New Problems Chapter 21

21.1-5. ***More Conversions of Mass Transfer Coefficients.*** From experimental results, $k_c' = 8.5\times10^{-4}\,\frac{m}{s}$ for the gas phase. If the total pressure is 2 atm, the temperature is 40°C and $y_{A1} = 0.1$ and $y_{A2} = 0.5$ calculate the following:

a) k_G

b) k_y

c) k_y'

21.2-2. ***Dimensional Analysis in Mass Transfer.*** A fluid is flowing in a vertical pipe and mass transfer is occurring from the pipe wall to the fluid. Relate the convective mass-transfer coefficient k_c' to the variables $D, \rho, \mu, \upsilon, D_{AB}$, where *D* is the pipe diameter. Choose k_c', ν and ρ as your core variables.

21.3-10. ***Mass Transfer of Liquids in Packed Beds.*** Pure Pure H_20 is flowing at a rate of 0.0701 ft_3/hr through a packed bed of 2in diameter benzoic acid spheres that are contained in a 0.5 ft diameter tube that is 5ft long and has a porosity (□) of 0.4. The solubility of benzoic acid is $0.00184\frac{lbmole - Benzoic}{ft^3 - solution}$. Calculate the mass – transfer coefficient $\left(k_c'\right)$ for this situation in the units of ft_2/s.

Tube holding spheres is 0.5 in diameter by 5ft long

Physical Property Data:

Water (l): $\rho = 62.4\frac{lb}{ft^3}$, $\mu = 6.72\times10^{-4}\frac{lb}{ft\cdot s}$, Cp=4.18$\frac{kJ}{kg\cdot K}$

Benzoic Acid (s): $\rho = 79\frac{lb}{ft^3}$, Cp=3.18$\frac{kJ}{kg\cdot K}$

$D_{AB} = 2.1\times10^{-5}\frac{cm^2}{s}$

$N_{Sh} = \frac{k_c'd}{D_{AB}}$, $N_{Re} = \frac{\rho\nu d}{\mu}$, $N_{Sc} = \frac{\mu}{\rho D_{AB}}$, $J_D = \frac{N_{Sh}}{N_{Re}N_{Sc}^{\frac{1}{3}}}$

21.4-3. ***Mass Transfer of Droplets.*** Pure carbon tetrachloride (CCl_4, MW = 153.82) droplets are rising in an unstirred water solution. The velocity of the carbon tetrachloride droplets is 1.0 m/s at 298 K and 1 atm and their diameter is 0.1cm. The solubility of carbon tetrachloride at 298 K in water is 0.081g/100mL and D_{AB} = 8.836 x 10_{-6} cm_2/s. Assume the viscosity and density of water at 298 K and 1 atm is 1.0 cp and 1.0 g/cm_3 respectively. What is the flux of carbon tetrachloride dissolving in the water? Both H_2O and CCl_4 are liquid phase and solution is dilute so $k_c' \approx k_c$. Use the following correlation: $\frac{k_c'D}{D_{AB}} = 1.13\left(\frac{D\nu}{D_{AB}}\right)^{0.8}$ where D is the drop diameter.

21.5-2. ***Mass Transfer using Penetration Theory.*** Pure water is flowing past a flat plate of solid naphthalene with a diffusivity of $D_{AB} = 7.5 \times 10^{-6} \frac{cm^2}{s}$ and a penetration time of 60s. What is the flux of naphthalene if the solubility is 31.4 mg/L?