

Process Simulation for Energy Consulting

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3. Distillation Column

● Distillation Column

- Problem : Light composition in the process stream that is composed of C4-C8 is fully refluxed with vapor in the distillation column and the composition containing C6 and greater components is being produced at the bottom of the column. At this time, n-Pentane is controlled at 0.1wt% at the bottom of the column and n-Hexane controlled on-spec at 0.05 wt% at the top of the column. Hence, a feed/bottom heat exchanger is to reduce heat duty of the distillation column reboiler by increasing feed temperature.

Set up the simulation model about this distillation column.

Feed Stream Composition	Stream Condition	Distillation Column Data
n-Butane 5 wt% n-Pentane 10 wt% n-Hexane 60 wt% n-Heptane 15 wt% n-Octane 10 wt%	Pressure: 4 kg/cm ² g Temperature: 50°C Flow: 50 ton/h	No. of Stage 48 Valve Tray Feed Stage: 28 stage Condenser Pressure: 3.4 kg/cm ² g Condenser DP : 0.1 bar Column Bottom Pressure: 3.8 kg/cm ² g Reboiler DP : 0.15 bar

● Step 1 – Add Component

distillation column.hsc - Aspen HYSYS V9 - aspenONE

File Home View Customize Resources

Cut Copy Paste Component Lists Fluid Packages Reactions Methods Assistant Map Components Update Properties Components Petroleum Assays Refining Hypotheticals Manager Convert Remove Duplicates Hypotheticals Oil Manager Convert to Refining Assay Oil Associate Fluid Package Definitions Options PVT Laboratory Measurements PVT Data

Search aspenONE Exchange

Properties Component List - 1

All Items

- Component Lists
 - Component List - 1
- Fluid Packages
 - Basis-1
 - Petroleum Assays
 - Reactions
 - Component Maps
 - User Properties

Properties Simulation Safety Analysis Energy Analysis

Source Databank: HYSYS

Select: Pure Components Filter: All Families

Search for: Search by: Full Name

Component	Type	Group
n-Butane	Pure Component	
n-Octane	Pure Component	
n-Heptane	Pure Component	
n-Hexane	Pure Component	
n-Pentane	Pure Component	

< Add

Replace

Remove

Simulation Name	Full Name / Synonym
Methane	C1
Ethane	C2
Propane	C3
i-Butane	i-C4
i-Pentane	i-C5
n-Nonane	C9
n-Decane	C10
n-C11	C11
n-C12	C12
n-C13	C13
n-C14	C14
n-C15	C15

● Step 2 – Select the thermodynamic package

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File Home View Customize Resources

Cut Copy Paste Component Lists Fluid Packages Methods Assistant Reactions User Properties Map Components Update Properties Components Petroleum Assays Refining Hypotheticals Manager Convert Remove Duplicates Hypotheticals Oil Manager Convert to Refining Assay Oil Associate Fluid Package Definitions Options PVT Laboratory Measurements PVT Data

Search aspenONE Exchange

Properties Basis-1

All Items

- Component Lists
 - Component List - 1
- Fluid Packages
 - Basis-1
- Petroleum Assays
- Reactions
- Component Maps
- User Properties

Properties Simulation Safety Analysis Energy Analysis

Set Up Binary Coeffs StabTest Phase Order Tabular Notes

Package Type: HYSYS Component List Selection: **Component List - 1 [HYSYS Databanks]** View

Property Package Selection

- Acid Gas - Physical Solvents
- Acid Gas - Chemical Solvents
- Antoine
- ASME Steam
- Braun K10
- BWRS
- Chao Seader
- Chien Null
- Clean Fuels Pkg
- CPA
- Esso Tabular
- Extended NRTL
- GCEOS
- General NRTL
- Glycol Package
- Grayson Streed

Options

Density Method	Costald
Viscosity Method	HYSYS Viscosity
Surface Tension Method	HYSYS Method
Thermal Conductivity	API 12A3.2-1 Method

