Assignment 1 Environmental Engineering (CENG594)

1. A settling tank is used to remove suspended solids from wastewater. The rate of flow of wastewater into the tank is 10 L/s, and the influent concentration of suspended solids (SS) is 200 mg/L. The removal efficiency of the settling tank for suspended solids is 60%. Calculate the amount of suspended solids (sludge) accumulating in the sludge zone each day.
2. The sludge removed from the sludge zone of the settling tank in Pro. 1 has solids concentration of 3%. To be able to burn the sludge in an incinerator, it must be dewatered. This is to be carried out by a gravity thickener which can achieve an underflow concentration of 8%, and then the sludge will be concentrated further in a vacuum filter that will remove 75% of the water from the feed stream. The density of wet sludge is approximately equal to that of water. Calculate (a) the flowrate of thickened sludge that must be handled by the vacuum filter, and (b) the composition of the filter cake produced by the vacuum filter.
3. A mixing tank contains 1 m^3 of water. a waste stream containing 32 kg/m^3 of pollutant A flows into the tank at a flow rate of 1.4 L/s. Liquid flows from the tank at a rate of 0.47 L/s. Assume that the tank is completely mixed (i.e., the effluent concentration is equal to the tank concentration of pollutant A). Calculate the concentration of A in the effluent when the tank contains 1.4 m^3 of solution. Assume that the pollutant is nonreactive.
4. dust is removed from the airstream of a municipal incinerator by four dust collectors operating in parallel, each handling one-fourth of the total airflow of 200 m3/min. the airstream contains 10 g/m3 of suspended solids and collector efficiency is 98% decreasing linearly to 74 % as the air flow is doubled. if the maximum permissible solids concentration from the combined stack discharge is 1.0 g/m3, can one collector be temporarily taken out of service (a) by overloading the other three units; (b) by not treating one-fourth of the air-flow?
5. A chemical reaction is carried out in a CSTR. Component A is converted to product C, the rate equation being reported as

   $$r_A = -0.15\ [A]\ mol/L.s$$

   (a) Calculate the volume required for a 90% conversion of A for a volumetric flow rate of 100 L/s, assuming that $[A_0] = 0.10$ mol/L.

   (b) After the design is completed, the engineer finds out that an error has been made in the order of reaction. It turns out to be first order, but zero order, the correct equation being

   $$r_A = -0.15\ mol/L.s$$

   What effect will this have on the design?
6. A liquid reaction is carried out in a batch reactor at constant temperature. A 50 % conversion is achieved in 20 min. How long will it take to achieve the same conversion in (a) in a PFTR; (b) in a CSTR?
7. If biodegradable organic matter, oxygen, and microorganisms are placed in a closed bottle, the microorganisms will use the oxygen in the process of oxidizing the organic matter. The bottle may be treated as a batch reactor and the decay of oxygen may be treated as a first-order reaction. Write the general mass balance equation for the bottle. Using a computer spreadsheet calculate and then plot the concentration of oxygen each day for a period of 5 days starting with a concentration of 8 mg/L. Use a rate constant of 0.35 d^{-1}.