

Process Simulation for Energy Consulting

Jan. 2018



한국에너지공단
KOREA ENERGY AGENCY

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

Search aspenONE Exchange

File Home View Customize Resources

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

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

distillation column.hsc - Aspen HYSYS V9 - aspenONE

File Home View Customize Resources

Clipboard Component Lists Fluid Packages Navigate Components Refining Hypotheticals Oil PVT Laboratory Measurements PVT Data

Cut Copy Paste Methods Assistant Reactions User Properties Map Components Update Properties Petroleum Assays Refining Hypotheticals Manager Convert Remove Duplicates Oil Manager Convert to Refining Assay Associate Fluid Package Definitions Options

Search aspenONE Exchange

Properties

All Items

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

Properties Simulation Safety Analysis Energy Analysis

Basis-1 x +

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

The image shows two overlapping software windows, both titled "Material Stream: Feed". The left window displays a list of parameters for a feed stream, with the "Worksheet" tab selected. The right window displays the composition of the feed stream, with the "Composition" tab selected.

Left Window: Material Stream: Feed

Worksheet	Stream Name	Feed
Conditions	Vapour / Phase Fraction	0.0000
Properties	Temperature [C]	50.00
Composition	Pressure [kg/cm2_g]	4.000
Oil & Gas Feed	Molar Flow [kgmole/h]	579.0
Petroleum Assay	Mass Flow [kg/h]	5.000e+004
K Value	Std Ideal Liq Vol Flow [m3/h]	75.51
User Variables	Molar Enthalpy [kJ/kgmole]	-1.942e+005
Notes	Molar Entropy [kJ/kgmole-C]	97.53
Cost Parameters	Heat Flow [Mkcal/h]	-2.687e+004
Normalized Yields	Liq Vol Flow @Std Cond [m3/h]	75.08
	Fluid Package	Basis-1
	Utility Type	

Right Window: Material Stream: Feed

Worksheet	Mass Fractions	Liquid
Conditions	n-Butane	0.0500
Properties	n-Octane	0.1000
Composition	n-Heptane	0.1500
Oil & Gas Feed	n-Hexane	0.6000
Petroleum Assay	n-Pentane	0.1000
K Value		
User Variables		
Notes		
Cost Parameters		
Normalized Yields		

Total: 1.00000

Buttons: Edit..., View Properties..., Basis...

Bottom Bar: 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

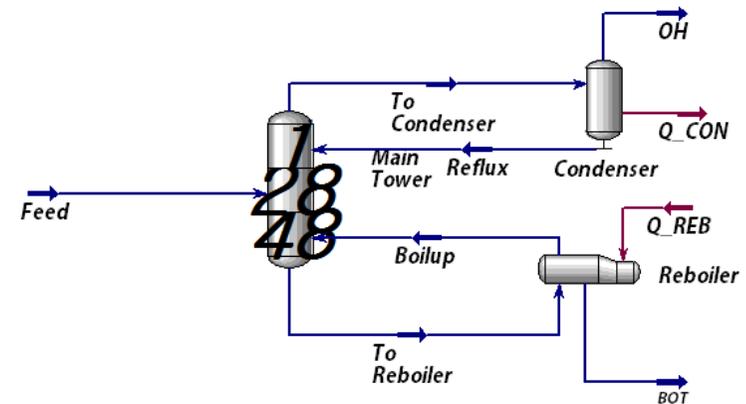
Internal Stream	External Stream	Inlet Stage	Transfer Basis	Split
Q_REB	Q_REB	Reboiler	None Req'd	
Feed	Feed	28_Main Tower	P-H Flash	<input type="checkbox"/>
** New **	<< Stream >>			

Stage Numbering
 Top Down
 Bottom Up
 Edit Trays...
 Split Inlets
 Design and Specify Column Internals

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 >>			

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

Input Summary View Initial Estimates...

Iter Step Equilibrium Heat / Spec

Profile

Temp Press Flows

Temperature vs. Tray Pc

Specifications

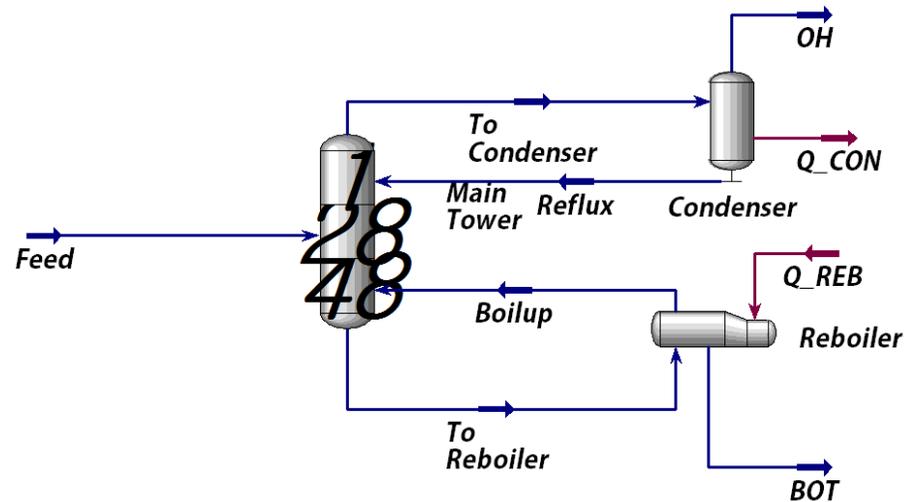
	Specified Value	Current Value	Wt. Error	Active	Estimate	Current
Reflux Ratio	<empty>	2.466	<empty>	┐	┐┐	┐
Ovhd Vap Rate	<empty>	111.8	<empty>	┐	┐┐	┐
Reflux Rate	<empty>	275.6	<empty>	┐	┐┐	┐
Btms Prod Rate	<empty>	467.3	<empty>	┐	┐┐	┐
MassFrac-Cond Hex	5.000e-004	4.988e-004	-0.0007	┐	┐┐	┐
MassFrac-Reb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

View... Add Spec... Group Active Update Inactive Degrees of Freedom 0

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