Demoövn. 5

Tis LV5

Sorels- och McCabe-Thieles metod

1. Kolonnens flöden
2. Driftlinjer
3. Jämviktssamband
4.

Demo uppg (givet)

Bensen B

Toluen T

$P_{tot} = 100\ kPa = 1\ bar = 760\ mmHg$

$F = 100\ \frac{kmol}{h}$, kokvarm

$x_{FB} = 0.45$

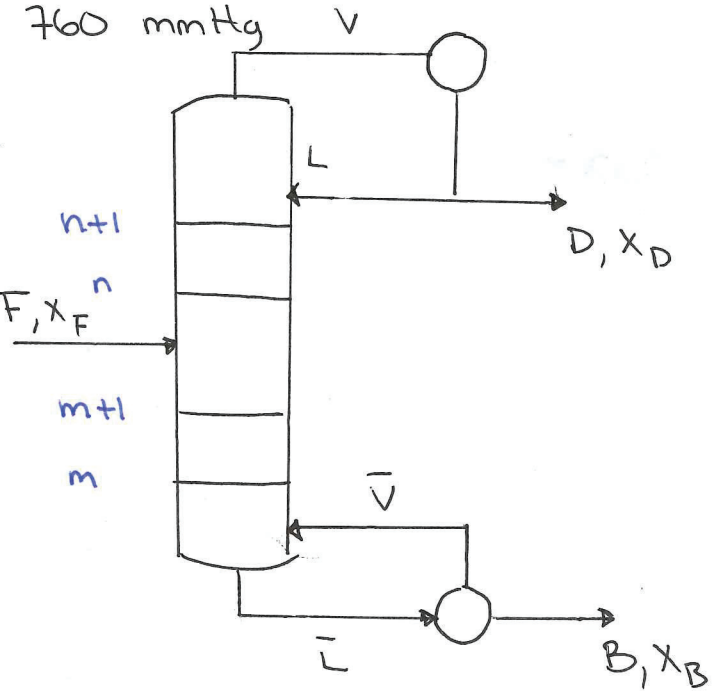
$x_{FT} = 0.55$

$x_{DT} = 0.1 \Rightarrow x_{DB} = 0.9$

$F x_{FB} = 0.08 = B \cdot x_{BB} =$

$= 100 \cdot 0.45 \cdot 0.08 = 3.6$

$R = \frac{L}{D} = 2$



jämviktssamband $y = \frac{\alpha x}{1+(\alpha-1)x}$

Antoines konstanter

systemet är idealt $\gamma_i = 1$

a) D, B

b) antalet bottnar med sorel och McCabe-Thiele

c) T feed

a) $F = D + B$ total balans

komponentbalans: (map bensen)

$$F \cdot x_{FB} = D x_{DB} + B x_{BB}$$

$$100 \cdot 0.45 = D \cdot 0.9 + 3.6 \longrightarrow D = 46 \text{ kmol/h}$$

$$B = F - D = 100 - 46 = 54 \text{ kmol/h}$$

b) **Sorel**

jämviktssamband $y = \dfrac{\alpha x}{1 + (\alpha - 1)x}$

$$\alpha = \frac{y_1/x_1}{y_2/x_2} = \left\{ \begin{array}{l} P_i = P_i^\circ x \\ P_i = y_i P_{tot} \end{array} \right\} \Rightarrow y_i = \frac{P_i^\circ x}{P_{tot}}$$

$$\Rightarrow P^\circ = \frac{y_i \cdot P_{tot}}{x} \Bigg\} = \frac{\dfrac{y_1 P_{tot}}{x_1}}{\dfrac{y_2 P_{tot}}{x_2}} = \frac{P_1^\circ}{P_2^\circ}$$

antar ren bensen i toppen och ren ~~bens~~ toluen i botten

$$\alpha = \frac{\alpha_{topp} + \alpha_{botten}}{2}$$

$$\log P^\circ = A - \frac{B}{C+T} \longrightarrow T = \frac{B}{A - \log P^\circ} - C$$

$$T_{bB} = \frac{1211.033}{6.90565 - \log 760} - 220.790 \approx 80.1\,^\circ C \quad \text{dvs } T_{topp}$$

$$T_{bT} = 110.6\,^\circ C \quad \text{dvs } T_{botten}$$

Bensen är mer lättflyktigt!

