Unite Operation

Sheet NO. (1)

Q1/ F = 400 kg — acetic acid, isopropyl ether

$X_0 = 25\%$

① S = 400 kg, co-current, N = 1, % precent of extraction = ?

$x_n = c_1 \left(\frac{1}{1+A}\right)^n$

B.C.1 $n = 0$, $x_n = x_0$

$x_0 = c_1 \left(\frac{1}{1+A}\right)^0 \rightarrow x_0 = c_1$

B.C.2 $n = N$, $x_0 = x_N$

$X_N = x_0 \left(\frac{1}{1+A}\right)^N$ —— eq1

$X_0 = \frac{x_0}{1 - x_0} = \frac{0.25}{1 - 0.25} = 0.333$ kgB/kgA

$F = F(1 - x_0) \rightarrow F = 400(1 - 0.25) = 300$ kg

$A = \frac{mS}{F} = \frac{1.5 * 400}{300} = 2$

$\frac{X_N}{X_0} = \left(\frac{1}{1+2}\right)^1 \rightarrow \frac{X_N}{0.333} = \frac{1}{3} \rightarrow X_N = 0.111$

$\% = \frac{X_0 - X_N}{X_0} = \frac{0.333 - 0.111}{0.333} * 100$

$= 66.67\%$ Ans

موضوع الدرس:

التاريخ / /

(B) $x_0 = 0.333$ $N = 4$ stage

$F = 300$ kg % extraction = ?

$S = 100$ kg $N = 4$ So $x_N = x_4$

$Y = 1.5x$

$$\frac{x_N}{x_0} = \left(\frac{1}{1+A}\right)^N \qquad A = \frac{mS}{F} = \frac{1.5 \times 100}{300} = 0.5$$

$$\frac{x_4}{0.333} = \left(\frac{1}{1+0.5}\right)^4 = \frac{x_4}{0.333} = 0.1975 \rightarrow x_4 = 0.0657$$

overall extraction =

$$\% = \frac{x_0 - x_4}{x_0} = \frac{0.333 - 0.0657}{0.333} = \%\ 80.27$$

Ans.

(2) $F = 1000$ kg/hr (S) not fresh Co-Current Find extract flowrate

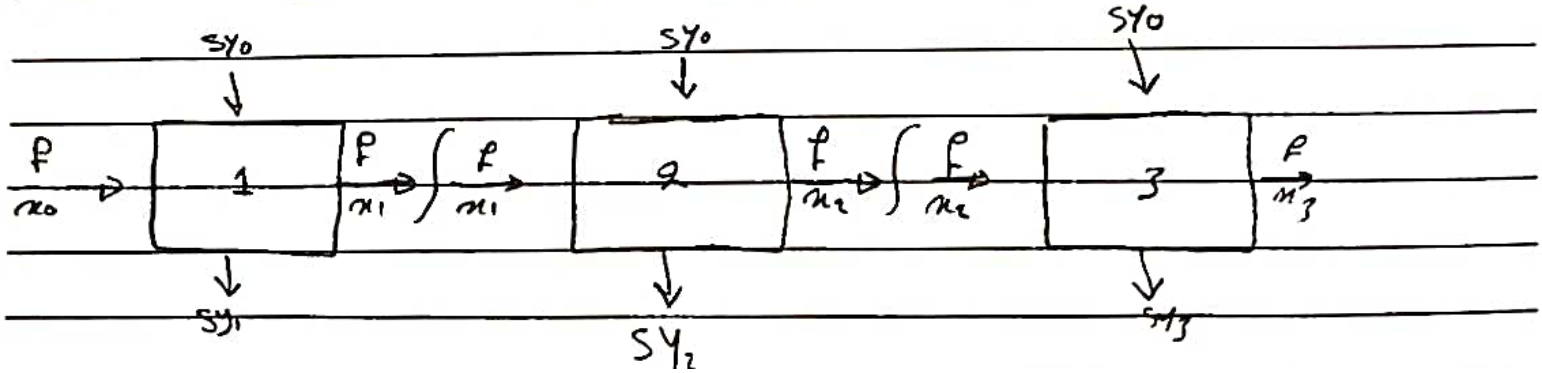
$x_0 = 28.6\%$ $y_0 = 4.75\%$ $y = 0.8x$

$x_N = 9.1\%$ $N = 3$ stage

$$X_0 = \frac{x_0}{1-x_0} = \frac{0.286}{1-0.286} = 0.4005 \text{ kgB/kgA}$$

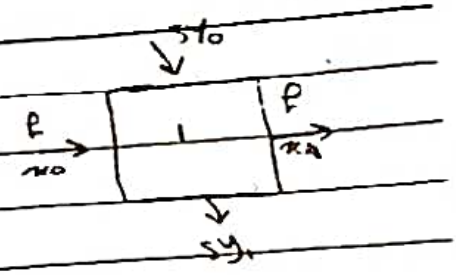
$$X_3 = X_N = \frac{x_N}{1-x_N} = \frac{0.091}{1-0.091} = 0.1001 \text{ kgB/kgA}$$

$$Y_0 = \frac{y_0}{1-y_0} = \frac{0.0475}{1-0.0475} = 0.0498 \text{ kgB/kgS}$$



التاريخ / /

M.B on each stage (stage 1)



