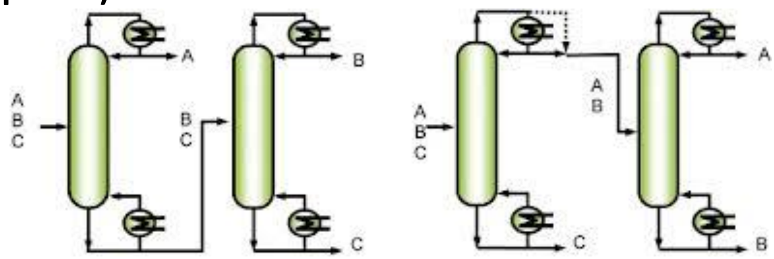
CHE 4253

Chemical Engineering Process Design and Safety, Fall 2018

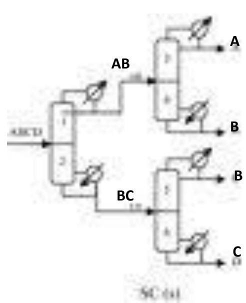
QUIZ # 7-Part II

(25 minutes)

1) **Show all possible distillation sequences to separate a mixture of 3 components. (30 points)**



THERE IS A 3rd solution that some students showed.



2) Consider the following data: 45 points

DATA
$\widehat{Q_v} = 0.13\ m^3/s$
$\widehat{Q_l} = 0.002\ m^3/s$
$\widehat{\rho_l} = 1100\ kg/m^3$
$\widehat{\rho_v} = 1.1\ kg/m^3$
$\widehat{D_d}$ =200 μm
$\widehat{\mu_v} = 1.8\ 10^{-5}$ Pa sec
$\hat{\sigma}$ = 35 mN/m
$\hat{t}_s = 600\ s$
$\hat{P} = 30\ psig$
$\hat{S} = 17500\ psi$
$\hat{E} = 1$

Obtain the flash diameter and height

Equations

$$v_{perm} = K\sqrt{\frac{(\rho_L-\rho_V)}{\rho_V}} \quad K=\sqrt{\frac{8gR_d}{3C_D}} \quad C_D=\frac{F_D}{\frac{1}{2}\rho_V A v_d^2}=f_c(\mathrm{Re}) \quad K=\sqrt{\frac{8gR_d}{3f_c(\mathrm{Re})}} \quad h_L=\frac{V_{pool}}{\pi D^2/4}$$

$$F_{vis}=6\pi\mu R_d v_d \quad F_{drag}=C_D\frac{1}{2}A\rho_V v_d^2$$

$A=-1.877478$
$B=-0.814580$
$C=-0.187074$
$D=-0.014523$
$E=-0.001015$

$$F=L+V$$
$$Fz_i=Lx_i+Vy_i$$
$$y_i=K_ix_i$$
$$\sum_i x_i=1$$
$$\sum_i y_i=1$$
$$\begin{cases} x_i=\dfrac{z_i}{\left[1+V/F(K_i-1)\right]} \\ y_i=\dfrac{K_iz_i}{\left[1+V/F(K_i-1)\right]}\end{cases}$$

$$D=\sqrt{\frac{4}{\pi}A}=\sqrt{\frac{4}{\pi}\frac{\hat{Q}_v}{v_{perm}}}$$ **(fixed!)**

$$F_g=(\rho_L-\rho_V)g\frac{4}{3}\pi R_d^3$$

$$F_{lv}=\frac{W_L}{W_V}\sqrt{\frac{\rho_V}{\rho_L}}$$ **(fixed!)**

$$K=e^{A+B\ln F_{lv}+C(\ln F_{lv})^2+d(\ln F_{lv})^3+E(\ln F_{lv})^4} \quad \frac{L}{D}< \text{??} \quad h_V=36''+\frac{1}{2}\textit{diameter of feedline}$$

$$h_f=12''+\frac{1}{2}\textit{diameter of feedline} \quad H=h_V+h_f+h_L \quad h_L=\frac{V_{pool}}{\pi D^2/4} \quad U_{N,f}=C_{SB}\left(\frac{\rho_L-\rho_V}{\rho_V}\right)^{0.5}\left(\frac{\sigma_L}{20}\right)^{0.2}$$

$$(u_{max})_{nozzle}=100/\sqrt{\rho_{mix}},\ \text{ft./sec.}$$
$$(u_{min})_{nozzle}=60\sqrt{\rho_{mix}},\ \text{ft./sec.}$$

$$\log 10(C_{SB})=-0.94506-0.70234\log 10(F_{LV})-0.22618\left[\log 10(F_{LV})\right]^2$$

$$\hat{t}_s=V_{pool}/\hat{Q}_L=\left[\frac{\pi D^2}{4}h_L\right]\Big/\hat{Q}_L \Rightarrow h_L=\hat{Q}_L\hat{t}_s\Big/\left[\frac{\pi D^2}{4}\right]$$

Sequence of equations to use:

1) $F_{lv}=\frac{W_L}{W_V}\sqrt{\frac{\rho_L}{\rho_V}}$ **2)** $K=e^{A+B\ln F_{lv}+C(\ln F_{lv})^2+d(\ln F_{lv})^3+E(\ln F_{lv})^4}$ **3)** $v_{perm}=K\sqrt{\frac{(\rho_L-\rho_V)}{\rho_V}}$ **4)** $D=\sqrt{\frac{4}{\pi}A}=\sqrt{\frac{4}{\pi}\frac{\hat{Q}_v}{v_{perm}}}$

5) $\rho_{mix}=\frac{(\hat{Q}_v\hat{\rho}_v+\hat{Q}_l\hat{\rho}_l)}{(\hat{Q}_v+\hat{Q}_l)}$ **6)** $v_{\max nozzle}=100\sqrt{\rho_{mix}}$ **7)** $v_{\min nozzle}=60\sqrt{\rho_{mix}}$ **8)** $v_{avg\ nozzle}=\frac{(v_{\max nozzle}+v_{\min nozzle})}{2}$

8) Area of Nozzle: $=(\hat{Q}_v+\hat{Q}_l)\Big/v_{avg\ nozzle}$ **9)** $d_{nozzle}=\sqrt{\frac{4}{\pi}\textit{Area of nozzle}}$ **10)** $h_f=12''+\frac{1}{2}\textit{diameter of feedline}$

11) $h_V=36''+\frac{1}{2}\textit{diameter of feedline}$ **12)** $h_L=\hat{Q}_L\hat{t}_s\Big/\left[\frac{\pi D^2}{4}\right]$ **13)** $H=h_V+h_f+h_L$

Comments about H/D are not needed, because it is not asked.