$$\left.\begin{aligned} P^\circ_{B,topp} &= \{80.1\,^\circ C\} = 760 \text{ mmHg} \\ P^\circ_{T,topp} &= \{80.1\,^\circ C\} = 292 \text{ mmHg} \end{aligned}\right\} \alpha_{topp} = \frac{760}{292} = 2.60$$

$$\left.\begin{aligned} P^\circ_{B,botten} &= \{110.6\,^\circ C\} = 1784 \text{ mmHg} \\ P^\circ_{T,botten} &= \{110.6\,^\circ C\} = 760 \text{ mmHg} \end{aligned}\right\} \alpha_{botten} = \frac{1784}{760} = 2.35$$

$$\alpha_{medel} = \frac{\alpha_{topp} + \alpha_{botten}}{2} = 2.47$$

jämviktssamband

$$y = \frac{2.47x}{1 + (2.47 - 1)x} = \frac{2.47x}{1 + 1.47x}$$

Nedre driftlinjen (ND)

$$\bar{L} x_{m+1} = \bar{V} y_m + B x_B$$

$$x_{m+1} = \frac{\bar{V}}{\bar{L}} y_m + \frac{B}{\bar{L}} x_B$$

Övre driftlinjen (ÖD)

$$L x_{n+1} + F x_F = V y_n + B x_B$$

$$x_{n+1} = \frac{V}{L} y_n + \frac{B}{L} x_B - \frac{F}{L} x_F$$

Behöver $x_B, \bar{V}, \bar{L}, V, L$

$$R = \frac{L}{D} = 2 \longrightarrow L = RD = 2 \cdot 46 = 92 \text{ kmol/h}$$

$$\bar{L} = L + F = 92 + 100 = 192 \text{ kmol/h} \quad \{\text{kokvarm feed}\}$$

$$\bar{V} = V$$

~~ND~~

$$x_{m+1} = \frac{\bar{V}}{\bar{L}}$$

T.B över återkokaren

$$\bar{L} = \bar{V} + B \longrightarrow \bar{V} = \bar{L} - B = 192 - 54 = 138 \text{ kmol/h}$$

x_B fås från KB över kokaren

$$F x_F = D x_D + B x_B$$

$$100 \cdot 0.45 = 46 \cdot 0.9 + 54 \cdot x_B \longrightarrow x_B = 0.067$$

ND

$$x_{m+1} = \frac{\bar{V}}{\bar{L}} y_m + \frac{B}{\bar{L}} \cdot x_B$$

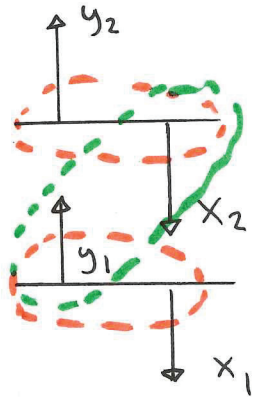
$$x_{m+1} = \frac{138}{192} y_m + \frac{54}{192} \cdot 0.067 \qquad (1)$$

ÖD

$$x_{n+1} = \frac{V}{L} y_n + \frac{B}{L} x_B - \frac{F}{L} x_F$$

$$x_{n+1} = \frac{138}{92} y_n + \frac{54}{92} \cdot 0.067 - \frac{100}{92} \cdot 0.45 \qquad (2)$$

jämvikt: $$y = \frac{2.47x}{1+1.47x} \qquad (3)$$



(1), (2)

(3)

Steg	x	y
0	0.067	0.150
1	0.127	0.263
2	0.208	0.394
3	0.302	0.516
4	0.390	0.612
5	0.459	

VIKTIGT! Stopkriterier

Villkor för (1): $x_F = 0.45 > x$

Villkor för (2): $y = x_D = 0.9$

Steg	x	y
6	0.565	0.762
7	0.694	0.848
8	0.822	0.920

Alltså totalt 8 botten + 1 Å.K. (återkokn.)

McCabe-Thiele

Kokvarm feed $X_F = 0.45$

ÖD

$X_D = 0.9$

$$V y_n = L X_{n+1} + D X_D$$

$$y_n = \frac{L}{V} X_{n+1} + \frac{D}{V} X_D$$

$$y_n = \frac{92}{132} X_{n+1} + \frac{46}{132} X_D \quad - 0.9$$

$$y_n = 0.66 X_{n+1} + 0.3$$

c) T feed

Bubbelpunkt

$X_{FB} = 0.45$ $X_{FT} = 0.55$ $P_{tot} = 760$ mmHg

$T_{bB} = 80.1\ ^\circ C$

$T_{bT} = 110.6\ ^\circ C$

Givet P, X → Gissa T → P° mha Antoine

→ $y_i = \frac{P^\circ x_i}{P_{tot}}$

→ $\Sigma y_i \overset{?}{=} 1$

nej ↑

Ja → Klart!

Gissa $T = 80.1 \cdot 0.45 + 110.6 \cdot 0.55 = 97\ ^\circ C$

T	P_B°	P_T°	y_B	y_T	Σy
97	1244	507	0.74	0.37	1.11
93.8	1138	459	0.67	0.33	1