CS/GS Component Parameters

	Solubility	Molar Volum [m ³ /kgmole]	Acentricity
n-Butane	6.7300	0.1014	0.1953
n-Octane	7.5510	0.1635	0.3992
n-Heptane	7.4300	0.1475	0.3403
n-Hexane	7.2660	0.1316	0.2927
n-Pentane	7.0210	0.1161	0.2387

Property Pkg OK Edit Properties

● Step 3 – Generate feed stream

Material Stream: Feed

Worksheet Attachments Dynamics

Worksheet

Conditions
Properties
Composition
Oil & Gas Feed
Petroleum Assay
K Value
User Variables
Notes
Cost Parameters
Normalized Yields

Stream Name	Feed
Vapour / Phase Fraction	0.0000
Temperature [C]	50.00
Pressure [kg/cm2_g]	4.000
Molar Flow [kgmole/h]	579.0
Mass Flow [kg/h]	5.000e+004
Std Ideal Liq Vol Flow [m3/h]	75.51
Molar Enthalpy [kJ/kgmole]	-1.942e+005
Molar Entropy [kJ/kgmole-C]	97.53
Heat Flow [Mkcal/h]	-2.687e+004
Liq Vol Flow @Std Cond [m3/h]	75.08
Fluid Package	Basis-1
Utility Type	

OK

Delete Define from Stream... View Assay

Material Stream: Feed

Worksheet Attachments Dynamics

Worksheet

Conditions
Properties
Composition
Oil & Gas Feed
Petroleum Assay
K Value
User Variables
Notes
Cost Parameters
Normalized Yields

	Mass Fractions	Liquid
n-Butane	0.0500	
n-Octane	0.1000	
n-Heptane	0.1500	
n-Hexane	0.6000	
n-Pentane	0.1000	

Total 1.00000

Edit... View Properties... Basis...

OK

Delete Define from Stream... View Assay

● Step 4 – Setting the distillation column flowsheet

Design Parameters Side Ops Internals Rating Worksheet Performance Flowsheet Reactions Dynamics

Design Column Name: **T-100** Sub-Flowsheet Tag: **COL1**

Connections
Monitor
Specs
Specs Summary
Subcooling
Notes

Inlet Streams

Internal Stream	External Stream	Inlet Stage	Transfer Basis	Split
Q_REB	Q_REB	Reboiler	None Req'd	
Feed	Feed	28_Main Tower	P-H Flash	<input type="checkbox"/>
** New **	<< Stream >>			

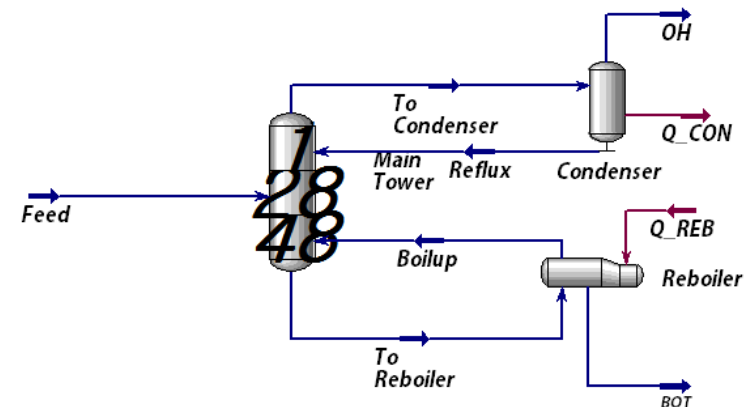
Outlet Streams

Internal Stream	External Stream	Outlet Stage	Type	Transfer Basis
Q_CON	Q_CON	Condenser	Q	None Req'd
OH	OH	Condenser	V	P-H Flash
BOT	BOT	Reboiler	L	P-H Flash
** New **	<< Stream >>			

Stage Numbering
☒ Top Down
☐ Bottom Up
 Edit Trays...

