7/25/2019

CE 407 Exam 2 Solution

1. A = Water, Diluent
   B = Solvent
   C = Solute

Feed Solution $L_0 = 300$ kg/hr $(x_B, x_C) = (0.58, 0.42)$
Solvent Entering $V_{N+1} = ?$ kg/hr $(x_B, x_C) = (1, 0)$

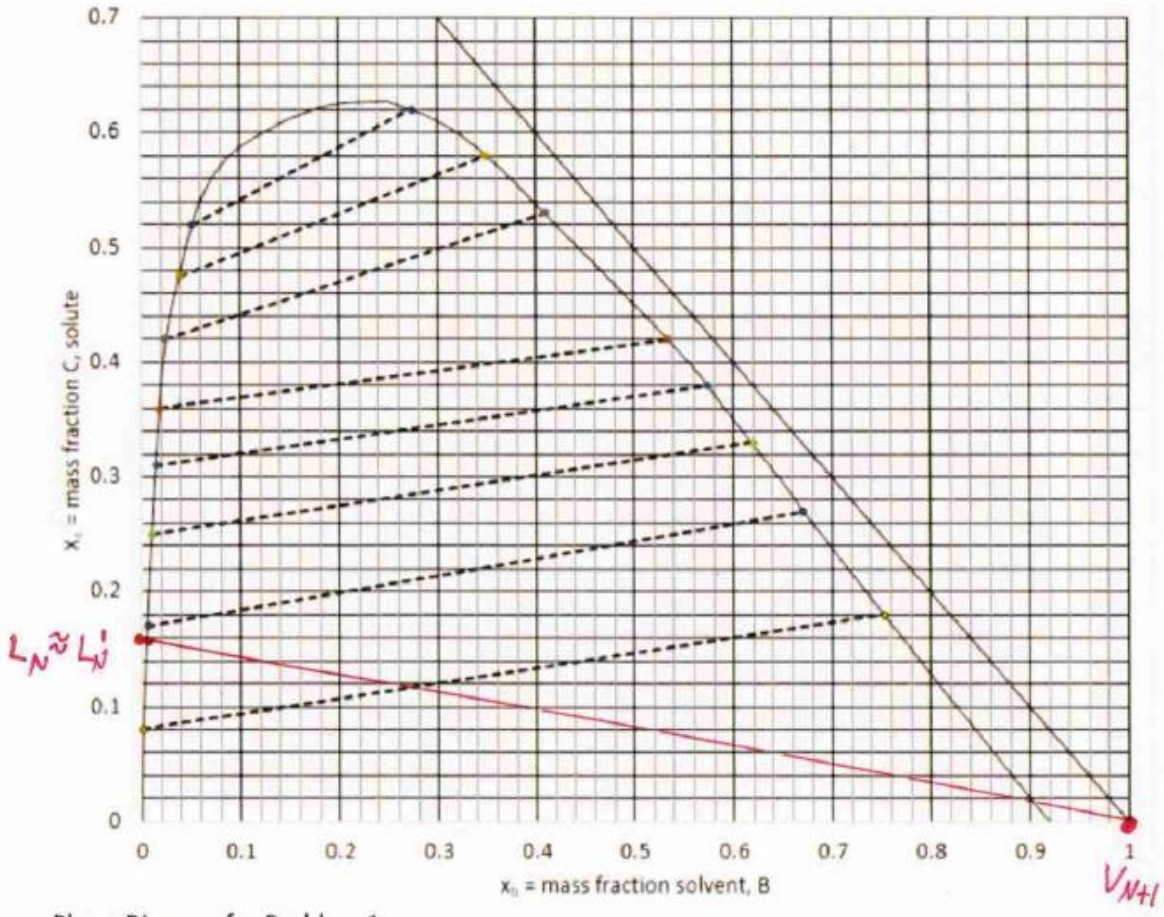
Exiting Raffinate $L'_N = 0.16$
Draw line from pure solvent to point $(0, 0.16)$
L_N is located on left boundary of 2 phase region where it intersects with line $\overline{L'_N V_{N+1}}$
$L_N \approx 0.16$

