

Process Systems Engineering

Prof. Davide Manca

Case studies with the process simulator: UNISIM

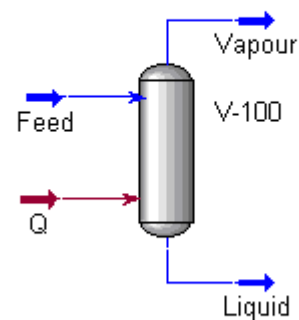
Example 1 - Flash

Case study 1.1

Thermodynamic Equation of State: SRK

Data:

- Liquid feed
 - Flow, kmol/h 300.
 - Temperature, K 343.
 - Pressure, kPa 1000.
 - Molar fractions:
 - 1 - BENZENE 0.1082
 - 2 - BUTANE 0.3243
 - 3 - 1-BUTENE 0.1351
 - 4 - 1,3-BUTADIENE 0.4324
- Operative conditions
 - Duty, 1E+6 kJ/h 2.
 - Pressure drop, kPa 400.

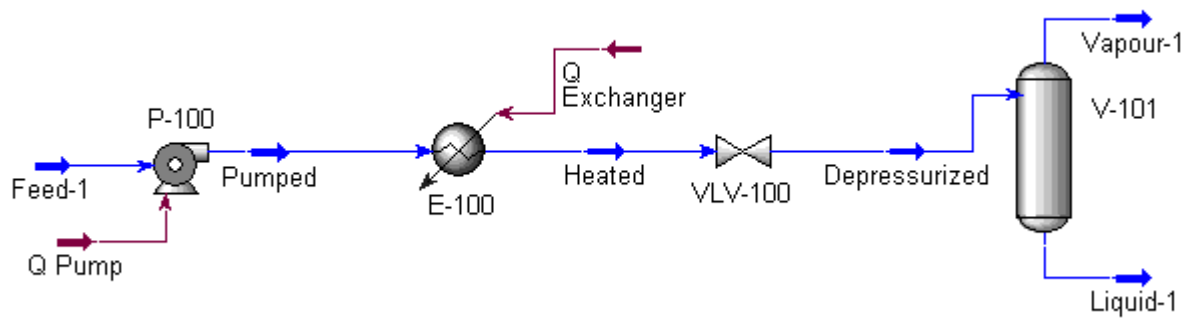


Case study 1.2

Thermodynamic Equation of State: SRK

Data:

- Liquid feed
 - Flow, kmol/h 300.
 - Temperature, K 343.
 - Pressure, kPa 1000.
 - Molar fractions: (see case study 1.1)
 - 1 - BENZENE 0.1082
 - 2 - BUTANE 0.3243
 - 3 - 1-BUTENE 0.1351
 - 4 - 1,3-BUTADIENE 0.4324
- Flash (Adiabatic)
 - Duty, 1E+6 kJ/h 0.
 - Pressure drops, kPa 0.
- Valve
 - Pressure drops, kPa 600.
- Heat exchanger (Cold Side)
 - Duty, 1E+6 kJ/h 2.
 - Pressure drops, kPa 0.
- Pump
 - Prevalence, kPa 500.



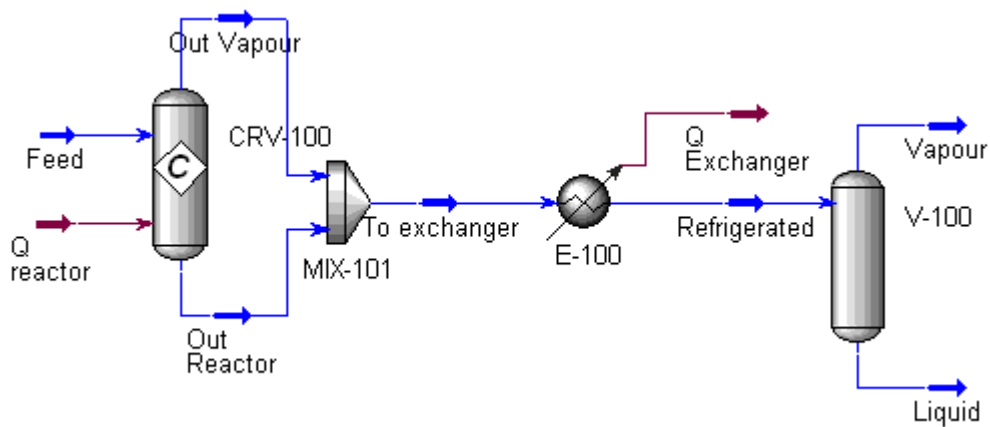
Example 2 – Ammonia production

Thermodynamic Equation of State: Grayson-Streed

Case study 2.1

Data:

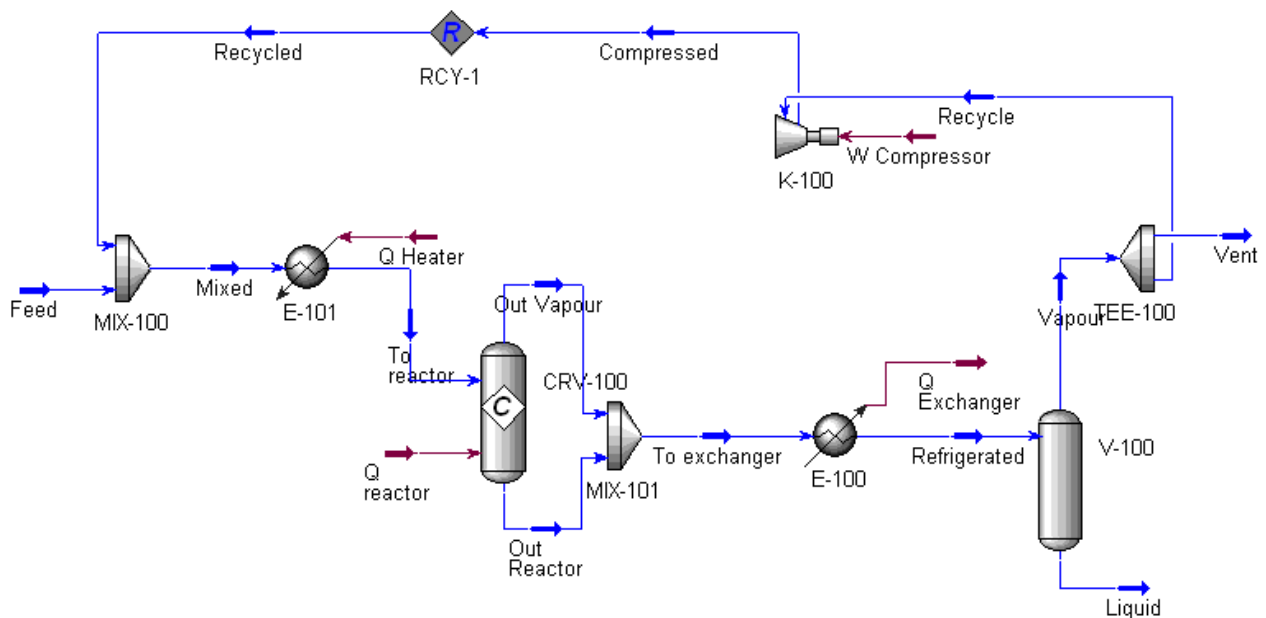
- | | |
|-----------------------------|----------------------|
| Feed | |
| • Flow, kmol/h | 1000. |
| • Temperature, K | 673. |
| • Pressure, kPa | 50000. |
| • Molar fractions: | |
| 1 - NH ₃ | 0.0000 |
| 2 - H ₂ | 0.7143 |
| 3 - N ₂ | 0.2381 |
| 4 - CH ₄ | 0.0476 |
| • Reactor (adiabatic) | |
| Reaction Set : Ammonia | |
| Reaction : Synthesis | $N_2 + 3H_2 = 2NH_3$ |
| Reaction phase: Overall | |
| • Conversion | 0.1 |
| • Pressure drops, kPa | 5000. |
| • Duty, 1E+6 kJ/h | 0. |
| • Heat exchanger (Hot side) | |
| Outlet temperature, K | 260. |
| Pressure drops, kPa | 0. |
| • Separator (adiabatic) | |
| Duty, 1E+6 kJ/h | 0. |
| Pressure drops, kPa | 0. |



Case study 2.2

Data:

- Splitter (Tee)
Purge/(Splitter feed) 0.1
- Compressor
Outlet pressure, kPa 50000.
- Heat exchanger (Cold Side)
Outlet temperature, K 673.
Pressure drops, kPa 0.



Example 3 – Distillation column

Thermodynamic Equation of State : SRK

Data:

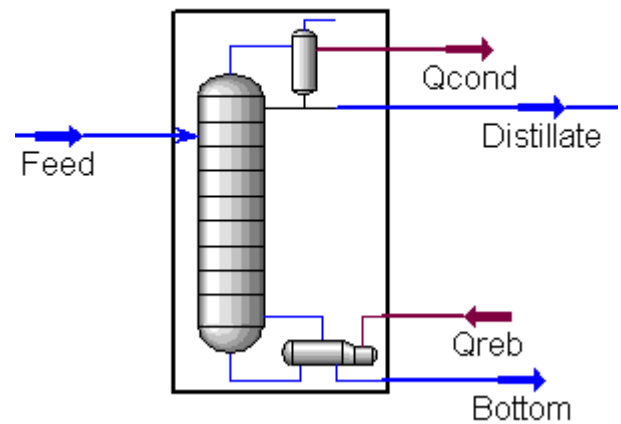
Feed (liquid at boiling point)

- Flow, kmol/h 380.
- Temperature, K 360.
- Pressure, kPa 101.32
- Molar fractions:
 - 1 - BENZENE 0.70
 - 2 - TOLUENE 0.28
 - 3 - DIFENILE 0.02

Column (Total condenser)

- Tray number 35
- Feed tray (Top Down) 24
- Reflux ratio, L/D 1.479
- Distillate rate, kmol/h 272.50

Murphree Efficiency				
Trays	from 2	up to 23	from 24	up to 34
Toluene	0.77	0.77	0.87	0.87
Biphenyl	0.64	0.64	0.72	0.72



The Murphree efficiency for the Benzene is close to one.

Check your results:

- Bottom rate, kmol/h 107.50
- Benzene in Distillate, kmol/h 266.0
- Condenser temperature, K 351.9
- Reboiler temperature, K 386.5