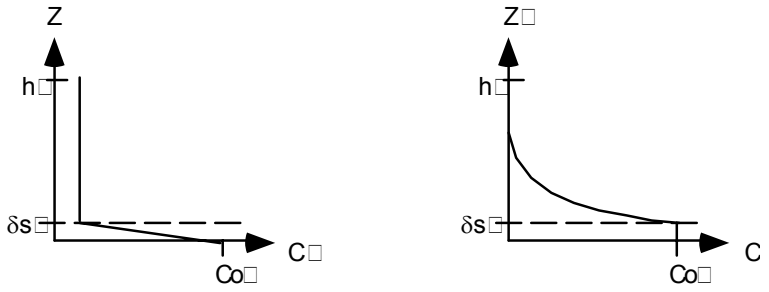
1.061 / 1.61 Transport Processes in the Environment
Fall 2008

1.061/1.61: Homework # 8 [10 pt total]

Problem 1 [4pts]: Consider a river channel of depth h = 1m and mean flow speed U = 1 m/s. The bed is a source chemical through dissolution. The equilibrium concentration is C_O. Which concentration profile would you expect to see in the channel. Defend your answer with clearly stated scaling arguments. The kinematic viscosity is $\nu = 10^{-6} m^2 s^{-1}$, and a typical molecular diffusion would be $10^{-9} m^2 s^{-1}$.



Problem 2[6 pts]: A container filled with water is h = 40-cm high and has a base area of 100 cm^2. At t = 0 a lid is placed on the container. The lid is filled with solid $CaS0_4$ and fits snuggly to the water surface. The water in the container is stirred gently, such that the laminar sub-layer is $\delta_s = 0.1$ cm at every surface. Outside the laminar sub-layer the diffusivity of all substances is $D_t = 0.01\ cm^2 s^{-1}$. Estimate the total of calcium [in grams] in the water column at t = 6 hours. The molecular diffusivity of Ca^{++} in water is $D_m = 8 \times 10^{-10} m^2 s^{-1}$. The solubility product for $CaSO_4$ is

$$K_{SP} = \frac{\left[Ca^{++}\right]\left[SO_4^{--}\right]}{\left[CaSO_{4(S)}\right]} = 230 \frac{mol^2}{m^6}$$

a) Write an expression for the calcium concentration, C(z), in the water at t = 6 hrs. **Beware**: you must account for the no-flux boundary at the bottom of the container.

b) Find the total mass of calcium in the water at t = 1 hr.