



Distillation Column Sizing



Example: Simulate and size a distillation column for the methanol + water mixture with the following condition:

Flowrate – kg/hr.	118484
Composition	Methanol 0.7 Water 0.3
Temperature- C	86
Pressure-barg	3.5

Steps to be taken:

- 1.Add water and methanol to the component list.
- 2.Select NRTL as the fluid package
- 3.Enter Simulation Environment and define the stream with the above conditions.

Material Stream: 1

Worksheet Attachments Dynamics

Worksheet

Stream Name	1	Liquid Phase
Vapour / Phase Fraction	0.0000	1.0000
Temperature [C]	86.00	86.00
Pressure [kPa]	451.3	451.3
Molar Flow [kgmole/h]	4562	4562
Mass Flow [kg/h]	1.185e+005	1.185e+005
Std Ideal Liq Vol Flow [m3/h]	139.8	139.8
Molar Enthalpy [kJ/kgmole]	-2.530e+005	-2.530e+005
Molar Entropy [kJ/kgmole-C]	72.41	72.41
Heat Flow [kJ/h]	-1.154e+009	-1.154e+009
Liq Vol Flow @Std Cond [m3/h]	139.0	139.0
Fluid Package	Basis-1	
Utility Type		

OK

Delete Define from Stream... View Assay



Material Stream: 1

Worksheet Attachments Dynamics

Worksheet

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

	Mass Fractions	Liquid Phase
CO2	0.0000	0.0000
CO	0.0000	0.0000
Hydrogen	0.0000	0.0000
Methanol	0.7000	0.7000
H2O	0.3000	0.3000

Total 1.00000

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

OK

Delete Define from Stream... View Assay

4. Add a distillation column and act like below:

Distillation Column Input Expert

Condenser Energy Stream QC

Column Name T-100

Inlet Streams

Stream	Inlet Stage
1	40_Main Top
<< Stream >>	

Stages n = 80

Stage Numbering Top Down Bottom Up

Condenser: Total Partial Full Rflx

Ovhd Liquid Outlet OVHD

Optional Side Draws

Stream	Type	Draw Stage
<< Stream >>		

Reboiler Energy Stream QB

Bottoms Liquid Outlet B

< Prev Next >

Connections (page 1 of 5) Cancel



Distillation Column Input Expert

Reboiler Configuration

Once-through Circulation without baffle Circulation with baffle

Reboiler Type Selection

Regular Hysys reboiler Heater Heat exchanger

Hot Side

Tube Shell

< Prev Next >

Reboiler Configuration (page 2 of 5) Cancel

Distillation Column Input Expert

Condenser Pressure:

Condenser Pressure Drop:

Reboiler Pressure Drop:

Reboiler Pressure:

< Prev Next >

Pressure Profile (page 3 of 5) Cancel



Distillation Column Input Expert

Optional Condenser Temperature Estimate

Optional Top Stage Temperature Estimate

Optional Reboiler Temperature Estimate

< Prev Next >

Optional Estimates (page 4 of 5)

