CE 407 Notes

Binary Distillation Column Flows

A 100 mol/h feed stream comprising 45 mole percent ethylbenzene and 55 mole percent n-propylbenzene enters a continuous distillation column operating at a reflux ratio R = 3.0. There is a 97 percent recovery of ethylbenzene in the distillate and 99 percent recovery of n-propylbenzene in the bottom product. Feed enters as a saturated liquid.

a) Fill in the labeled flow rates in the column schematic shown in figure 1.
b) Prepare an operating diagram showing the operating lines for the rectifying and stripping sections of the column and the feed line. Note: you do NOT need to count stages. The xy diagram for mixtures of ethylbenzene and n-propylbenzene is supplied.
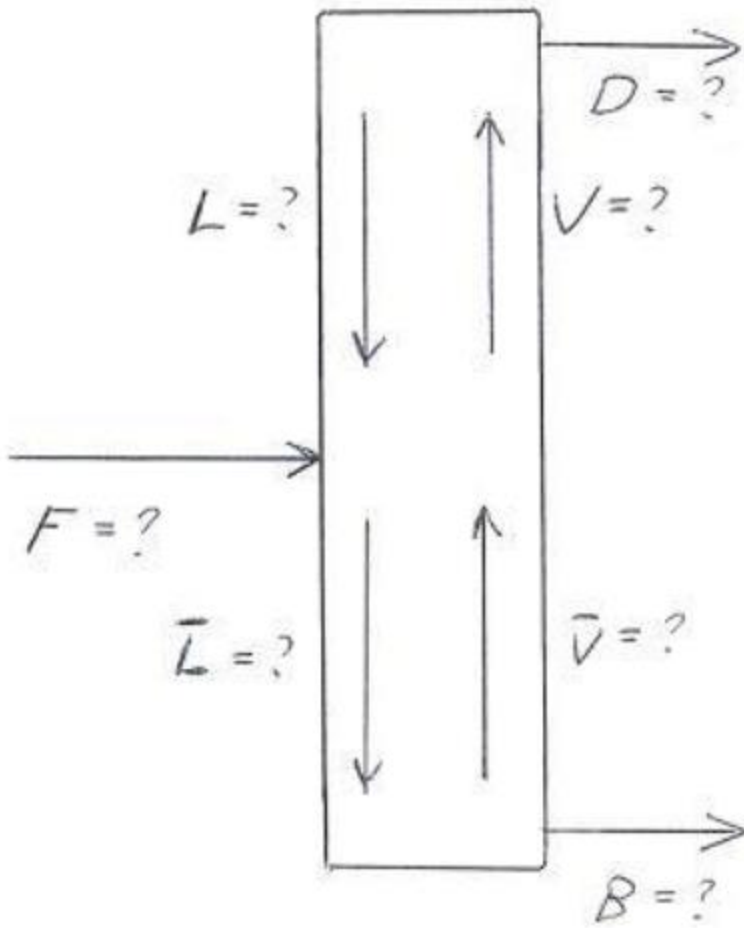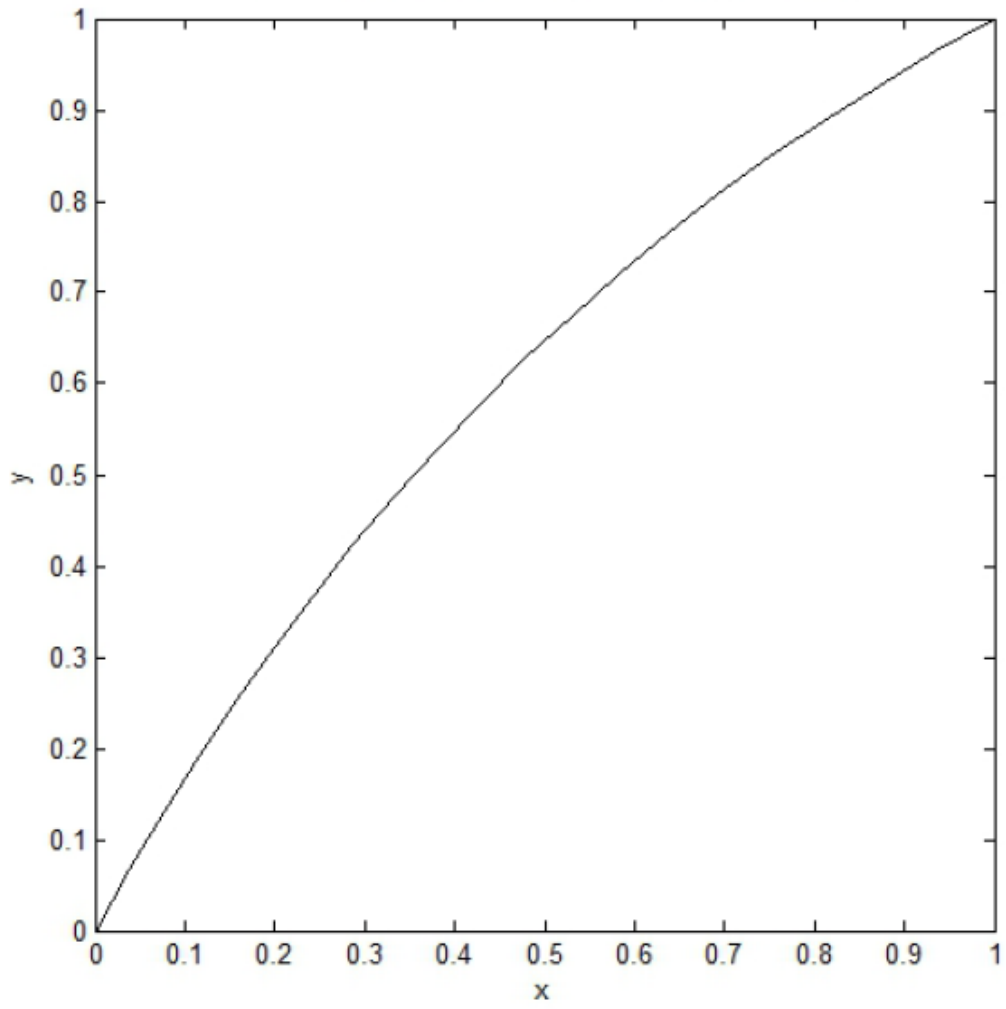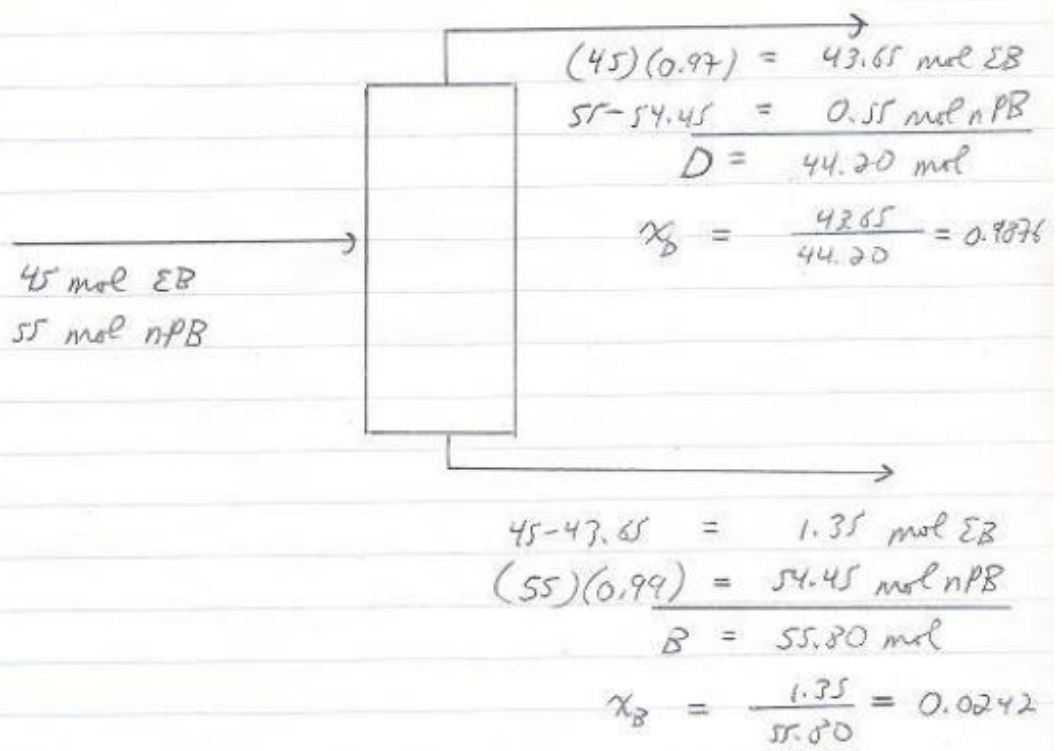
$L = ?$

$D = ?$

$V = ?$

$F = ?$

$\bar{L} = ?$

$\bar{V} = ?$

$B = ?$

Figure 1.

