Homework #4

Due: June 02 (Tue) 23:59

1. Derive the overall mass transfer coefficient with gas phase as a reference, K_G, for air-water interface as a function of k_L, k_G, and H_{cc}. Recall that the overall mass transfer coefficient with liquid phase as a reference is given as

$$K_L = \frac{k_L k_G H_{cc}}{k_L + k_G H_{cc}}$$ (L32 lecture note slide 8)

Derive the relationship between K_L and K_G.
(30 points)

2. The K_La value for oxygen in an aerobic bioreactor is determined to be 5.0 hr^{-1}. What would be the K_La value for nitrous oxide (N_2O), a greenhouse gas that may be produced by biological reactions, in the bioreactor? Use the following data and assumptions.

* H_{cc} (oxygen) = 30; H_{cc} (nitrous oxide) = 1.7
* Surface renewal theory applies to the gas-liquid mass transfer.
* $k_G/k_L \fallingdotseq 100$.
* Less than 5% error is negligible.
* Diffusion coefficient in water, D_{aq}
  D_{aq} (oxygen) = 2.0×10^{-9} m^2/s; D_{aq} (nitrous oxide) = 1.6×10^{-9} m^2/s

(20 points)