ME 3007 – HW 5 Solutions

1. $y_i P = x_i P_i^{sat} \rightarrow K_i = \frac{y_i}{x_i} = \frac{P_i^{sat}}{P}$. At an azeotrope, $x_i = y_i$, so $K_i = 1$, and P_i^{sat} must = P.

However, we know that P_i^{sat} varies for different substances, and so is not equal to a set P for all components in a mixture.

2.

$y_i P = x_i \gamma_i P_i^{sat}$

$\ln \gamma_1 = 1.8 x_2^2, \quad P_1^{sat} = 1.24 \text{ bar}$

$\ln \gamma_2 = 1.8 x_1^2, \quad P_2^{sat} = 0.89 \text{ bar}$

a & b)

$x_1 = 0.65, \; x_2 = 0.35$

$\gamma_1 = e^{1.8(0.35)^2} = 1.247 \rightarrow y_1 P = (0.65)(1.247)(1.24) = 1.005 \text{ bar}$

$\gamma_2 = e^{1.8(0.65)^2} = 2.139 \rightarrow y_2 P = P(1 - y_1) = (0.35)(2.139)(0.89) = 0.666 \text{ bar}$

2 equations and 2 unknowns (P and y_1): **$P = 1.6713$ bar and $y_1 = 0.6013$**

$z_1 = x_1 L + y_1 V$

$L + V = 1$

$z_1 = x_1 + (y_1 - x_1) V \quad \text{for } 0 \le V \le 1$

so $y_1 \le z_1 \le x_1$

or **$0.60 \le z_1 \le 0.65$**

c) At an azeotrope, $x_1 = y_1$ and $x_2 = y_2$.

$\frac{y_1}{x_1} P = \gamma_1 P_1^{sat} = e^{1.8 x_2^2} (1.24) = e^{1.8(1-x_1)^2} (1.24)$

$\frac{y_2}{x_2} P = \gamma_2 P_2^{sat} = e^{1.8 x_1^2} (0.89)$

2 equations and 2 unknowns (x_1 and P)

$x_1 = y_1 = 0.592$
$P = 1.674$ bar