Process Simulation in Aspen HYSYS

Part 1

PFD Generation

- Installing equipment
- Attaching streams
- Shortcuts (F10, F11 and F12)
- Important keys 
- Add a new PFD

Flowsheet Architectures

- Sequential Modular Architecture
- Equation-Based Architecture

How much data should be provided to each unit?

- Degrees of freedom analysis
  - The degrees of freedom (DOFs) are the variables in a set of independent equations that must have their values assigned.
- DOF = no. of variables – no. of equations and constraints or $N_d = N_v - N_c$
- The number of process variables to describe a stream containing N_{sp} species is given by $N_v = N_{sp} + 2$.

Degrees of freedom

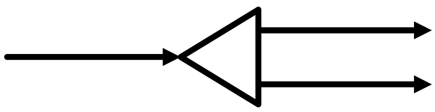
- For the DOF, important process variables include temperature, pressure, mass (mole) component flow rates, concentration and total flow rates, specific enthalpies, heat flow, work, and flow ratios (e.g., recycle, feed/product, reflux).
- For the DOF, equations and constraints include the independent material balances for each species or a total flow balance and (N_{sp} – 1) species balances, the energy balance, the phase equilibrium relationships that link the compositions between phases, and the chemical equilibrium relationships.

Example

- Determine the number of process variables, equations, and constraints and the overall DOF for an adiabatic stream splitter.

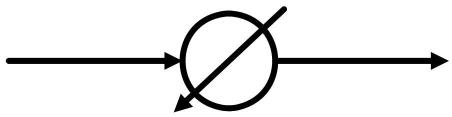
N_v:	Stream variables	$3(N_{sp}+2)$
N_c:	Material balance	1
	Composition specification	$2(N_{sp}-1)$
	Temperature specification	2
	Pressure specification	2

Overall DOF: $N_d = \{3(N_{sp}+2)\} - \{2N_{sp}+3\} = N_{sp}+3$



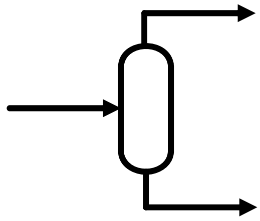
Example

- Determine the number of process variables, equations, and constraints and the overall DOF for an heater.



Example

- Determine the number of process variables, equations, and constraints and the overall DOF for a flash separator.



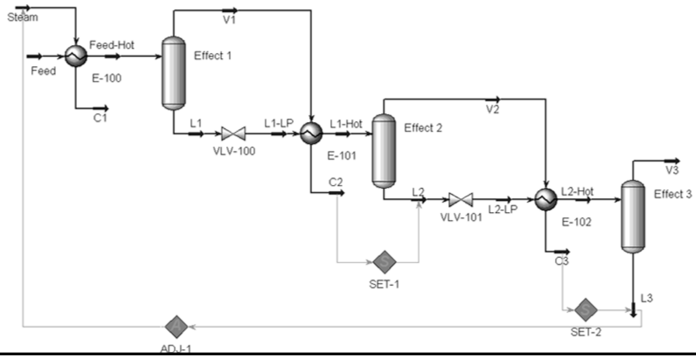
Case Study 1

- The stream in following table comes out of a distillation tower. It is at 36 psia and 141.5 ◦F. If the pressure is reduced (adiabatically) to 20 psia, what will be the vapor fraction and temperature?

Chemical	lb mol/h
Propane	1.00
Isobutane	297.00
n-Butane	499.79
i-Pentane	400.00
n-Pentane	500.00

Case Study 2

- Simulation of a series of three evaporators to concentrate a solution of sucrose/water.
- Each evaporator is modelle



Case Study 2

- Defining the Simulation Basis
  - Add Sucrose and H2O as components
  - Use Wilson/Ideal as the Property Package

Case Study 2

- Defining the Material streams
  - Feed
  - Steam

In this cell...	Enter...
Name	Feed
Vapour Fraction	0
Pressure	101.3 kPa (14.7 psia)
Flowrate	50 kg/h (110 lb/hr)
Mass Fraction Surcose	0.3
Mass Fraction Water	0.7

In this cell...	Enter...
Name	Steam
Vapour Fraction	1.0
Pressure	275 kPa (40 psia)
Mass fraction H2O	1.0

Case Study 2

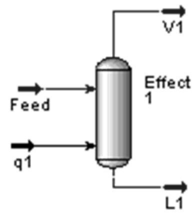
- The Triple Effect Evaporator consists of six operations:
  - A series of three evaporators modelled as flash tanks (2 Phase separators)
  - Three coolers

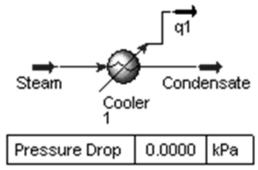
Case Study 2

- Add unit operations to the flowsheet
  - Menu Bar (Select Add Operation from the Flowsheet menu or press F12)
  - Workbook (Open the Workbook and go to the UnitOps page, then click the Add UnitOp button.)
  - Object Palette (Select Object Palette from the Flowsheet menu or press <F4> to open the Object Palette and double click the icon of the Unit Operation you want to add)
  - PFD/Object Palette (Using the right mouse button, drag’n’drop the icon from the Object Palette to the PFD)

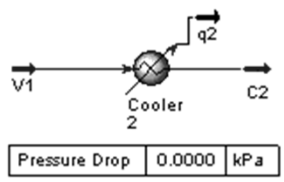
Case Study 2

- Adding a Separator
  - The Evaporator is modelled using a Separator in HYSYS.
- Adding a Cooler
  - The Heat Exchanger is modelled using a Cooler

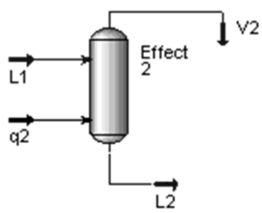




Case Study 2

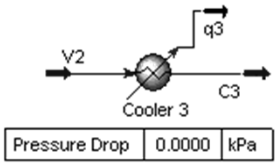


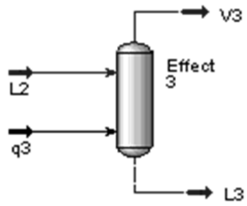
- Add the Second Cooler
- Add Another Separator



Case Study 2

- Add the Third Cooler
- Add the Third Separator





Vessels

- Types:
  - 3-Phase Separator
  - Separator
  - Tank
- Sizing

HW 3

- A reservoir in Northern Louisiana contains a volatile oil. The reservoir conditions at discovery were 246 ◦F, 4800 psia. The composition of the stream is in following Table.
- You will have to choose how to model the butanes and pentanes: normal? Iso-?
- You will also have to choose which chemical to use to model the heptanes plus: heptane? octane?
- The gas–liquid separator at the surface is at 500 psia, 65 ◦F. Find the composition of the gas and liquid streams and the vapor fraction.
- The liquid is taken to the stock tank, which is at 14.7 psia, 70 ◦F. Find the vapor fraction at these conditions.

Chemical	Mole Fraction
Nitrogen	0.0167
Methane	0.6051
Carbon dioxide	0.0218
Ethane	0.0752
Propane	0.0474
Butane	0.0412
Pentane	0.0297
Hexane	0.0138
Heptane plus	0.1491