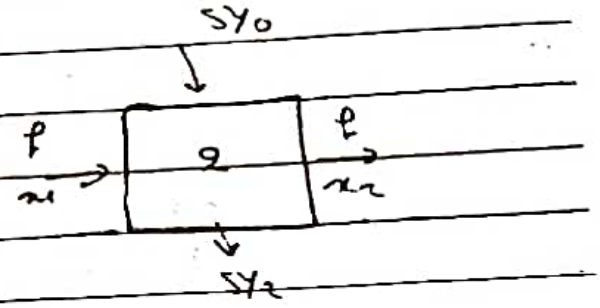
in = out put

$F x_0 + S y_0 = F x_1 + S y_1$

$F(x_0 - x_1) = S(y_1 - y_0)$

$\frac{F}{S} = \frac{y_1 - y_0}{x_0 - x_1}$ ---- eq1

M.B on stage 2:



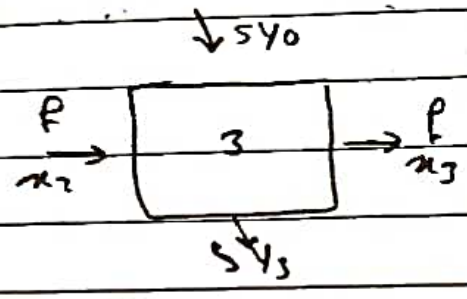
input = out put

$F x_1 + S y_0 = F x_2 + S y_2$

$F(x_1 - x_2) = S(y_2 - y_0)$

$\frac{F}{S} = \frac{y_2 - y_0}{x_1 - x_2}$ ---- eq2

M.B on stag 3:



input = out put

$F x_2 + S y_0 = F x_3 + S y_3$

$F(x_2 - x_3) = S(y_3 - y_0)$

$\frac{F}{S} = \frac{y_3 - y_0}{y_2 - x_3}$ ---- eq3

Trail and error.

assume initial value of $\frac{F}{S} = 0.5$ $\quad y_1 = \alpha \cdot 8 x_1$

from eq(1)

$\frac{F}{S} = \frac{y_1 - y_0}{x_0 - x_1}$

$0.5 = \frac{0.8x_1 - 0.0498}{0.4005 - x_1} \rightarrow 0.2002 - 0.5x_1 = 0.8x_1 - 0.0498$

$0.25 = 1.3x_1 \rightarrow x_1 = \frac{0.25}{1.3} = 0.1923$ kg B/kg A

موضوع الدرس:

التاريخ / /

From eq(2) $\frac{P}{S} = \frac{Y_2 - Y_0}{X_1 - X_2}$ $Y_2 = 0.8 X_2$

$0.5 = \frac{0.8 X_2 - 0.0498}{0.1963 - X_2}$

$0.09615 - 0.5 X_2 = 0.8 X_2 - 0.0498 \rightarrow 0.1459 = 1.3 X_2$

$X_2 = \frac{0.1459}{1.3} = 0.1122$ kgB/kgA

From eq(3) $\frac{P}{S} = \frac{Y_3 - Y_0}{X_2 - X_3}$ $Y_3 = 0.8 X_3$

$0.5 = \frac{0.8 X_3 - 0.0498}{0.1122 - X_3}$

$0.0561 - 0.5 X_3 = 0.8 X_3 - 0.0498 \rightarrow 0.1059 = 1.3 X_3$

$X_3 = 0.08146$ kgB/kgA

error = 0.1001 − 0.0814 = 0.0187

Second Trial $\left[\frac{P}{S} = 0.75\right]$ assum

eq1 $\frac{P}{S} = \frac{Y_1 - Y_0}{X_0 - X_1} \rightarrow 0.75 = \frac{0.8 X_1 - 0.0498}{0.1005 - X_1}$

$0.3003 - 0.75 X_1 = 0.8 X_1 - 0.0498 \rightarrow 0.3501 = 1.55 X_1$

$X_1 = 0.2258$ kgB/kgA

eq2 $\frac{P}{S} = \frac{Y_2 - Y_0}{X_1 - X_2} \rightarrow 0.75 = \frac{0.8 X_2 - 0.0498}{0.2258 - X_2}$ $Y_2 = 0.8 X_2$