Ethylbenzene n-propylbenzene at 1 atm: xy diagram

<u>Preliminaries</u>   (1 h basis)

$(45)(0.97) = 43.65$ mol EB
$55 - 54.45 = 0.55$ mol nPB
$D = 44.20$ mol

$x_D = \dfrac{43.65}{44.20} = 0.9876$

45 mol EB
55 mol nPB

$45 - 43.65 = 1.35$ mol EB
$(55)(0.99) = 54.45$ mol nPB
$B = 55.80$ mol

$x_B = \dfrac{1.35}{55.80} = 0.0242$

<u>Part (a)</u> $R = L/D$ so $L = RD = (3.0)D$
$= 132.6$ mol

$V = L + D = 176.8$ mol

$q = 1$ (sat. liquid feed)

$\bar{L} = L + qF = 132.6 + 1(100) = 232.6$ mol
$V = \bar{V} + (1-q)F \Rightarrow \bar{V} = V - (1-q)F = V = 176.8$ mol
<u>Check:</u> $\bar{L} \stackrel{?}{=} \bar{V} + B$
$232.6 \stackrel{?}{=} 176.8 + 55.80$ ✓ ok

$D = 44.20$ mol/h

$L = 132.6$ mol/h

$V = 176.8$ mol/h

$F = 100$ mol/h

$\bar{L} = 232.6$ mol/h

$\bar{V} = 176.8$ mol/h

$B = 55.80$ mol/h
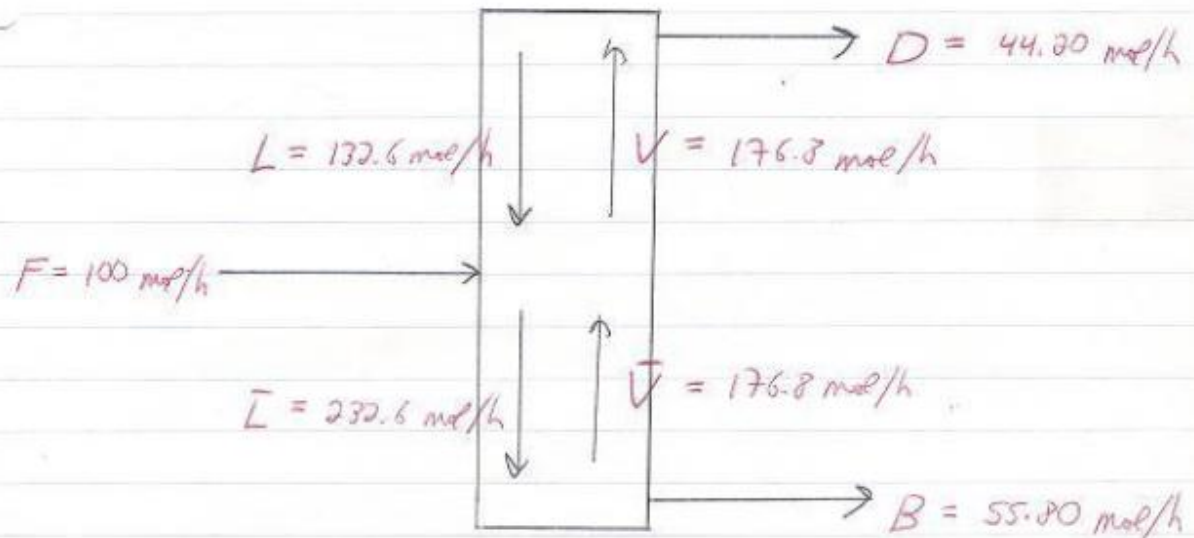
Part (8)   R-op line passes through point (x_D, x_D)
= (0.9876, 0.9876) and has intercept
$x_D/(R+1) = 0.9876/(3+1) = 0.2469$.

Feed line passes through point $(x_F, x_F) = (0.45, 0.45)$
and is vertical (because sat. liquid feed $\Rightarrow q=1$
$\Rightarrow$ slope infinite). S-op line passes through
point $(x_B, x_B) = (0.0242, 0.0242)$ and pt. of
intersection of R-op + feed lines. See operating
diagram on next page.

equil. curve

feed line

R-op line

S-op line

0.2472

0.0242

0.45

0.8876

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