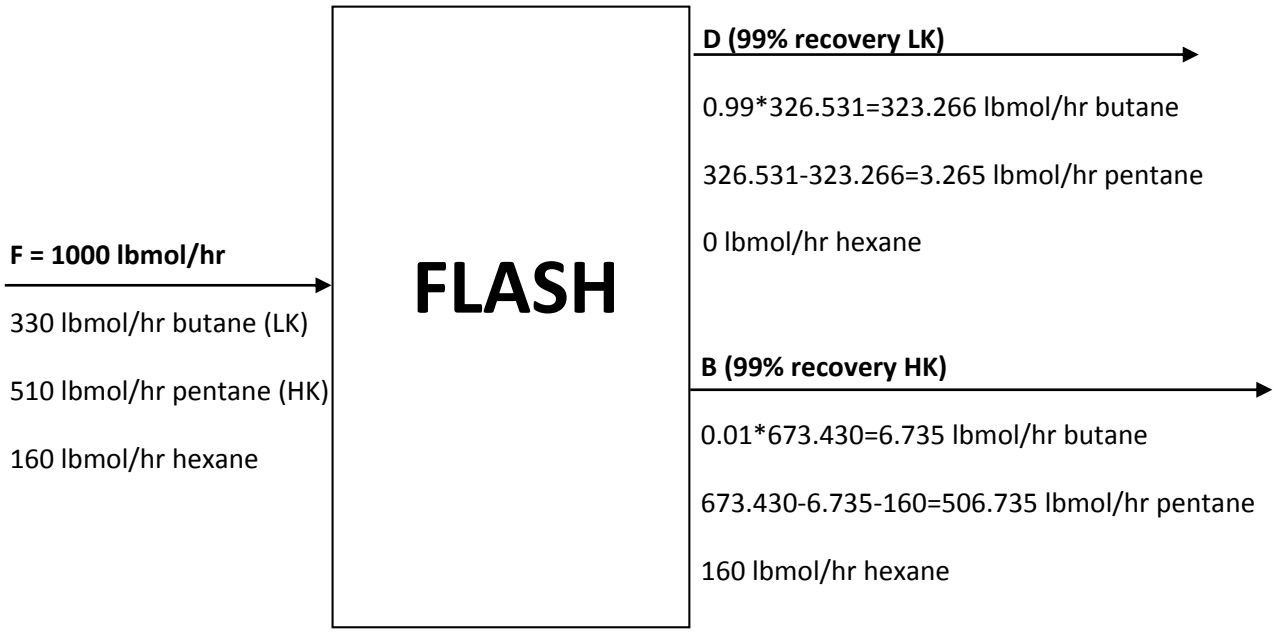
Problem 1 (Individual) - KEY

Consider a two phase 1000 lb-mole/hr stream with the following composition: Butane 33 mol %, Pentane 51 mol %, Hexane 16 mol %, at 15 pisa and 130 °F. This is the same mixture used in the previous assignment. It is desired to separate this mixture into two streams. One with 99% butane and another one with NO MORE THAN 1% butane.

Use the Fenske method to determine the number of trays that you will approximately need.




Mass Balance:

$F = D + B$

$z_{butane}F = (x_D)D + (x_B)B$

We assume that F = 1000 lbmol/hr, $z_{butane}$ = 0.33, $x_D$ = 0.99, and $x_B$ = 0.01.

$$1000\frac{lbmol}{hr} = D + B$$

$$0.33\left(1000\frac{lbmol}{hr}\right) = (0.99)D + (0.01)B$$

Solving the two equations yields:

$$D = 326.531 \frac{lbmol}{hr}$$

$$B = 673.470 \frac{lbmol}{hr}$$

Use the Fenske Equation.

$$N_{min} = \frac{LOG\left[\left(\frac{x_d}{1-x_d}\right) * \left(\frac{1-x_b}{x_b}\right)\right]}{LOG(\alpha_{avg})}$$

$$\propto_{\frac{butane}{pentane}} = \frac{K_{butane}}{K_{pentane}}$$

$$K_i = \frac{P_i^{sat}}{P}$$

$$K_i = \frac{10^{A_i - \left(\frac{B_i}{C_i + T}\right)}}{P}$$

| F (lbmol/hr) | 1000 |
|---|---|
| P (psia) | 35 |
| P (bar) | 2.41317 |
| T (°F) | 130 |
| T (K) | 327.594 |
| $z_{butane}$ | 0.33 |
| $z_{pentane}$ | 0.51 |
| $z_{hexane}$ | 0.16 |

| Butane | |
|---|---|
| A | 4.35576 |
| B | 1176.58 |
| C | -2.071 |
| $P^{sat}$ (bar) | 5.51223 |
| K | 2.28423 |
| x | 0.22918 |
| y | 0.52351 |

| Pentane | |
|---|---|
| A | 3.9892 |
| B | 1070.62 |
| C | -40.454 |
| $P^{sat}$ (bar) | 1.82241 |
| K | 0.75519 |
| x | 0.55668 |
| y | 0.4204 |

| Hexane | |
|---|---|
| A | 4.00266 |
| B | 1171.53 |
| C | -48.784 |
| $P^{sat}$ (bar) | 0.63207 |
| K | 0.26193 |
| x | 0.21414 |
| y | 0.05609 |

$$\propto_{\frac{butane}{pentane}} = \frac{2.28423}{0.75519} = 3.02469$$

$$N_{min} = \frac{LOG\left[\left(\frac{0.99}{1-0.99}\right) * \left(\frac{1-0.01}{0.01}\right)\right]}{LOG(3.02)}$$

$$N_{min} = 8.315$$

~8 trays are needed.