$0.1693 - 0.75 X_2 = 0.8 X_2 - 0.0498 \rightarrow 0.2191 = 1.55 X_2$

$X_2 = 0.1413$ kgB/kgA

eq3: $\frac{P}{S} = \frac{Y_3 - Y_0}{x_2 - x_3} \rightarrow 0.75 = \frac{0.8X_3 - 0.0498}{0.1413 - X_3}$ $Y_3 = 0.8 X_3$

$0.1059 - 0.75X_3 = 0.8X_3 - 0.0498 \rightarrow 0.1557 = 1.55x_3$

$x_3 = 0.1005$ ✓

error: $0.1001 - 0.1005 = 0.0004$

So $\frac{P}{S} = 0.75$

$P = F(1 - X_0) = 1000(1 - 0.286) = 714$ kg/hr

$S = \frac{P}{0.75} = \frac{714}{0.75} = 952$ kg/hr

$Y_3 = 0.8x_3 \rightarrow Y_3 = 0.8 * 0.1001 = 0.080$ kgB/kgA

Three stage so $(3*S)$

$S = 3 * (952) = 2856$ kg/hr

$E_3 = S(1 - Y_3) =$
$= 2856(1 - 0.080) = 3084.48$ kg/hr ✓
$E_3 \cdot Y_3 = 3084.48(0.080) = 246.75$ kg/hr. ✓

Q3/ Counter current $X_0 = 0.20$ $\frac{S}{F} = 1.45$

$X_N = X_0(1-0.95)$ $N = ?$

a/ $Y = 1.5X$

$$A = \frac{L}{Sm} = \frac{1}{1.45 \times 1.5} = 0.459$$

$$X_N = 0.20(1-0.95) = 0.01$$

$$X_0 = \frac{X_0}{1+X_0} = \frac{0.20}{1-0.20} = 0.25$$

$$X_N = \frac{0.01}{1-0.01} = 0.01$$

General Solution

$$X_n = C_1 + C_2 A^n$$

$n = 0$

$X_0 = C_1 + C_2$

$C_1 + C_2 = 0.25$

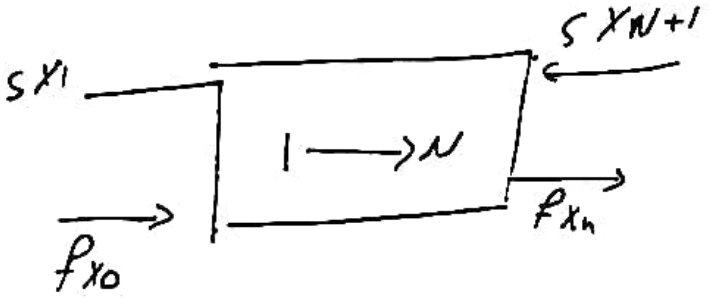
$n = 1$

$X_1 = C_1 + C_2\ 0.459$

$Y_1 = mX_1$

$X_1 = \frac{Y_1}{m}$

to find X_1 do a overall MB



$F X_0 + S Y_{N+1} = F X_N + S Y_1$

$$\frac{F}{S} = \frac{Y_1 - Y_{N+1}}{X_0 - X_N}$$

$$\frac{1}{1.45} = \frac{Y_1}{0.25 - 0.01}$$

$Y_1 = 0.1655$ $X_1 = 0.1103$

$C_1 + C_2 = 0.25$

$0.1103 = C_1 + C_2\, 0.459$

$C_1 = 0.25 - C_2$

$0.1103 = 0.25 - C_2 + 0.459\, C_2$

$$C_2 = \frac{-0.1397}{-0.541} = 0.258$$

$C_1 = 0.25 - 0.258 = -0.008$

$$N = \frac{\log \frac{X_N - C_1}{C_2}}{\log \alpha} = \frac{\log\left(\frac{0.01 + 0.008}{0.258}\right)}{\log 0.459} = \frac{-1.156}{-0.338}$$

$N = 3.42 \simeq 3$

B/ $Y = 1.5X$ لێرەدا سەیری یەکەکان هاوکێشەی لادی بە ماس فراکشن

دەمە ئەوان بە Ratio بۆیە دەبێ بیکەینە Ratio

تا بگۆڕدرێ

$Y = \frac{y}{1-y} \rightarrow Y(1-y) = y \rightarrow Y - Yy = y \rightarrow Y = y + Yy$

$Y = y(1+Y) \rightarrow \boxed{\frac{Y}{1+Y} = y}$

$X = \frac{x}{1-x} \rightarrow X(1-x) = x \rightarrow X - Xx = x \rightarrow X = x + Xx$

$X = x(1+X) \rightarrow \boxed{x = \frac{X}{1+X}}$

$\frac{Y}{1+Y} = 1.5 \frac{X}{1+X}$ ئەمە linear نیە بۆیە وتنە

ماددەم Counter Current وتبێ

X_0 مەعلوم مەرجە داتا وەربگرە بەبینی

X	Y
0.01	0.015
0.06	0.0927
یا ئەمە 0.11 → 0.~~016~~	0.174
~~0.16~~ 0.16	0.254
0.21	0.351
0.26	0.448