☐ Split Inlets
 Design and Specify Column Internals

dP Top: 10.00 kPa
 P Top: 3.400 kg/cm2_
 dP Bot: 15.00 kPa
 P Bot: 3.800 kg/cm2_



● Step 5 – Run

Design
Parameters
Side Ops
Internals
Rating
Worksheet
Performance
Flowsheet
Reactions
Dynamics

Design
Connections
Monitor
Specs
Specs Summary
Subcooling
Notes

Optional Checks

Iter	Step	Equilibrium	Heat / Spec

Profile
☒ Temp
☐ Press
☐ Flows

Temperature vs. Tray Pc

Specifications

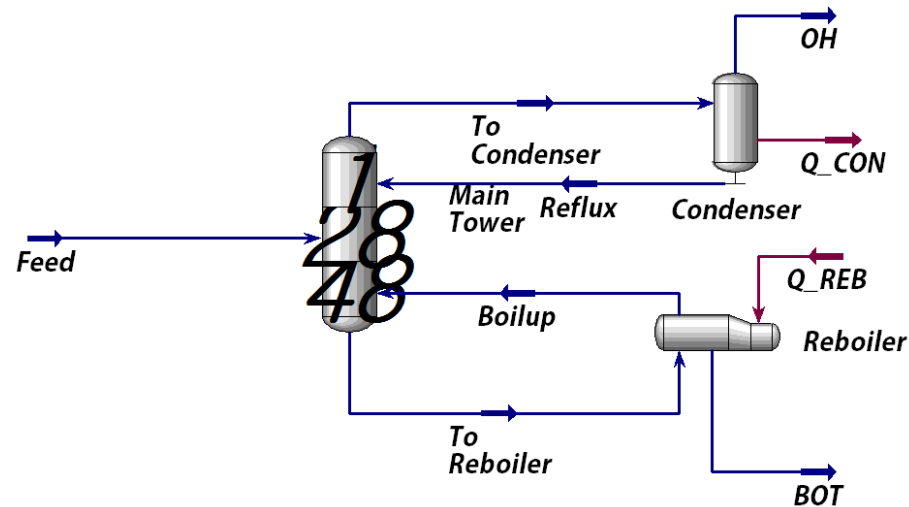
	Specified Value	Current Value	Wt. Error	Active	Estimate	Current
Reflux Ratio	<empty>	2.466	<empty>	L	L	L
Ovhd Vap Rate	<empty>	111.8	<empty>	L	L	L
Reflux Rate	<empty>	275.6	<empty>	L	L	L
Btms Prod Rate	<empty>	467.3	<empty>	L	L	L
MassFrac-Cond Hex	5.000e-004	4.988e-004	-0.0007	L	L	L
MassFrac-Reb Pen	1.000e-003	1.000e-003	-0.0000	L	L	L

Degrees of Freedom

Set the target spec (Mass fraction of Condenser and Reboiler)

● Distillation Column

- Solution



Material Streams

		Reflux	To Condenser	Boilup	To Reboiler	OH	BOT	Feed
Vapour Fraction		0.0000	1.0000	1.0000	0.0000	1.0000	0.0000	0.0000
Temperature	C	75.79	80.97	136.8	132.5	75.79	136.8	50.00
Pressure	kg/cm2_g	3.400	3.502	3.800	3.647	3.400	3.800	4.000
Molar Flow	kgmole/h	275.6	387.3	714.1	1181	111.8	467.3	579.0
Mass Flow	kg/h	1.910e+004	2.656e+004	6.309e+004	1.056e+005	7461	4.254e+004	5.000e+004
Liquid Volume Flow	m3/h	30.74	42.91	94.62	158.0	12.16	63.34	75.51
Heat Flow	Mkcal/h	-1.049e+004	-1.255e+004	-2.616e+004	-5.098e+004	-3572	-2.033e+004	-2.687e+004