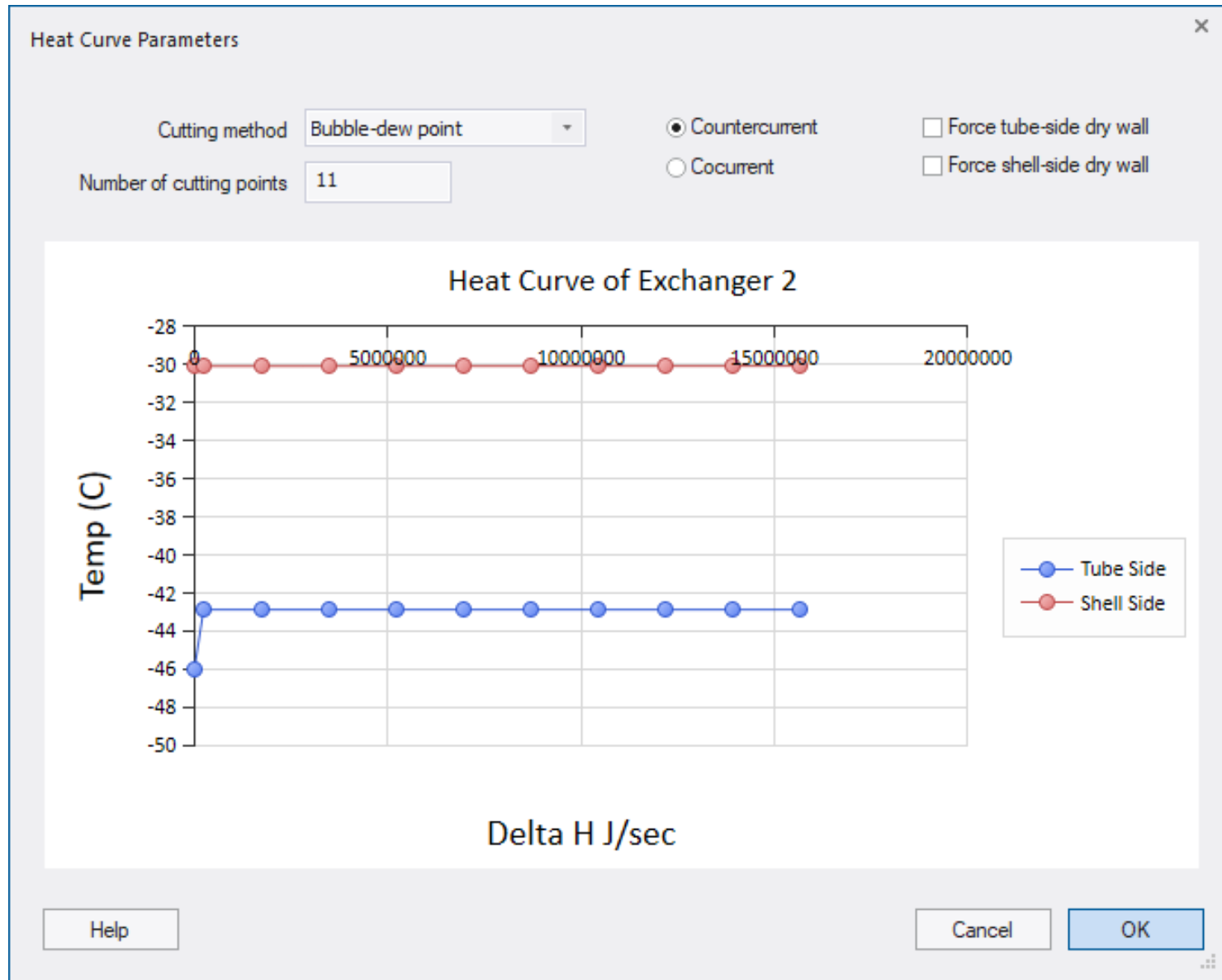
Optional h Coeff.: W/m<sup>2</sup>-K

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

Lesson9\_AY232\_Trial1\* Lesson9\_AY232\_Trial1\_1 Steady State

Diagram showing a process flow with streams 4, 5, 6, 7, and 8, and a reboiler unit. Red circles and arrows indicate key elements: 1. Design Constraints button, 2. Tube Length input, 3. Upper Limits header, 4. Shell Diameter input, 5. OK button.