Extend line $\overline{L_N V_{N+1}}$ out to left of diagram

Mark point for L_0 at $(0, 0.42)$
There are 5 tie lines located between L_0 and L_N, extend these to see where they intersect with $\overline{L_N V_{N+1}}$

The 2nd tie line has intersection which is furthest from phase diagram. Label this Δ_{min}

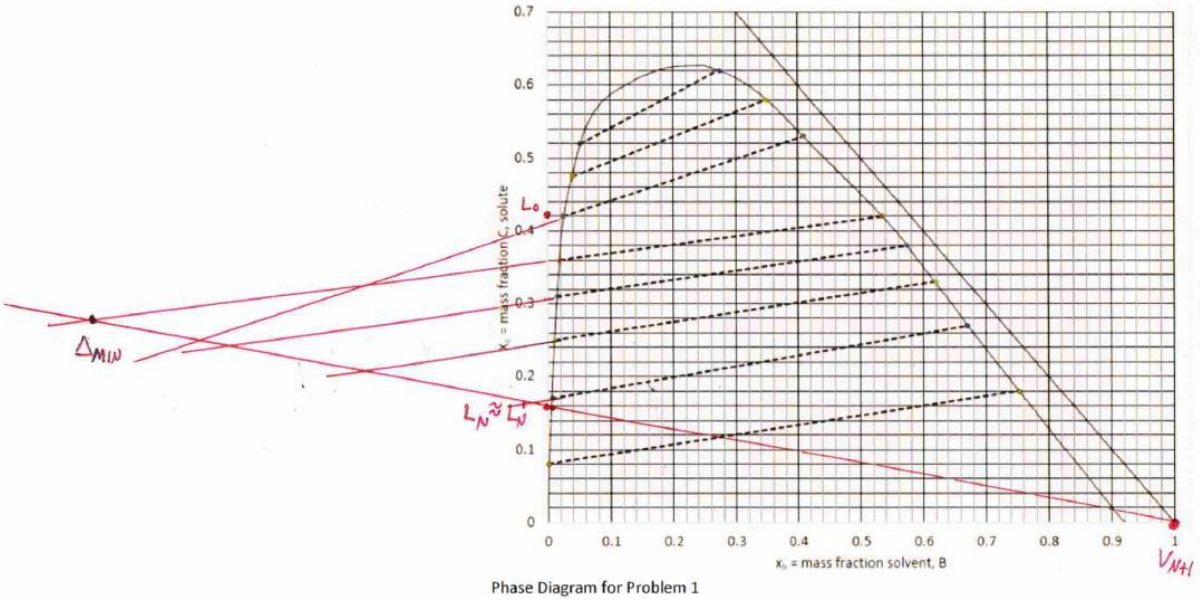
Draw line from Δ_{min} through L_0, extend to right hand side of 2 phase boundary



Phase Diagram for Problem 1

Tie lines

(0.001, 0.08) and (0.753, 0.18)
(0.006, 0.17) and (0.67, 0.27)
(0.01, 0.25) and (0.62, 0.33)
(0.015, 0.31) and (0.573, 0.38)
(0.019, 0.36) and (0.535, 0.42)
(0.024, 0.42) and (0.41, 0.53)
(0.04, 0.475) and (0.35, 0.58)
(0.052, 0.52) and (0.273, 0.62)



