Example 6.1 Open Steam separation of MeOH / water.

Feed 60% MeOH
40% Water
Two Phase $V_F/F = 0.3$
$m_F = 350$ kg mole/h
$Q_{col} = 0$ insulated.
Total condenser.
Reflux is sat'd liq
$L_0/D = 3$

Require $X_D = 95\%$
$X_B = 8\%$
Injected with sat'd steam (second feed?)
1 atm operation.

Calc: N stage
N Feed opt.

① Draw Column schematic Fig 6-1

② Check CMO $\lambda_M = 8.43$ kcal/gmole
$\lambda_W = 9.72$
∴ Variation ≈ 15% CMO not great but utilize

③ Derive top op line (upper --- CV)

$\frac{MB}{Tot}$: $V_{j+1} = L_j + D$

$\frac{MB}{MVC}$: $y_{j+1} V_{j+1} = L_j x_j + D x_D$

④ Assume CMO ∴ $V_j = V$ $L_j = L$

$$\therefore y_{j+1} = \frac{L}{V} x_j + \left(1 - \frac{L}{D}\right) x_D$$

⑤ Obsekve slope $= L/V$

$y\,int = (x=0) = \left(1 - \frac{L}{V}\right) x_D$

⑥ Consider reflux (sat'd liq)

$V_1 = L_o + D$ (see Fig)

$\therefore V = L_o + D$

$$\therefore \frac{L}{V} = \frac{L_o}{L_o + D} = \frac{L_o/D}{L_o/D + 1}$$ ~ given

$$\frac{L}{V} = \frac{3}{4}$$ (slope top op line)

⑦ Feed line

$$y = \frac{q}{q-1} x + \frac{z}{1-q}$$

$$\text{slope} = \frac{q}{q-1} = \frac{0.7}{-0.3} = -\frac{7}{3}$$

$$y\,int = (x=0) = \frac{z}{1-q}$$ ~ book errok p 160

$$q \equiv \frac{\bar{L} - L}{F} \equiv \frac{\bar{V} - V + F}{F} = \frac{F}{F} - \frac{V_F}{F}$$

$$q = 1 - \frac{V_F}{F}$$

⑧ Botton Op Line (see ---- bot sect)

$\frac{MB}{Tot}$: $\bar{V} + B = \bar{L} + S$ ~ steam injected

$\frac{MB}{MVC}$: $\bar{V} y + B x_B = \bar{L} x + S y_S$

↖ dropped subscripts

Pure Steam :: $y_S = 0$

Sat'd Steam :: $S = \bar{V}$

and $B = \bar{L}$

(no liquid added due to addition of steam)

Bot Op Line solved for y

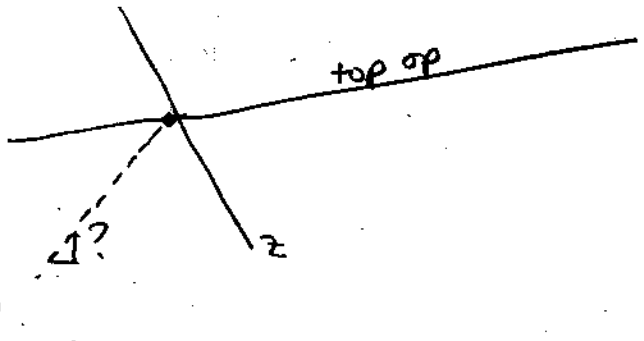
$$y = \left(\frac{\bar{L}}{\bar{V}}\right)x - \left(\frac{\bar{L}}{\bar{V}}\right)x_B \qquad (6\text{-}1)$$

(Not identical w/ Reboiler type)

$$\text{slope} = \frac{\bar{L}}{\bar{V}} \quad (\text{unk})$$

$$y\ \text{int} = (x=0) = -\left(\frac{\bar{L}}{\bar{V}}\right)x_B \quad (\text{unk})$$

We do know the bot op line "attaches" to the top op line at the feed line intersection.



?

However solve 6-1 for $y = 0$ ∴

$x = x_B$ is the other end of the op. line (see Fig 6-2)

Note This is not on the diagonal.

With the above, we can complete the stepping off process.

Construct TOL at $y = x = x_D = 0.95$

slope = 3/4

(or $y_{int} = \left(1 - \frac{L}{V}\right) x_D = 0.2375$)

Construct FOL slope = $-7/3$

$y = x = z = 0.6$

Construct BOL TOL int FOL

$x_{int} = (y=0) = x_B = 0.08$.

From Fig 6-2

$N_{stage} \simeq 5$ (no reboiler)

Act. $N_{stage} = 4.92$

$N_{Feed} = 4$

(fin)