Study Problems for Midterm 3/Final Exam

CENG 340–Introduction to Environmental Engineering

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1. **Wastewater Treatment**
   An activated sludge, or conventional wastewater treatment, plant is operated at steady state to treat domestic sewage. The aeration basin has a volume of 1000 m^3. The concentration of volatile suspended solids in the aeration tank (MLVSS) is 4000 mg/L. The mass of solids wasted per day is 1000 kg. Kinetic coefficients for the biological treatment reactor are $K_s = 20\ \frac{mg\ BOD_u}{L}$, $\mu_{max} = 0.8\ day^{-1}$, and $k_d = 0.1\ day^{-1}$. Determine the effluent soluble BOD_u *Answer: S = 15.6 mg/L*

2. **Wastewater Treatment**

   (a) Assume that the flow rate to a wastewater treatment plant is 10^7 liters/day, and that the BOD_u concentration going into secondary treatment is 150 mg/L.

   If the aeration basin (CMFR) is 2.5×10^6 L, at what concentration must the microorganims, or mixed liquor volatile solids (MLVSS), be maintained to have a food to microorganism ratio of 0.25 $day\frac{kg\ BOD_u}{kg\ VSS \bullet day}$? *answer: X = 2400 mg/L*

   (b) At steady state, the *net* rate of biomass (MLVSS) growth is wasted (neglecting loss of solids in the secondary-clarifier effluent). If the daily biomass wasting rate is one-eighth $\left(\frac{1}{8}\right)$ of the total biomass in the system, what is the effluent BOD_u concentration? Use the following kinetic coefficients, and note that part (b) may be solved independently from your answer to part (a):

   $\mu_{max} = 0.3\ day^{-1}$

   $K_s = 15$ mg/L

   $k_d = 0.1\ day^{-1}$

   answer: S = 45 mg/L

   (c) Ignoring solids lost to the effluent, what will be the mass of solids (VSS) wasted per day? Assume that the parameters calculate in parts (a) and (b) apply to part (c). *answer: 750 kg VSS*

3. **BOD Test** A waste of composition $C_{10}H_{19}O_3N$ (molecular weight=201 g/mole) has been evaluated in a BOD test. 15 mL of full-strength waste (conc. = 100.5 mg/L of $C_{10}H_{19}O_3N$) with a dissolved oxygen concentration of 2 mg/L is diluted to a total volume of 300 mL with dilution water containing 9 mg/L dissolved oxygen and zero BOD_u. After 5 days the dissolved oxygen concentration

in the bottle is 3 mg/L. Assuming that, given enough time, the waste is 80% biodegradable, what is the rate constant, k, for the BOD use by the test bacteria. *answer: $k = 0.245\ day^{-1}$*

4. **Reactor Modeling** A small, well-mixed pond has been contaminated with 10 mg/L of a toxic chemical. The chemical is conservative and the volume of the pond is 2500 m^3. To rid the pond of contaminant it was decided to flush *clean* water through the pond at a rate of 400 $\frac{m^3}{day}$. Determine how long it will take to reduce the chemical concentration to 5% of its original value. *answer: 18.72 days*