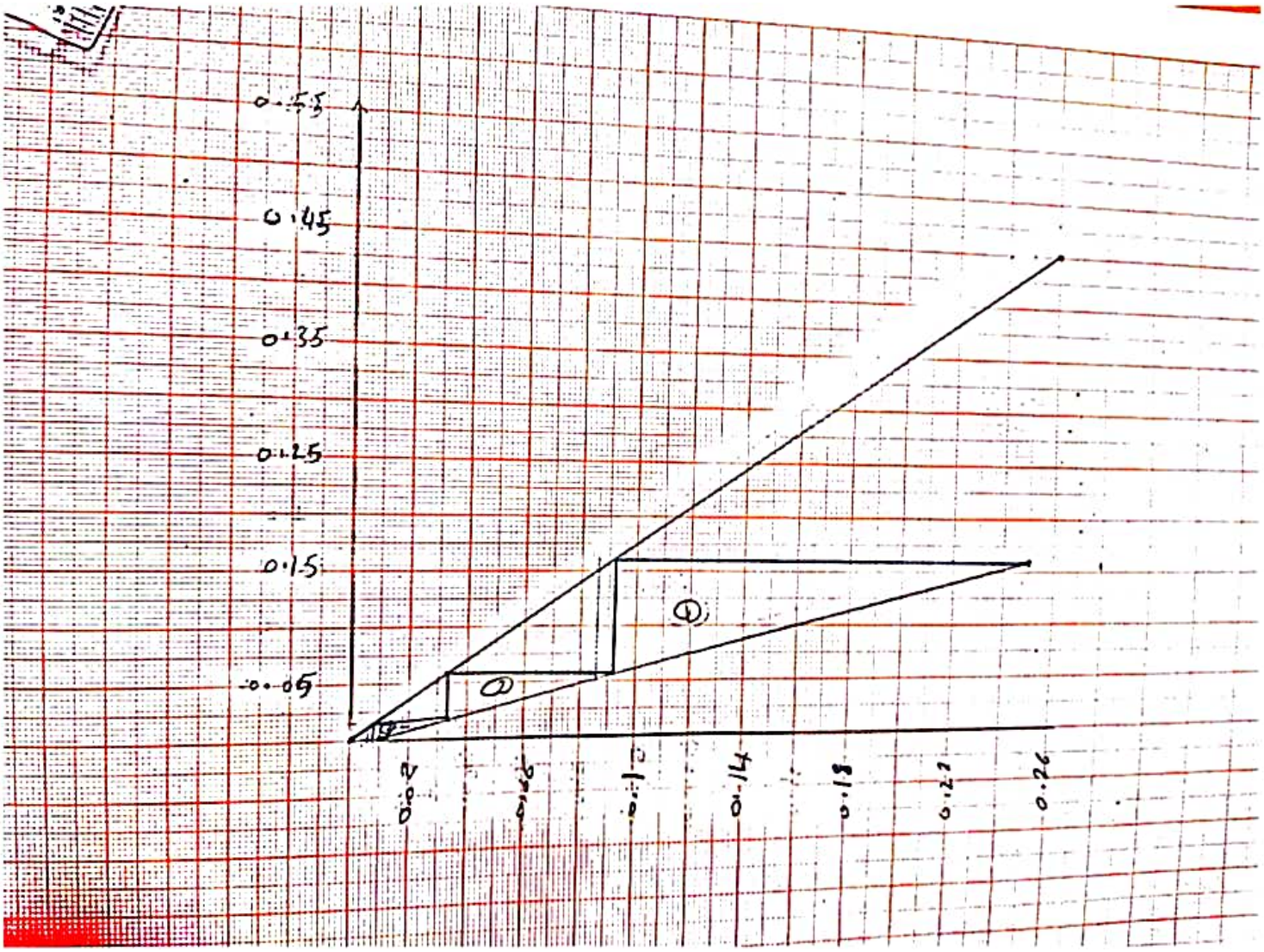
T.B لەوەیە بتوانی بنوسی $\frac{X}{1+X}$
و حسابات نەکەی زۆر وەک
ئەوەی ئیستا نەکەین

حسابات ادنه

$$\frac{Y}{1+Y} = 1.5 \; \frac{0.01}{1+0.01} \rightarrow \frac{Y}{1+Y} = 0.01485 \rightarrow Y = 0.01485 + 0.01485Y$$

$$Y - 0.01485Y = 0.01485 \quad \Rightarrow 0.015$$

draw the graph and determine N. of stages


0.55
0.45
0.35
0.25
0.15
0.05
0.14
0.18
0.22
0.26
①
②