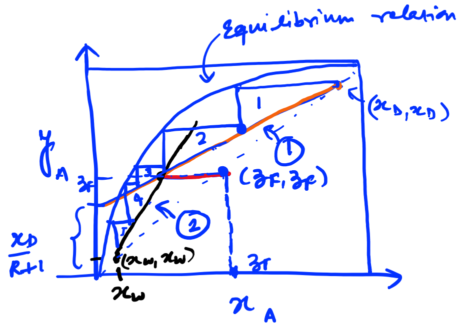
McCabe & Thiele Method continue..

Recall:

- Enriching section: $y_{n+1} = \left(\frac{R}{R+1}\right) x_n + \frac{x_D}{R+1}$

- Stripping section: $y_{m+1} = \frac{\bar{L}}{\bar{L}-W} x_m - \frac{W}{\bar{L}-W} x_w$

Feed line: $y = \frac{q}{q-1} x - \frac{z_F}{q-1}$

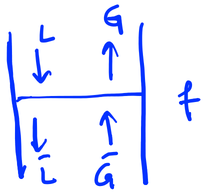


- Start by drawing the operating line of enriching section
  $\Rightarrow R, x_D$ should be known

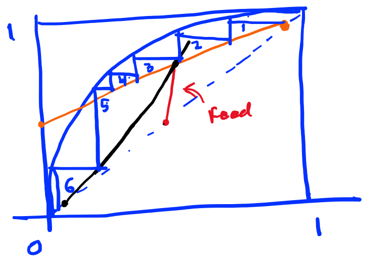
- Lets assume, $q = 0$ in this example $\Rightarrow$ Slope of the feed line $= 0$

- **Question:** When do you switch from operating line 1 to operating line 2 when finding the number of ideal stages?

- **Recall:** Region above the feed tray is termed as the enriching section & region/column below the feed tray is termed as the stripping section. Therefore, we switch from operating line 1 to 2 at feed tray.

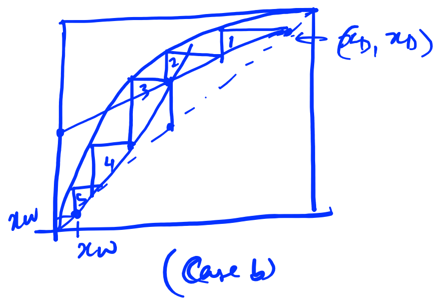


- Consider the following cases:



(Case a)

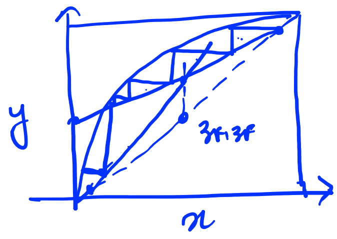
- Feed is between tray 4 & 5.
- Therefore, follow operating line of enriching section till tray 4 & then switch to the operating line of stripping section



(Case b)

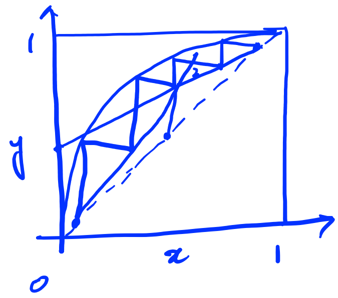
- Feed introduced between tray 2 & 3
- Thus, switch from the operating line of enriching section to that of the stripping section after tray 2.

- <u>Location of feed tray:</u> For an optimum design, large steps must be taken between the operating line & the equilibrium line so that the driving force is large.

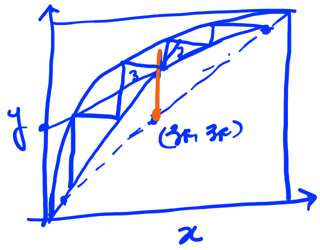


(Case a)

- Too long on the enriching section operating line ⇒ Less driving force on tray 4



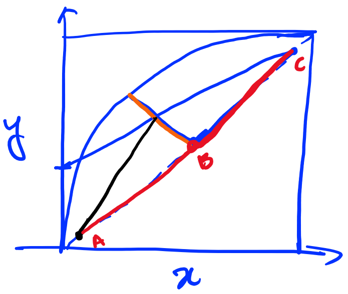
- Too early 'switching' lead to less driving force



optimum to switch near the feed line.

- <u>Total Reflux or infinity reflux ratio:</u>

$R = (L_0/D)$; Total reflux means $D \to 0 \Rightarrow \underline{R} \to \infty$



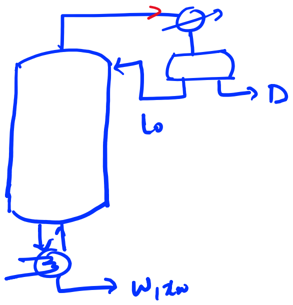
Slope of enriching section operating line $= R/R+1$

$= \dfrac{1}{1+\frac{1}{R}}$

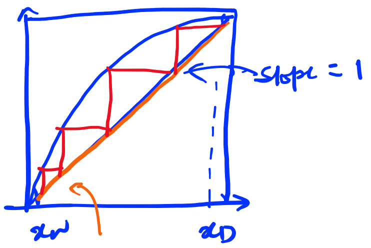
At total reflux:

AB = operating line of stripping section

BC = operating line of enriching section



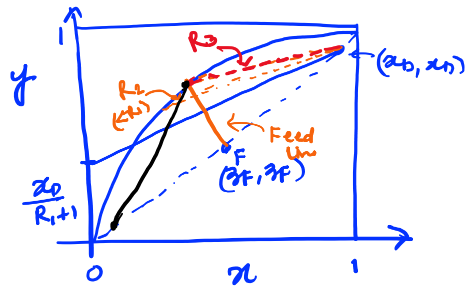
At total reflux, slope of both the operating lines = 1



- Operating line when <u>$R \to \infty$</u>
- Driving force is maximum when $R \to \infty$ ⇒ Minimum number of trays needed for a given separation.
- Reboiler duty & condenser load is maximum at total reflux.
- Alternatively, the condenser & reboiler work at infinity capacity.

- Minimum Reflux ratio : Rm , the minimum reflux ratio.

$R_1 > R_2 > R_3$



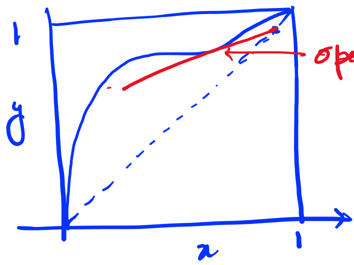
Slope of the enriching section operating line $= R/_{R+1} = \frac{1}{1+(1/R)}$

$R = L_0/D$

- If you lower R, slope of the operating line decreases.

- For reflux ratio = R_3, the operating lines hit the equilibrium curve, therefore, infinity number of trays are needed for the desired seperation.
- Therefore, the actual reflux ratio must be more than the minimum reflux ratio. Typically, $R_{act} \approx (1.2-1.5)\,R_{min}$

Other cases:



operating line corresponding to the minimum reflux