## **DWSIM Simulation**

(Mobile Version) – Part #8 by Keren Perulu

## Simulation of Heat Exchanger Using "Heater" and "Cooler" Blocks

#### Objective

Develop a simple process flow sheet to simulate heat exchanger using "heater" and "cooler" blocks and determine the heat duty and exit temperature of a stream.

#### Data:

Problem statement (Adapted from Example 13.7, Seider et. al., 2008)

#### Hot Stream Fluid: Styrene

Molar Flow rate = 150000 lb/h

Inlet Temperature = 300 deg F

Exit Temperature = 178 deg F

Pressure = 50 psia

#### **Cold Stream Fluid: Toluene**

Molar Flow rate = 125000 lb/h

Inlet Temperature = 100 deg F

Pressure = 90 psia



#### Procedure

- 1. Open the DWSIM app
- 2. On the home screen select the **COMPOUNDS** menu and Add the two components required for simulation - Toluene and Styrene. Ensure that all the components are added from the same property package. (Example: All the components are selected from the *Chemsep database*).
- 3. Specify the thermodynamic package.

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	COMPOUNDS	i i		Ť.
CREA	Check compounds to add them to the	e simulation, uncheck to	CREATING AND RUNNING A NEW SIMULATIO	ч
1. Sel 2. el	remove.		1. Select Compounds to add to the simulation 2. Select and add at least one Property Packa	
3. de	d		3. Add Unit Operations, Material and Energy S	treams to the
	🗹 Toluene		Flowsheet ('OBJECTS' > touch and drag any	available item)
4. or	(С6Н5)СНЗ	ChemSep	<ol> <li>connect unit Operation blocks to streams object &gt; 'CONNECTIONS')</li> </ol>	
5. di			5. Edit properties of the upstream Material St	
a d	Styrene		and all Unit Operations (select object > 'PR	
6. <u>u</u>	(C6H5)CHCH2	ChemSep	6. Run the simulation (press the 'Play' button	on the top bar)
7. To	🔲 Air		7. To view the simulation results, go 'REPORT	S' and generate
are	(N2)0.781 (O2)0.209 (Ar)0.01	ChemSep		
			SIMULATION BASIS	
	L Argon		Select and Add Property Packages t	o use on this simulation.
	Ar	ChemSep		
			Add Property Package select an i	
	BrBr	ChemSen		
			Raoult's Law	
	Carbon tetrachloride		Learn more about which methods a	nd correlations are being used
	CCI4	ChemSep	Property Packages to calculate fluid	properties by visiting <u>https://</u>
			.org/wiki/index.php?title=Property_I	Methods_and_Correlation_Prot
			Get help on selecting the best Therr	nodynamic Model/Property Pa
		CnemSep	for your system: https://dwsim.org/	wiki/index.php?title=Property
	Carbon dioxide			
	осо	ChemSep		
	Carbon disulfide			
	SCS	ChemSep		
	COCI2	ChemSep		
	Available Compounds: 1255			
	Compounds from the 'ChEDL Thermo' database may have			
	estimated properties. Read more: <u>https://goo.gl/8rggxc</u>			
	CREATE A NEW CO	MPOUND		
CON	LOAD COMPOUND FRO	DM JSON FILE	COMPOUNDS BASIS OF	JECTS REACTIONS
	•		•	•

- 4. Drag and drop the Material streams from the object palette. Rename them as "Hot-In", "Hot-Out", and "Cold-In", Cold-Out".
- 5. Insert an Energy stream from the object pallet and Rename it as "Q-Stream"
- 6. Specify the feed compositions, flow rate, temperature and pressure for the inlet streams.

Quantity	Hot-In	Cold-In
Temperature, (°F)	300	100
Pressure, (psia)	50	90
Molar Flowrate (lb/h)	150000	125000
Composition (mass fraction)	Styrene: 1	Styrene: 0
	Toluene: 0	Toluene: 1



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	STREAM ID			
	Name	Hot-In		
	PROPERTY PACKAGE			
	Property Package	Raoult's Law		
	Flash Algorithm	Default		
	STATE SPECIFICATION			
	Flash Specification	Temperature and P		
	Select a pair of properties to specify the t	ermodynamic state of the stream's m	ixture.	
	Temperature (F)		<u>300</u> ×	
	Enter the temperature of the stream if the calculated.	Flash Spec is T/P or T/VF, otherwise it		
	Pressure (psi)		50 ×	
	Enter the pressure of the stream if the Els			

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Ø	MATERIAL STREAM PROPERTIES: Cold-In			
	STREAM ID			
	Name	Cold-In		
	PROPERTY PACKAGE			
	Property Package	Raoult's Law 🔫		
	Flash Algorithm	Default 🗣		
	STATE SPECIFICATION			
	Flash Specification	Temperature and P 🖣		
	Select a pair of properties to specify the	hermodynamic state of the stream's mixtur		
	Temperature (F)	100		
	Enter the temperature of the stream if th calculated.	Flash Spec is T/P or T/VF, otherwise it will	be	
	Pressure (psi)	90		
	Enter the pressure of the stream if the Fl. will be calculated.	aon opeu io 17r, r7n, r7o ui r7vr, uneiwioe	n.	

