CHE 305 – Separation Processes
Spring 2010 – Quiz 7

A 20 wt% ethanolamine solution in water is used to absorb hydrogen sulfide (H_2S) from a natural gas (CH_4) stream. The feed natural gas has an H_2S concentration of 50 g/m^3. The exit gas stream must contain a maximum of 3 g H_2S/m^3. The volumetric flow rate of the gas stream is 1,000 m^3/hr, and the stream is fed at 25 ^{o}C and 3 bar. A spray tower is used to contact the two streams, with an average ethanolamine/water droplet size of 1 mm diameter. The feed liquid stream contains no H_2S. Assume that each droplet is well mixed (penetration theory) and that the H_2S concentration in each phase is a linear function of the column height. **(HINT: Where is the mass transfer taking place?)**

Given:

- **Column Diameter = 1 m**
- **$D_{H2S\text{-}CH4}$ (25 ^{o}C, 3 bar) = 0.4 cm^2/s**
- **$D_{H2S\text{-}Ethanolamine/Water}$ (25 ^{o}C) = 1x10^{-5} cm^2/s**
- **μ_{gas} = 1.1 g/m s**
- **μ_{liquid} = 200 g/m s**
- **Liquid density = 1 g/cm^3**
- **R = 0.08314 L bar/mol K**

Useful Equations:

$$\mathrm{Re} = \frac{Du\rho}{\mu} \qquad Sc = \frac{\mu}{\rho D_{AB}} \qquad Sh = 1.13\mathrm{Re}^{1/2}\,Sc^{1/2} \qquad Sh = \frac{k_c D_{Drop}}{D_{AB}}$$

a. Determine the Reynolds number.

b. Determine the Schmidt number.

c. Determine the Sherwood number.

d. Determine k_c.