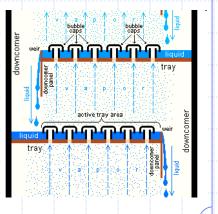
Internal column design Radfrac

Maurizio Fermeglia

Maurizio.fermeglia@units.it

Department of Engineering & Architecture

University of Trieste



Separation of a mixture of hydrocarbons by distillation

- The feed is 0.100 mol fraction ethane, 0.300 mole fraction propane, 0.500 mole fraction n-butane and 0.100 mole fraction n-pentane.
- The feed is 1.0 kmol/s at 25°C and 15.0 atm.
- The column has N (Aspen notation) = 35 equilibrium stages and the feed is on stage 16.
- The column operates at 15.0 atm, has a partial condenser and produces a vapor distillate with D = 0.400 kmol/s (D/F=0.4).
- The column has a kettle type reboiler.
- Reflux ratio is L/D = 2.5.
- Use the Peng-Robinson VLE correlation with standard binary interaction parameters.

Separation of a mixture of hydrocarbons by distillation

Using Radfrac perform the following calculations:

- 1. With a base case obtain the column profiles: T, Kij, L/V, compositions. Verify that:
 - 1. Max. n-C4 mole fraction in the vapor distillate of $y_{D,C4,max} = 0.001$
 - 2. Max. C3 mole fraction in the liquid bottoms of $x_{Bot,C3,max} = 0.0$
- 2. Create a new column internal section for a sieve tray column internal using the following specifications:
 - 1. Create an auto section and verify that two sections are created (2-15 and 16-34 stage)
 - 2. Specify Sieve trays with 2 pass (sec.1) and 4 pass (sec.2).
 - 3. Verify and understand the Design parameters (in the Geometry section).
 - 4. Estimate D and tray spacing.
 - 5. Verify hydraulic plots and adjust the geometry, until you have no warnings / errors.
- 3. Change the tray type to BubbleCup
 - 1. Adjust the geometry until you have no warnings / errors.

Components

Component ID		Туре				Aliat					
ETHANE	Convent	ianal		ETHAN	IE			C2H6			
PROPANE	Convent	lanal		PROPA		СЗНВ					
N-BUTANE	Convent	ional		N-BUT	ANE		C4H10-1 C5H12-1				
N-C5	Convent	ional		N-PEN	TANE						
Mixed	Fee		h Opt	ions EO Op	otions	Costing	g Comments Composition Mole-Frac				
Mixed	CI Solid	NC Solid Flas	h Opt		otions						
Mixed	CI Solid			ions EO Op	otions	• _ Co	mposit	ion —			
Mixed Specific Flash Type	CI Solid cations ables	NC Solid Flas		Pressure	otions	• _ Co	imposit Iole-Fra	ion —	nt		
Mixed Specific Flash Type State vari	CI Solid cations ables	NC Solid Flas	•	Pressure		• _ Co	mposit Iole-Fr	ion ac	nt		
Mixed Specific Flash Type State vari Temperat	CI Solid cations ables ture	NC Solid Flas	• 25	Pressure		- Co N	omposit Tole-Fra C ETH	ion ac	nt		
Mixed Mixed Specific Flash Type State vari Temperat Pressure	CI Solid cations lables ture	NC Solid Flas	• 25	Pressure		Co N	omposit tole-Fra C ETH PRO	ion ac componer ANE	nt		
Mixed Mixed Specific Flash Type State vari Temperat Pressure Vapor fra	CI Solid cations ables ture ction v basis	NC Solid Flas	• 25	Pressure		• Co N	omposit lole-Fra ETH PRO N-Bi	ion ac omponer ANE PANE UTANE	nt		

Method

Value

0.1 0.3 0.5 0.1

Property n	methods & d	options		Method name	
Method fi	ilter	COMMON		PENG-ROB	Methods Assistant
Base meth	hod	PENG-RO)B +		The roos hasistant
Henry cor	nponents			Modify	
Patrolau	im calculatio	n ontions		EOS	ESPRSTD +
	ter method		4 ÷	Data set	1.
Water so	olubility	3	•	Liquid gamma	*
		<i></i>		Data set	0
Electroly	te calculatio	on options		Liquid molar enthalpy	
Chemist	ry ID			Liquid molar volume	VLMX20 ···
Use t	true compor	nents		Heat of mixing	
				Poynting correction	1
				Use liquid reference	
				Use liquid reference	e state enthalpy