Pressure (psi)	90	
Enter the pressure of the stream if the Flash Spec is T/P, P/H, P/S will be calculated.	r P/VF, otherwise it	
Specific Enthalpy (BTU/lbm)	0	
Enter the enthalpy of the stream if the Flash Spec is P/H, otherwis	it will be calculate	d.
Specific Entropy (BTU/[lbm.R])	0	
Enter the entropy of the stream if the Flash Spec is P/S, otherwise	will be calculated	
Vapor Phase Mole Fraction (spec)	0	
If the Flash Spec is T/VF or P/VF, enter the vapor phase mole fract stream, otherwise it will be calculated.	on (quality) of the	
FLOW SPECIFICATION		
Mass Flow (lbm/h)	7936.64	
Enter the Mass flow of the stream. Molar and Volumetric ones will match this value.	e calculated to	
Molar Flow (lbmol/h)	125000	
Enter the Molar flow of the stream. Mass and Volumetric ones will match this value.	e calculated to	
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- 7. Below the **OBJECTS** tab, locate the "**Heater/Cooler**" block. Drag and drop into the flow sheet. Rename it "COOLER".
- 8. On clicking the cooler block. Under the "CONNECTIONS" tab, click the dropdown button and select the necessary connections. In the calculation parameter (**PROPERTIES** tab), specify the calculation as "Outlet temperature.
- 9. Now, add a block for Cooler. Drag and drop into the flow sheet. Rename it "HEATER". No need to give a separate energy stream for the heater. The "Q-stream" itself serves as an energy stream for this also. In the calculation parameter, specify the calculation as "Energy stream".
- 10. Once all the connections are given correctly, Simulate by pressing the "Solve flow sheet" button on the top corner of the screen.





Long-press and release or drag buttons straight up to add objects to the

#### **OBJECT REPORT: COOLER**

View the calculation results report for the currently selected flowsheet object.

Object successfully calculated on 06/29/2024 16:41:48

Heater/Cooler: COOLER Property Package: Raoult's Law

Inlet conditions

```
Temperature: 300 F
Pressure: 50 psi
Mass flow: 1.56223E+07 lbm/h
Volumetric flow: 5321.13 ft3/min
Vapor fraction: 0
Compounds: {Styrene; Toluene}
Molar composition: {1; 0}
```

Calculation parameters

Results

Calculation mode: OutletTemperature Outlet temperature: 178 F Efficiency: 100 Pressure drop: 0 psi

Outlet vapor mole fraction: O Heat added/removed: -277334 kW

#### **OBJECT REPORT: HEATER**

View the calculation results report for the currently selected flowsheet object.

Object successfully calculated on 06/29/2024 16:41:35

Heater/Cooler: HEATER Property Package: Raoult's Law

Inlet conditions

Temperature: 100 F Pressure: 90 psi Mass flow: 1.15176E+07 lbm/h Volumetric flow: 3604.17 ft3/mir Vapor fraction: 0 Compounds: {Styrene; Toluene} Molar composition: {0; 1}

Calculation parameters

Calculation mode: OutletTemperature Outlet temperature: 254.2 F Efficiency: 100 Pressure drop: 0 psi

Results

Outlet vapor mole fraction: O Heat added/removed: 247243 kW

The simulation results can be viewed directly from each stream. You can also click on each stream/block for detailed information via the "**RESULTS**" tab. Detailed reports can be saved to PDF/TXT files on the "**REPORTS**" tab

#### **Self-Learning Exercises:**

- 1. Determine the exit temperature of hot (styrene) and cold (toluene) streams, if heat duty removed from the hot stream is 3 MW
- 2. How to perform simulation for a counter-current heat exchanger using two heaters?
- 3. Find out the inlet temperature of toluene if toluene should be heated to 250 deg F using the available styrene feed

# #Thanks

Source: PROCESS SIMULATION USING DWSIM: A Free and Open Source Chemical Process Simulator By Dr. P. R. Naren Senior Assistant Professor, Chemical Engineering