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)

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

UnitOp ID 2  
Case 14-15 Design

Type Shell and Tube

General

Configuration

Enter Stream Information

Heat Curve Specification

Edit Heat Curve

Materials

Label

Simulation Mode

Tube

Shell

Baffle

Geometry

Calculate

Charts

Reports

Design

Rating

Fouling Rating

should see 46 iterations after running

Lesson9\_AY232\_Trial1b\*

Iteration 46

Steady State

100.0%

Sizing

Tools

CC-THERM

Tube Nozzle  
Shell Clearance  
Baffle Miscellaneous

Geometry



Design

Run



Charts



Reports

1

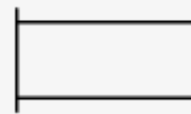
## CC-THERM Reports



Overview



Summary Results



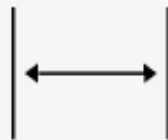
Shell-side Data



Tube-side Data



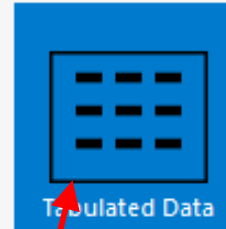
Baffle Data



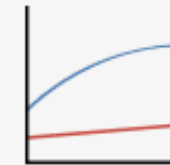
Clearances



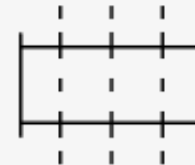
Overall Data



Temperatures



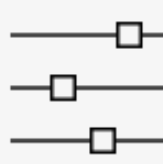
Heat Curve



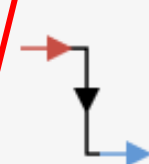
Zone-by-zone A...