Volume flow reference temperature

 Setup 				Calcula	ition type				Equilibri	um		
Configuration Streams	Pressure	Conden	iser 🛛 📿 R	Numbe	er of stages						35 🗘	Stage
Feed streams				Conde	nser				Partial-	Vapor		
		Convent		Reboile	er -				Kettle			
			uon	Valid p	hases				Vapor-Li	iquid		
FEED	16 Above-St	oge		Conve	gence				Standard	ł		
				Operat	ing specifica	tions						
A				Reflu	x ratio			-	Mole		•	2.5
Internals				Distil	ate to feed	ratio			Mole			0.4
				Free w	ater reflux ra	tio				0		Feed B
Status Active	Column descrin	tion Sim	ve trav column inte	renal						loost Cor	molata	
L L	Column description Sieve tray of Add New Auto Section			01.576	Input Complete						i i i i i i i i i i i i i i i i i i i	
→			Section * Dup	licate Import	mport Template Export Template			View	Internals S	ummary	A	
	Name	Start E Stage St	End Mode	Internal Type	Tray/Packir Type			y Details	ds		Packing Details	
		suge	and a	.,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	.,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		Number o Passes		ber of	Vendor	Material	Dimensi
	CS-1	2	15 Interactive si	zing Trayed	SIEVE	्र	(100000000	2				
	► CS-2	16	34 Interactive si	zing Trayed	SIEVE	٠		4				
16	Don't update	e preisure	drop									
	O Update pres	sure drop	from top stage									
	O Update pres	sure drop	from bottom stage									
	💟 Include stati	c vapor he	ead in pressure drop	calculations								
	Calculate pr	essure dro	op across sump									
	Sump											
	Diameter		4.53006	meter *								
	C) Liquid resid	tence time	e 0.0166667	hr +								

Separation of a mixture of hydrocarbons by distillation

- The feed is 0.100 mol fraction ethane, 0.300 mole fraction propane, 0.500 mole fraction n-butane and 0.100 mole fraction n-pentane.
- The feed is 1.0 kmol/s at 25°C and 15.0 atm.
- The column has N (Aspen notation) = 35 equilibrium stages and the feed is on stage 16.
- The column operates at 15.0 atm, has a partial condenser and produces a vapor distillate with D = 0.400 kmol/s (D/F=0.4).
- The column has a kettle type reboiler.
- Reflux ratio is L/D = 2.5.
- Use the Peng-Robinson VLE correlation with standard binary interaction parameters.

Data are the same as for the example done for staged column

- Separation of a mixture of hydrocarbons by distillation
 Using Radfrac open the file used for staged column design and perform the following calculations:
 - 1. Verify the base case reported in the old file, and in particular that:
 - 1. Max. n-C4 mole fraction in the vapor distillate of $y_{D,C4,max} = 0.001$
 - 2. Max. C3 mole fraction in the liquid bottoms of $x_{Bot,C3,max} = 0.001$
 - Create a new column internal section (INT-2) for a packed column internal (leave the INT-1 internal section of the tray design), using the following specifications:
 - 1. Create an auto section and verify that two sections are created (2-15 and 16-34 stage)
 - 2. Specify packed column interactive sizing with pall rings.
 - 3. Verify and understand the Design parameters (in the Geometry section) and specify packed height per stage (HETP) in geometry section (.5 m for pall rings)
 - 4. Estimate D and tray spacing.
 - 5. Verify hydraulic plots and adjust the geometry, until you have no warnings / errors.
 - 3. Change the packing to Mellapack
 - 1. Verify and understand the Design parameters (in the Geometry section) and specify packed height per stage (HETP) in geometry section (.2 m for mellapack)
 - 2. Adjust the geometry until you have no warnings / errors.
 - 4. Add design specifications to obtain the desired purities:
 - 1. Max. n-C4 mole fraction in the vapor distillate of $y_{D,C4,max} = 0.001$
 - 2. Max. C3 mole fraction in the liquid bottoms of $x_{Bot,C3,max} = 0.001$

