Homework #2

Due: April 21, 2016 (Tue), in class

1. Determine the pH of a buffer prepared by dissolving 5×10^{-4} M NaAc and 5×10^{-4} M HAc in pure water using i) numerical calculation method and ii) graphical method (pH-pC diagram).

(25 points)

2. The current atmospheric partial pressure of CO_2 is around $10^{-3.5}$ atm, and you have seen that the rainwater pH at this condition is approximately 5.6 assuming equilibrium. According to the Intergovernmental Panel on Climate Change (IPCC), the 2100 atmospheric CO_2 concentration is predicted to be 1000 ppm ($=10^{-3.0}$ atm) applying the worst case scenario. Estimate the rainwater pH in equilibrium with 1000 ppm CO_2 in the atmosphere. Use the graphical method (pH-pC diagram) for estimation.
(K_H for CO_2 = $10^{-1.5}$ M/atm)

(15 points)

3. Describe the difference in the cell wall of the Gram positive [G(+)] and Gram negative [G(-)] bacteria.

(10 points)

4. Classify the following bacterium species by carbon sources, energy sources, and growth in the presence/absence of O_2.

- *Acidithiobacillus ferrooxidans*
- *Escherichia coli*
- *Nitrobacter vulgaris*

(15 points)

5. Mathematically derive the steady state solutions (in the form of $C = f(C_0, k, \tau)$) for PFR and CSTR when a substance is degraded in the reactors by a chemical reaction described by 2nd order reaction rate. For an influent concentration of 10 mg/L and a second order reaction rate constant of 3 L/mg/d, compare the effluent concentrations of the steady state PFR and CSTR at a hydraulic retention time (HRT) range of 0 to 1 day.

   Note: compare the effluent concentrations of PFR and CSTR by plotting the concentrations against HRT. In other words, x-axis: HRT, y-axis: effluent concentrations of PFR and CSTR.

(25 points)

6. Read the following article discussing the ecology of *Vibrio cholerae* and briefly summarize the article. (in less than 0.5 page, strictly monitored for plagiarism).

   Cottingham, K.L.; Chiavelli, D.A.; Taylor R. K. Environmental microbe and human pathogen: the ecology and microbiology of *Vibrio cholerae*. *Frontiers in Ecology and the Environment*. Vol. 1, No. 2, 80-86, 2003.

   link:

   http://onlinelibrary.wiley.com/doi/10.1890/1540-9295(2003)001%5B0080:EMAHPT%5D2.0.CO;2/abstract

(10 points)