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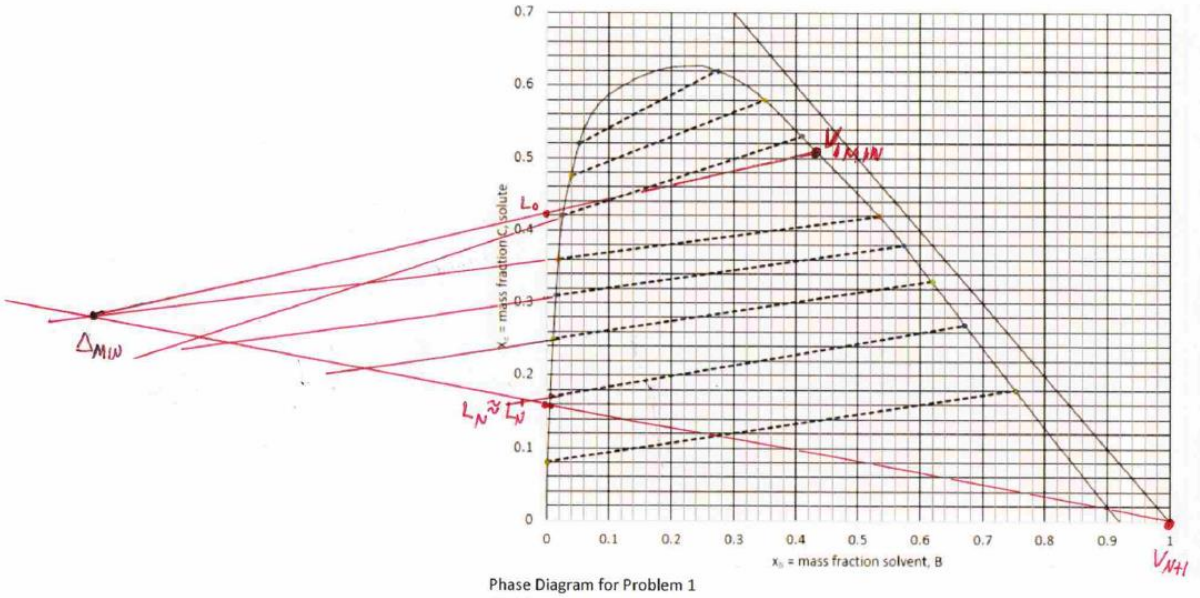

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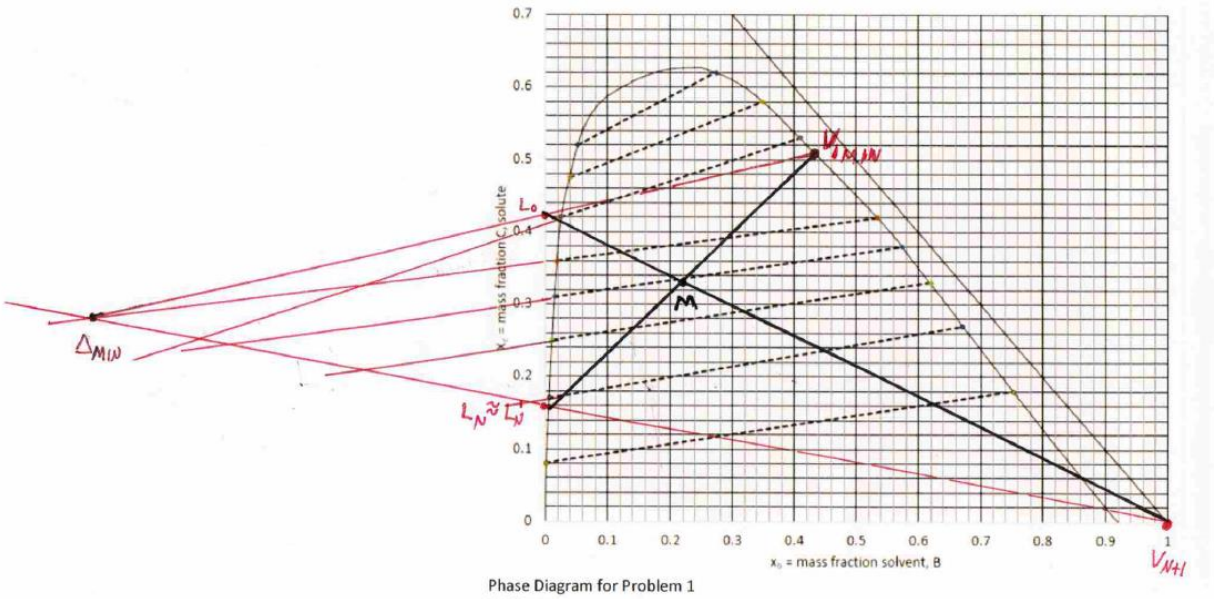

