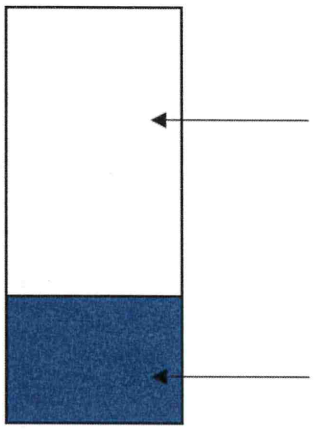
Liquid composition known

(i.e., Bubble Point)

Find: P_{tot}, y_B, y_T



Gas consists only of benzene & toluene

Liquid at 25°C consists of:
35 mol% benzene
65 mol% toluene

Using Antoine equation, at 25°C

$P^*_B = 95.1$ mm Hg
$P^*_T = 28.5$ mm Hg

Raoult's Law for each species:

$x_B P_B^* = y_B P_{tot}$ → solve for y's
$x_T P_T^* = y_T P_{tot}$

$y_B = \frac{x_B P_B^*}{P_{tot}}$

$y_T = \frac{x_T P_T^*}{P_{tot}}$

add

$1 = (x_B P_B^* + x_T P_T^*) / P_{tot}$ ← wanted

$P_{tot} = x_B P_B^* + x_T P_T^*$
$= (.35)(95.1) + (.65)(28.5)$
$= 51.81$ mm Hg
(pretty low)

Now find y_i's

$y_B = \frac{x_B P_B^*}{P_{tot}} = \frac{(.35)(95.1)}{51.81} = 0.642$

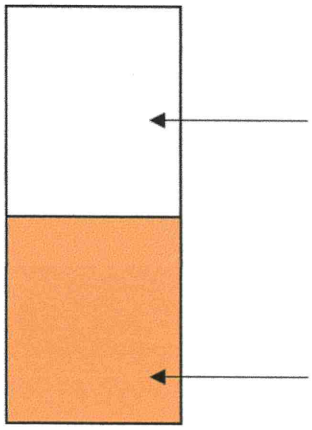
$y_T = 1 - .642 = 0.358$

} vapor enhanced in benzene, which has the higher vapor pressure

Gas composition known

(i.e., Dew Point)

Find: T, x_B, x_T



Gas at 2 atm (1520 mm Hg) consists of
40 mol% benzene
60 mol% toluene

T = ?

Using Antoine equation, at guessed T

P^*_B = ? mm Hg
P^*_T = ? mm Hg

Raoult's Law for each species:

$x_B P_B^* = y_B P_{tot}$
$x_T P_T^* = y_T P_{tot}$

Solve for x's ⇒

$$x_B = \frac{y_B P_{tot}}{P_B^*}$$

$$x_T = \frac{y_T P_{tot}}{P_T^*}$$

add

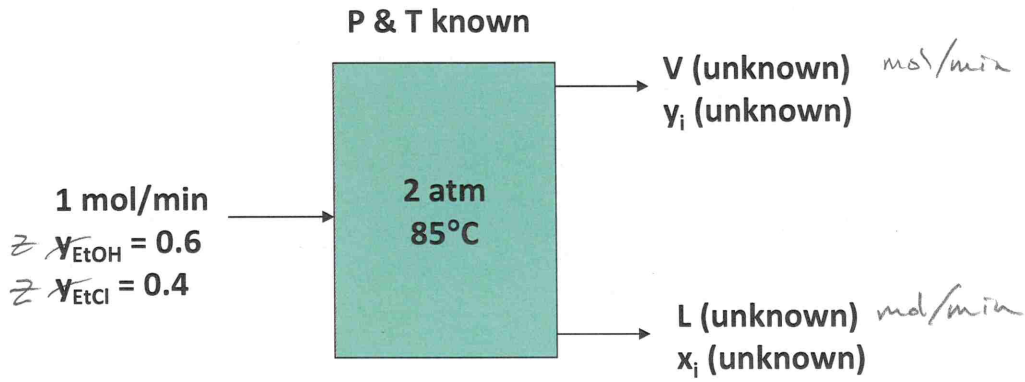
$$1 = \frac{y_B P_{tot}}{P_B^*} + \frac{y_T P_{tot}}{P_T^*}$$

$$1 = \left(\frac{y_B}{P_B^*} + \frac{y_T}{P_T^*} \right) P_{tot}$$

Strategy

- Guess T
- Find P_B^*, P_T^*
- See if equation is solved
  - no → Guess T
  - yes → find x_B ; x_T

Flash Calculation



Using Antoine equation, at 85°C

P^*_{EtOH} = 985.1 mm Hg

P^*_{EtCl} = 6362.45 mm Hg

P_{tot} = 2 atm = 1520 mm Hg

Total Mole Balance: $1 = V + L$

Balance on EtOH: $.6(1) = y_{EtOH} V + x_{EtOH} L$

Raoult's Law for each species:

$$(y_{EtOH})(P_{tot}) = (x_{EtOH})(P^*_{EtOH})$$

$$(y_{EtCl})(P_{tot}) = (x_{EtCl})(P^*_{EtCl})$$

add

$$P_{tot} = x_{EtOH} P^*_{EtOH} + x_{EtCl} P^*_{EtCl}$$

1 unknown

$$P_{tot} = x_{EtOH} P^*_{EtOH} + (1 - x_{EtOH}) P^*_{EtCl}$$

$$P_{tot} = x_{EtOH}(P^*_{EtOH} - P^*_{EtCl}) + P^*_{EtCl}$$

$$\frac{P_{tot} - P^*_{EtCl}}{P^*_{EtOH} - P^*_{EtCl}} = x_{EtOH} = \frac{1520 - 6362.45}{985 - 6362.45}$$

$$= 0.90$$

So $x_{EtCl} = 0.1$

$$y_{EtOH} = \frac{(.9)(985.1)}{1520} = 0.584$$

Now do material balances

$1 = V + L$

$.6 = .584V + .9L$

$.9 = .9V + .9L$

$.3 = .316V$

$V = .949 \quad L = .051$