ENV 4417: WATER QUALITY & TREATMENT

Fall 2015 University of South Florida
Problem set #6 Civil & Environmental Eng.
Due Tuesday, Nov. 10 Prof. J. A. Cunningham

1. (50 pts) Choose any five of the following problems in your text book (10 points each): 12.46, 12.49, 12.50 (not the clarifiers), 12.51 (not the clarifiers), 12.59 (use $\mu_{max} = 1.3\ d^{-1}$ rather than the value given), 12.60, 12.62.

2. (25 pts) *Based on a problem from Water and Wastewater Engineering: Design, Principles, and Practice, by Mackenzie L Davis*
   The town of Cape Verde has been directed to upgrade its primary WWTP to a secondary plant that can meet an effluent standard of 25.0 mg/L BOD_5 and 30 mg/L suspended solids. They have selected a completely mixed activated sludge system for the upgrade.
   - The existing primary treatment plant has a flow rate of 2,506 m^3/d.
   - The effluent from the primary tank has a BOD_5 of 240 mg/L. Half of that BOD_5 is soluble and half is from suspended matter.
   - The BOD_5 concentration (in mg/L) of effluent suspended solids is 70% of the suspended solids concentration (in mg/L).
   - Monod parameters are estimated to be: K_S = 100 mg/L BOD_5; $k_d = 0.025\ d^{-1}$; $\mu_{max} = 10\ d^{-1}$; Y = 0.8 mg VSS per mg BOD_5 removed.
   - The design MLVSS is 3,000 mg/L.

   a) Estimate the required mean cell residence time (d). Is it in the range you would expect?
   b) Estimate the required average hydraulic residence time (hr) and the volume of the aeration tank. Hint: you can use a material balance for soluble BOD_5, using the entire secondary treatment process as the control volume; or, you can use a formula that comes from that material balance. Is the aeration time in the range you would expect?
   c) Estimate the food-to-microorganism ratio. Does it appear reasonable?
   d) If the return activated sludge flow rate is 30% of the influent flow rate (i.e., 30% sludge recycle), estimate the concentration of MLVSS in the recycle stream, in units of mg/L. Does it seem reasonable?
   e) Estimate the sludge wasting rate in units of kg/d. Assume that the sludge is 70% bacteria and 30% inert material. Also the effluent suspended solids are 70% bacteria and 30% inert material.
   f) [skip for Fall 2015] Estimate the mass of oxygen to be supplied (kg/d) for the new activated sludge plant. Assume that BOD_5 = rbsCOD and that it is 68% of the bCOD.

3. (10 pts) Answer problem 14.33 *or* problem 14.41 in your text book.

4. (15 pts) Answer problem 14.37 in your text book. In addition to the parameters requested in the problem, estimate the mean cell residence time for the nitrification reactor. However, do not worry about the clarifier surface area following the denitrification reactor. (You probably would run the denitrification process in a denitrification filter, so a clarifier would not be necessary. Note that you do still have to estimate the clarifier area following the nitrification reactor – that part you still need.)