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BONUS SECTION - EXTRA PROBLEM

SOLUTION

- a) BECAUSE FEED IS A SATURATED VAPOR, $q = 0$.
THUS THE q -LINE IS A HORIZONTAL LINE
WHICH INTERSECT $x=y$ LINE AT $(0.15, 0.15)$.
IT ALSO HAS THE EQUATION

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

$$y = \frac{-0.15}{-1} = 0.15$$

SEE PLOT 1

- b) THE MINIMUM REFLUX RATIO CORRESPONDS WITH THE
RECTIFYING OPERATING LINE HAVING THE LOWEST
POSSIBLE SLOPE. SINCE THE TARGET DISTILLATE
IS 65% 1-PROPANE, THIS RECTIFYING LINE
MUST INTERSECT $x=y$ AT $(0.65, 0.65)$. THE
LINE WITH THE MINIMUM POSSIBLE SLOPE
INTERSECT THE SAME POINT ON THE EQUILIBRIUM
CURVE THAT THE q -LINE INTERSECTS

SEE PLOT 2

THE SLOPE OF THIS "MINIMUM" IS:

$$\frac{\Delta y}{\Delta x} = \frac{0.65 - 0.15}{0.65 - 0.007} = 0.778$$

THIS SLOPE IS ALSO $\frac{L}{V} \neq \frac{R}{R+1}$

$$\text{SO } \frac{R}{R+1} = 0.778 \quad \text{OR } R = \frac{0.778}{1-0.778}$$

$$\underline{\underline{R_{\min} = 3.5}}$$

c) IF $R=5$ THEN

$$\begin{aligned} 100 &= B + D \\ (0.15)(100) &= 0.02B + 0.65D \\ 15 &= 0.02B + 0.65D \\ 750 &= B + 32.5D \end{aligned}$$

OVERALL BALANCE
1-PROPANE BALANCE

$$\text{OR } 650 = 31.5D$$

$$\begin{aligned} D &= 20.6 \text{ Kg mol/h} \\ B &= 79.4 \text{ Kg mol/h} \end{aligned}$$

$$\begin{aligned} L &= (5)(20.6) = 103.0 \text{ Kg mol/h} \\ V &= (6)(20.6) = 123.6 \text{ Kg mol/h} \\ L' &= 0 + 103.0 = 103.0 \text{ Kg mol/h} \\ V' &= 100(0-1) + 123.6 = 23.6 \text{ Kg mol/h} \end{aligned}$$

SO, THE TWO LINES ARE:

STRIPPING
SECTION

$$Y = \frac{L'}{V'} X - \frac{B}{V'} X_B$$

$$Y = \frac{103}{23.6} X - \frac{79.4}{23.6} (0.02)$$

$$\underline{\underline{Y = 4.36X - 0.067}}$$

RECTIFYING
SECTION

$$y = \frac{L}{V}x + \frac{D}{V}x_D$$

$$y = \frac{103.0}{123.6}x + \frac{20.6}{123.6}(0.65)$$

$$\underline{y = 0.833x + 0.108}$$

NOTE $\frac{R}{R+1} = \frac{5}{5+1} = 0.833$

SEE FIGURE 3

STEP OFF STAGES

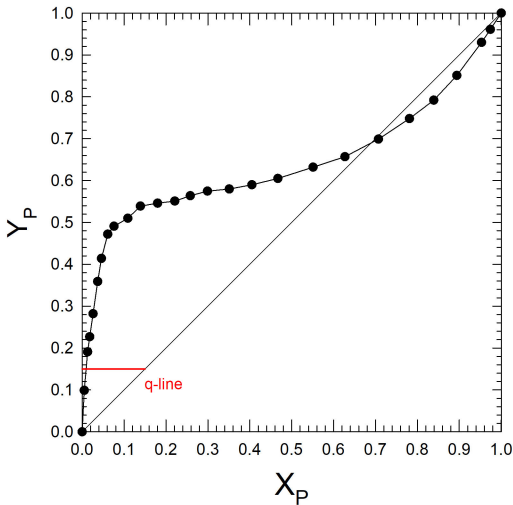
THE SEPARATION NEEDS 4 STAGES

WITH THE FEED ON THE LOWEST STAGE (#4)

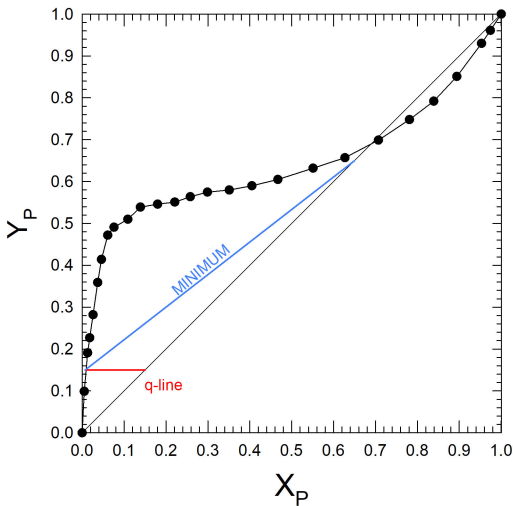
- d) NO, 1-PROPANOL $\neq$ WATER FORM AN AZEOTROPE
AT THIS PRESSURE $\&$ IT LIES AT $x \approx 0.68$
IT IS NOT POSSIBLE TO ACHIEVE GREATER
THAN 68% 1-PROPANOL IN THIS BINARY
DISTILLATION PROCESS.

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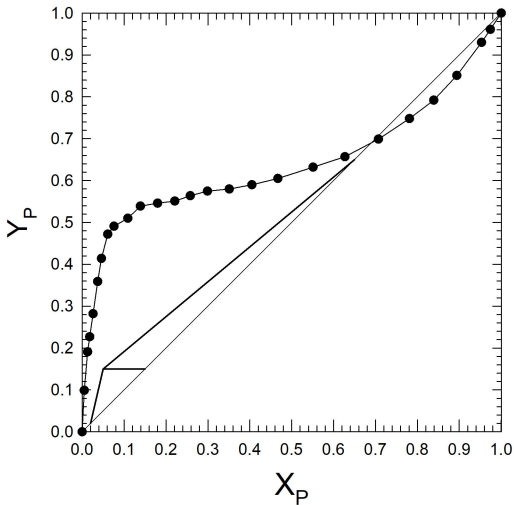
1-Propanol - Water Equilibrium



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