Cancel

Distillation Column Input Expert

Liquid Rate

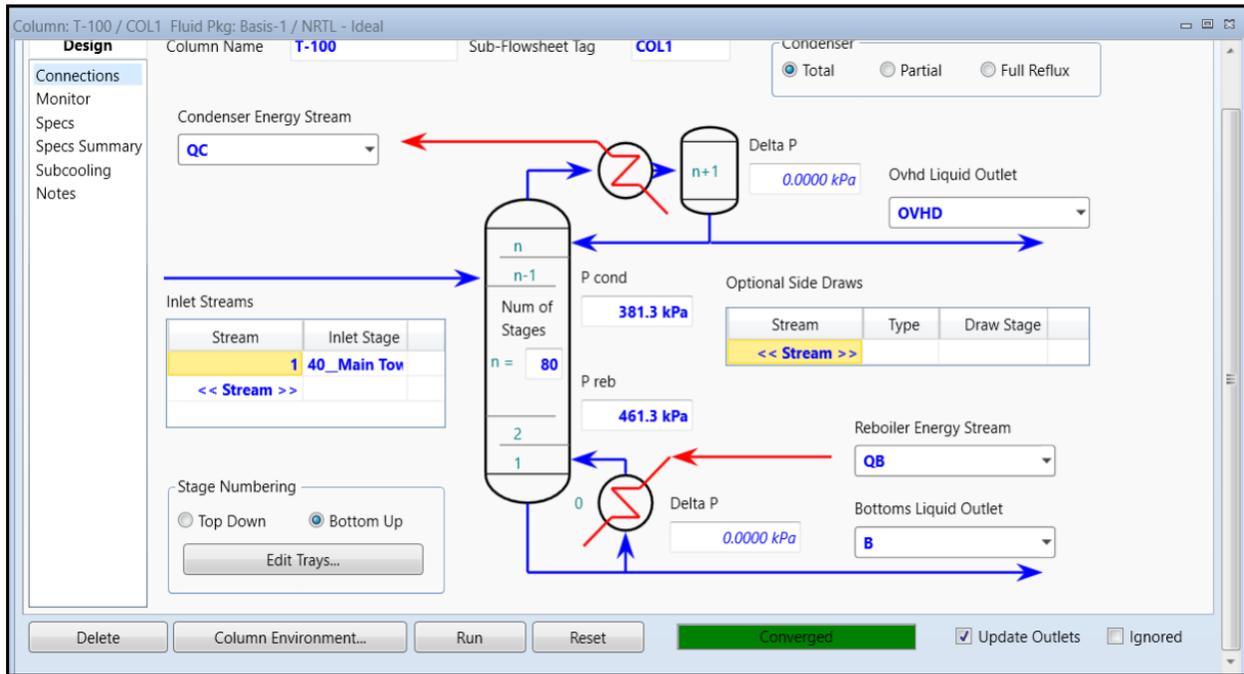
Reflux Ratio

Flow Basis

< Prev Done... Side Ops >

Specifications (page 5 of 5)

Cancel



Based on Worksheet/composition, the separation has been perfect.

Column: T-100 / COL1 Fluid Pkg: Basis-1 / NRTL - Ideal

Worksheet

	1	OVHD	B
Conditions			
Properties			
Compositions			
PF Specs			
CO2	0.0000	0.0000	0.0000
CO	0.0000	0.0000	0.0000
Hydrogen	0.0000	0.0000	0.0000
Methanol	0.5675	1.0000	0.0146
H2O	0.4325	0.0000	0.9854

Buttons: Delete, Column Environment..., Run, Reset, Converged, Update Outlets, Ignored



5. Go to Internals and add new.

Section	Start Stage	End Stage	Mode	Internals Type	Tray/Packin Type	Number of Passes	Number of Downcomers	Packing Vendor	Packing Material	Packing Dimension	Tray Spacing / Section Packed Height [m]	Diameter [m]	Details
CS-1	80_Main Tower	1_Main Tower	Interactive Sizing	Trayed	Sieve	2					0.6096	6.220	View

The moment we create one, the diameter is calculated.

6. Click view and see how you can change the geometry.

Warning: Please Check the Messages tab for Detailed Warnings



CS-1@Internals-1@Main Tower@COL1: Geometry

Geometry Results Messages

Tray Results

Name CS-1 Active

Section Starting Stage	80_Main Tower
Section Ending Stage	1_Main Tower
Tray Type	Ballast-V4
Number of Passes	2
Tray Spacing [m]	0.6096
Section Diameter [m]	6.220
Section Height [m]	48.77
Section Pressure Drop [mbar]	1460
Section Head Loss [mm]	2.098e+004
Trays With Weeping	None
Section Residence Time [seconds]	541.6

Limiting Conditions

Property	Value	Tray	Location
Maximum % Jet Flood (%)	80.00	80_Main To	
Maximum % Downcomer Backup (Aerated) (%)	88.01	80_Main To	
Maximum Downcomer Loading (m3/h-m2)	205.7	11_Main To	Center
Maximum Weir Loading (m3/h-m)	84.75	11_Main To	Side
Maximum Aerated Height Over Weir (mm)	206.0	40_Main To	
Maximum % Approach To System Limit (%)	49.45	80_Main To	
Maximum Cs Based On Bubbling Area (m/s)	9.337e-002	80_Main To	
Maximum % Downcomer Choke Flood (%)	34.32	10_Main To	Center

Under result, we see that the diameter calculated by Aspen Hysys is 6.22 m. As stated, before it is recommended to see how such tower is designed using KG Tower and excel-sheet. Here is the comparison between KG method's result, Aspen Hysys result, excel result and licensor's result.

Licensor	Excel-sheet	KG Tower	Aspen Hysys
6350 mm	6140 mm	6332 mm	6220 mm



Now let's focus on the tower height:

To see how Aspen Hysys calculates the height let's do it manually; we know that the tray spacing is 0.6096 m and since we have 80 trays, the height between first tray and last tray would be:

$$\text{Height} = (80-1) \times 0.6096 = 48.15 \text{ m}$$

Assuming that the feed tray has the same tray spacing of 0.6096 m. Such assumption is not exact and is one of the reasons why there is a difference of 0.5 m. Nonetheless, the difference is negligent.

Neither calculation by Aspen Hysys or manual approach is right since they do not take into account bottom height or spacing above first tray.

$$\text{Total Height} = H1 + H2 + H3$$

The problem arises from the fact Aspen Hysys simply neglects H1 and H3.

