Josh Whitehead
ChEn 5103

HW9

1) $f(C_{LA}) = \frac{K_{1A} C_{LA}}{K_{2A} + C_{LA}}$ $\quad f(C_{LB}) = \frac{K_{1B} C_{LB}}{K_{2B} + C_{LB}}$

$K_{1A} = 0.2 \frac{mg\ A}{mg\ adsorb}$ $\quad K_2 A = 0.1 \frac{mg\ A}{mL\ liq}$

$K_{1B} = 0.05$ $\quad K_{2B} = 0.02$

$M = \frac{3000}{150} = 20 \frac{mg}{mL}$

$\varepsilon = 0.35$

$A = 6\ cm^2$ $\quad C_{LA} = 0.1 \frac{mg}{mL}$

- assume equil mix: $C_{LA} = C_{LB}$

$\Delta x = \frac{\Delta V}{A(\varepsilon + M f')}$

$f'(C_{LA}) = \frac{K_{1A} K_{2A}}{(K_{2A} + C_{LA})^2}$ $\quad f'(C_{LB}) = \frac{K_{1B} K_{2B}}{(K_{2B} + C_{LB})^2}$

$\boxed{\therefore \Delta x_A = 0.81\ cm, \quad \Delta x_B = 4.79\ cm}$

@ $C_L = 0.05 \frac{mg}{mL}$

$\boxed{\Delta x_A = 0.46\ cm, \quad \Delta x_B = 1.88\ cm}$

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2) a) $Y_{\Delta t} = \frac{1}{2}\left[\operatorname{erf}\left(\frac{t_2 - t_{max}}{\sqrt{2}\,(\theta_{t_{max}})}\right) + 1\right]$

$\rightarrow t_2 = (\theta \cdot t_{max})(\sqrt{2})\,\text{inverf}(2Y-1) + t_{max}$

$\theta \cdot t_{max} = 14$ min

$Y = 0.9$

$t_{max} = 100$ min

$\boxed{t_2 = 118.\ \text{min}}$

b.) $\frac{\theta_1}{\theta_2} = \frac{\sqrt{v_1}}{\sqrt{v_2}} \longrightarrow \theta_2 = \frac{\theta_1 \sqrt{v_2}}{\sqrt{v_1}}$

$\theta_1 = \frac{\theta \cdot t_{max}}{t_{max}} = \frac{14}{100} = 0.14$

$v_2 = \frac{60}{60} = 1\ \frac{cm}{min}$

$v_1 = \frac{40}{60} = 0.667\ \frac{cm}{min}$

$\boxed{\therefore\ \theta_2 = 0.171}$

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2) c) $\underbrace{\text{if } l = 60 \text{ cm} \quad v = 1 \frac{\text{cm}}{\text{min}}}_{\text{new}}$ $\qquad$ $\underbrace{l = 40 \text{ cm} \quad v = \frac{2}{3} \frac{\text{cm}}{\text{min}}}_{\text{old}}$

~~case~~ Internal diffusion Control!

$\sigma_1^2 \approx \frac{v_1 d_1^2}{l_1}$ $\qquad$ $\sigma_2^2 \approx \frac{v_2 d_2^2}{l_2}$ $\qquad$ $d_1 = d_2$

$$\frac{\sigma_1}{\sigma_2} = \frac{\sqrt{v_1}\, d_1}{\sqrt{l_1}} \cdot \frac{\sqrt{l_2}}{\sqrt{v_2}\, d_2} = \frac{\sqrt{\frac{2}{3} \cdot 60}}{\sqrt{1 \cdot 40}} = 1$$

$\frac{\sigma_1}{\sigma_2} = 1 \quad \therefore \sigma_1 = \sigma_2$ and

σ_1 is the same as σ_2 because even though the column length was increased, the superficial velocity also increased

~~The standard deviation is the same so t_{max} should be the same.~~

~~The width of the peak is $2\sigma_i t_{max}$. If $\sigma_1 = \sigma_2$ and t_{max} doesn't change then~~

t_{max} should be about the same because it is going faster but the column is longer so it should take the same amount of time to elute.

The width of the peak is $2\sigma_i t_{max}$. Since $\sigma_1 = \sigma_2$ and t_{max} doesn't change, the width of the peak won't change