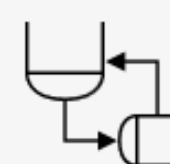
Vibration



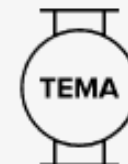
Optimization



Stream Data



Reboiler Data



TEMA Sheet



Input Data Report

2



# Design Results

## 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.

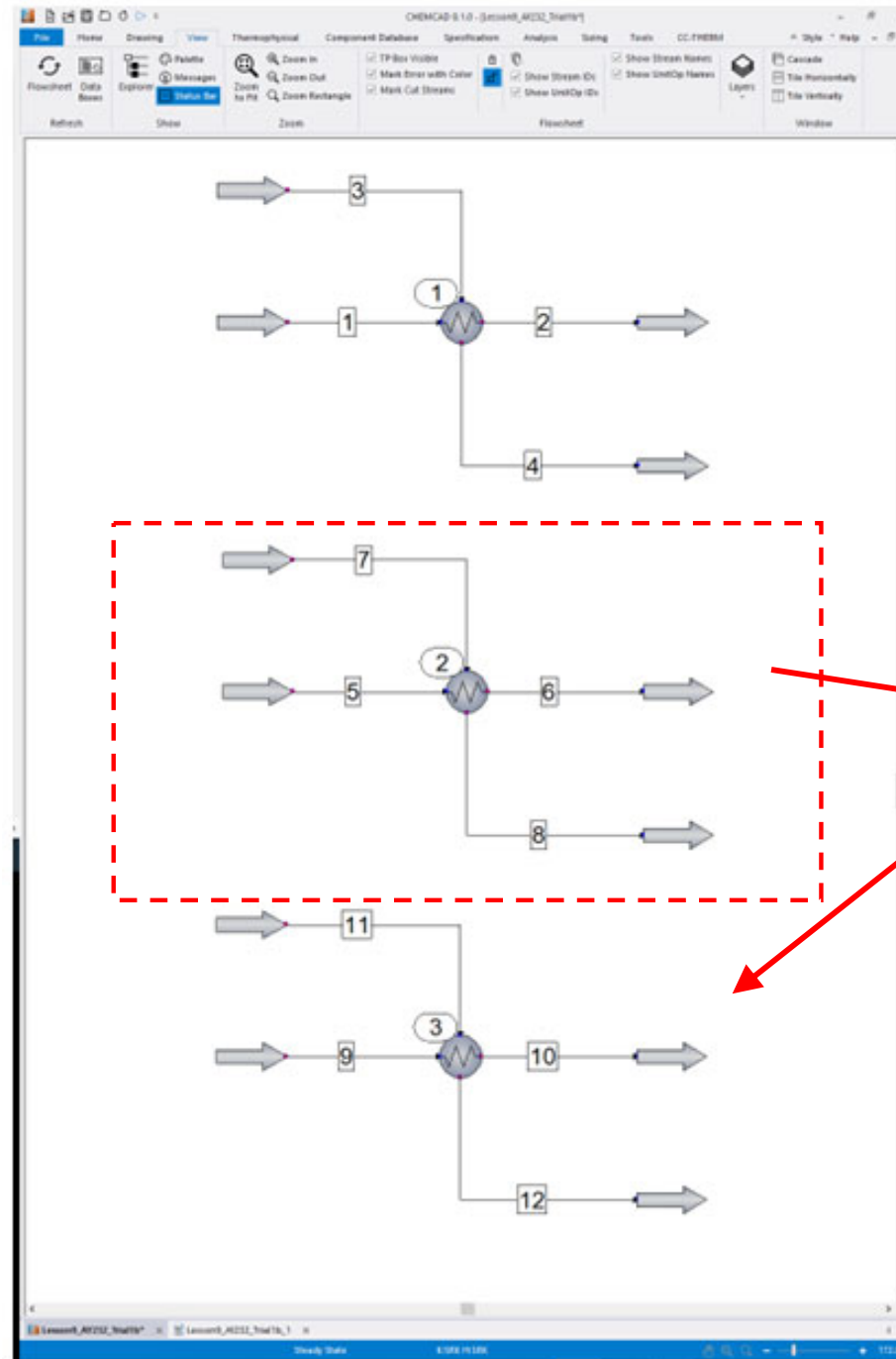
# STOP HERE

Confirm results in slide 12 before proceeding

Steps 2-5 of L8 Slide 5 are 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 5).

CHEMCAD 8.1.0 - [Lesson9\_AY232\_Trial3\*]

File Home Drawing View Thermophysi 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

double-click

1

3

11

9

10

12

- 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

Parameter	Value	Unit	Description
Temperature stream 10		C	Delta temperature specification
Temperature stream 12		C	Minimum delta temperature
Vapor fraction stream 10			Hot outlet - cold inlet
Vapor fraction stream 12			Hot inlet - cold outlet
Subcooling stream 10		C	Stream 10 - stream 12
Subcooling stream 12		C	Stream 10 - stream 9
Superheat stream 10		C	Stream 12 - stream 11
Superheat stream 12		C	Heat transfer coefficient and a
Heat duty (specified)		J/sec	Specifying both U and A count

Heat transfer coefficient (U)  
Area (per shell)

Cancel OK

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 <sup>2</sup> -K
Area (per shell)		m <sup>2</sup>

Help Cancel OK

# Heat Exchanger After Running

**8 - 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

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

Parameter	Value	Unit
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:

Parameter	Value	Unit
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.

Parameter	Value	Unit
Heat transfer coefficient (U)	452.164	W/m <sup>2</sup> -K
Area (per shell)	2699.65	m <sup>2</sup>

Help | Cancel | OK

Click "Run All" in the Home tab

CHEMCAD 8.1.0 - [Lesson9\_AY232\_Trial1b\*]

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

Style Help

Show Grid Snap to Grid Snap to Center Change Grid Size Styles... Font Text Box Title Block Stream Box UnitOp Box TP Box Excel Range Image

Workspace Insert Objects Arrange

ID	7
T	-30.10 C
P	1945.81 kPa

ID	5
T	-46.00 C
P	125.00 kPa

ID	6
T	-42.88 C
P	125.00 kPa

ID	8
T	-30.11 C
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	-39.50 C
P	121.82 kPa

ID	12
T	-30.18 C
P	1941.92 kPa

Simulation Results

CHEMCAD 8.1.0 - [Lesson9\_AY232\_Trial1b\*]

File Home Drawing View Thermophysical 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

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 2024 Source Database

Month February } make sure to set this to February 2024

Type	Cost Index
CE Index	780.00
Equipment	974.60
Heat exchangers and tanks	785.30
Process machinery	1002.40
Pipes, valves, and fittings	1304.00
Process instruments	559.20
Pumps and compressors	1505.00
Electrical equipment	807.10
Structural supports and misc.	1067.80
Construction labor	381.60
Buildings	787.00
Engineering and supervision	315.80

Help Cancel OK

945.81 kPa

10
-39.34 C
121.81 kPa

12
-30.18 C
941.89 kPa

Lesson9\_AY232\_Trial1b\* CEINDEX.my 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

1 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	945744	\$
Total installed cost	1.89149e+06	\$
Utility cost		\$/sec
Purchase cost override		\$

Help Cancel OK

Answer to last question is found here.

# STOP HERE

Finished.

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