Components

Component ID		Туре				Alias				
ETHANE	Conventi	onal			ETHANE				C2H6	
PROPANE	Conventi	anal			PROPAN	IE.			C3H8	
N-BUTANE	Conventi	anal			N-BUTA	NE			C4H10	-1
N-C5	Conventi	anal			N-PENT/	ANE			C5H12	-1
	Fee									
Mixed	CI Solid	NC Solid	Flash Opt		EO Opti	ions	Costi		Comments	
Mixed	CI Solid cations		Flash Opt	Press		lons	Costi	Con	Comments nposition ole-Frac	•
Mixed Specific Flash Type	CI Solid cations iables	NC Solid	Flash Opt	Press		ions •		Con	nposition —	ent
Mixed Specific Flash Type State var	CI Solid cations iables ture	NC Solid	- 25	Press		1		Con	nposition — ole-Frac	ent
Mixed Specific Flash Type State var Tempera	CI Solid cations iables ture	NC Solid	- 25	Press		•		Con	nposition	ent
Mixed Specific Flash Type State var Tempera Pressure	CI Solid cations iables ture	NC Solid	- 25	Press		•		Con	nposition ble-Frac Compon ETHANE	ent
Mixed Specifie Flash Type State var Tempera Pressure Vapor fra	CI Solid cations iables ture action w basis	NC Solid	- 25	Press	ure	•		Con	Compon ETHANE PROPANE	ent

Method

Value

0.1 0.3 0.5 0.1

Property in	nethods & d	options		Method name		
Method fil	ter	COMMON		PENG-ROB	 Methods Assista 	ent.
Base meth	od	PENG-RO	8 +	A CONTRACTOR		200,700
Henry corr	ponents			Modify		
Patroleur	n calculatio	n ontions		EOS	ESPRSTD *	Ĩ.
	er method		• •	Data set	10	NAME OF BRIDE
Water so	lubility	3	÷	Liquid gamma		
	ano an A	110		Data set	0	
1 73	te calculatio	on options		Liquid molar enthalpy	HLMX106 -	
Chemistr	y ID			Liquid molar volume	VLMX20 ····	
Use to	rue compor	nents		Heat of mixing		
				Poynting correction	1	
				Use liquid reference	e state enthalpy	

Separation Processes – Maurizio Fermeglia

Volume flow reference temperature

_						0	Configurat	tion 📀	Streams	Pressure	Conde	nser 📀	Reboiler	3-Phase	Comments
Setup)						tup option lculation ty			1	Equilibriu	m		-	
Configuration	Streams	Pressure	Condenser	© Re		1000	mber of s	24					35	Stag	e Wizard
						Co	ndenser				Partial-V	apor			
Feed streams	1 20000	1	12000000000000			Re	boiler				Kettle				-
Name	Stage		Convention			Val	lid phases				Vapor-Lie	quid			
FEED 16 Above-Stage						Co	Convergence				Standard				•
						Op	perating sp	ecification	15				~		
						R	eflux ratio	5		•	Mole		·	2.5	
Interr	nals					D	Distillate to feed ratio		•	Mole -		0.4			
						Fre	Free water reflux ratio				0		Feed B	lasis	
	Status 7	Active	Column descrip	otion							Input Complete				
	1		Add New	Au	to Section		Duplicité	Import	Template	Export Ten	nplate	View Interna	ls Summan		
		→	Name		End		lode	Internal	Tray/Packin	g	Tray Del	Details		Packing Details	
				Stage	e Stage			Туре	Туре	Num	ber of	Number of	Vendo	r Mate	rial Dimens
	_		-							Pa	sses	Downcomers			
			CS-1 CS-2		2 15 6 34	Rating Rating		Packed	PALL				MTL	METAL	0.625-IN
			1			Kaung		Packed	PALL				MIL	MEIAL	0.023-114
	→ · · · · · H	(* * * * *	Oon't update Update pres												
			O Update pres		Second 2		-								
			Include stati				1. Sec. 19	tions							
			Calculate pr												
			Sump		50	~									
			Diameter			2.34	1009 meter	61 (H)							
			C Liquid resk		me	0.0166	5667 hr	*							
			O Liquid leve	al.			meterr	1							

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Example: packed column design with Radfrac Hydraulic plots Stage 15 Stages View Vapor Liquid Stages 7e+04 Vapor Mass Flow (kg/hr) 6e+04 68.53 mm-water/m 5e+04 τ 4.03 mm-water/ 4e+04 Constant \ 3e+04 39 mm-water/m 2e+04 Operating point mm-water/m = CS-1 16 5000 1e+04 1.5e+04 2e+04 2.5e+04 Liquid Mass Flow (kg/hr) All Stages Stages with Errors/Warnings 13 14 16 17 15 CS-2 35

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