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LABEL INTERSECTION of $\overline{\Delta_{min} L_o}$ AND RHS of 2 PHASE BOUNDARY AS V_{1MIN}

DRAW IN LINES $\overline{L_N V_{1MIN}}$ and $\overline{L_o V_{N+1}}$

THEIR INTERSECTION IS POINT M

$x_M = 0.33$ FROM DIAGRAM

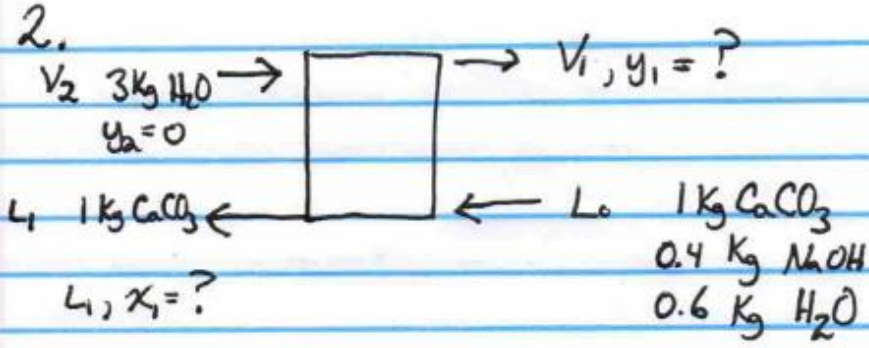
$x_o = 0.42$, $y_{N+1} = 0$, $x_M \approx 0.33$ SOLUTE MASS FRACTIONS

$$L_o/V_{N+1} = \frac{y_{N+1} - x_M}{x_M - x_o} = \frac{0 - 0.33}{0.33 - 0.42} = 3.67$$

$$V_{N+1} = \frac{L_o}{3.67} = \frac{300 \text{ kg/hr}}{3.67} = 81.8 \text{ kg/hr}$$

ONE MINUTE BASIS

2.



NOTE $x_1 = y_1$!!!

OVERALL MASS BALANCE

IN = OUT

$3\,Kg + 0\,Kg + 0.6\,Kg + 0.4\,Kg = L_1 + V_1$

V_2 H_2O NaOH H_2O NaOH

(H_2O NaOH = L_0)

$4\,Kg = L_1 + V_1$

NaOH MASS BALANCE

IN = OUT

$0 + 0.4 = x_1 L_1 + y_1 V_1$

$0.4 = x_1 (L_1 + V_1)$ REMEMBER $x_1 = y_1$

$0.4 = x_1 (4)$ FROM OVERALL BALANCE

a.) $0.1 = x_1 = y_1$

FROM TABLE FOR 10 wt % $NaOH$ ($x_1 = 0.1$)

1 Kg $CaCO_3$ will RETAIN 2.20 Kg solution

$$L_1 = \frac{2.20 \text{ Kg solution}}{1 \text{ Kg } CaCO_3} \times 1 \text{ Kg } CaCO_3 = 2.2 \text{ Kg solution}$$

Mass of $NaOH$ in L_1 $0.1 \frac{\text{Kg } NaOH}{\text{Kg Solution}} \times 2.2 \text{ Kg solution}$

$= 0.22$ Kg $NaOH$

$\therefore$ Mass of $NaOH$ in $V_1 = 0.4 - 0.22$ Kg $NaOH$

$= 0.18$ Kg $NaOH$

f.) % RECOVERY $= \frac{0.18}{0.40} \times 100\% = 45\%$

3.

Component	Distillate	Bottoms
A	Large	Negligible
B	Large	Small
C	Large	Large
D	Large	Large
E	Small	Large

A is lighter than light key and will be almost entirely in distillate

B is light key and will have a small (but not negligible) amount in bottoms

C and D are between the light and heavy keys and will be distributed between the distillate and bottoms

E is the heavy key and will have a small (but not negligible) amount in distillate