1. An industrial plant generates a process wastewater stream which has averaged 440 gal/min and 4,800 mg/L of COD over the past three years. The regulatory agency has stated that the organic chemical constituents are hazardous and must be reduced to 100 mg/L measured as COD. The stormwater runoff from the site also contains the organic chemicals of concern, and all runoff from an annual average rainfall of 60 inches must also be treated.

   The industrial plant conducted some studies and found the following:

   - Rainfall/runoff measurements over three months reported a total of 12 inches of rainfall over the period which yielded 3,300,000 gallons of runoff containing 300 mg/L of COD.
   - Treatability tests of the process wastewater reported the following data:
     - BOD:COD = 1:2
     - Biomass production rate = 0.7 mg/mg BOD removed
     - Endogenous decay rate = 0.05 day^{-1}

   The plant is evaluating the feasibility of treating the wastewater and runoff in a full-scale completely mixed, suspended growth system with solids recycle. Based on the above information, could a sufficient biomass concentration be maintained to prevent settling problems?

2. The total mass of contaminants leached in a column leaching test from the unstabilized and pozzolanic reagent stabilized Imhoff sludge example presented above is as follows:

Parameter	Untreated sludge	Treated sludge
Arsenic	0.724	0.049
Cadmium	3.3	0.126
Chromium	0.566	1.16
Copper	3.86	3.2
Iron	48.4	1.57
Lead	0.238	0.019
Manganese	11.5	1.48
Zinc	120	3.02

   a.) Calculate the percent reduction in the mass of the leached constituents.

   b.) What do you consider the average reduction in leached constituent concentrations?

   c.) Which chemical parameter requires further consideration in evaluating the effectiveness of stabilization and why?

(背面仍有題目,請繼續作答)

3. Chlorinated organics, when burned in air, will produce HCl gas and some chlorine gas in the combustion products. The amount of chlorine in the flue gas is proportional to the incineration temperature and the amount of excess air in the combustion process. It is desirable to maximize the HCl and minimize the Cl_2 in the flue gas because HCl is very soluble in water. If much chlorine is formed it will have to be removed with a caustic solution.

   The reason the excess air affects the chlorine content is due to the following reaction:

$$2HCl + 1/2O_2 \rightarrow H_2O + Cl_2$$

   The equilibrium constant (K_p) for this reaction can be expressed as follows:

$$K_p = \frac{(P_{HCl})^2 (P_{O_2})^{1/2}}{(P_{H_2O})(P_{Cl_2})}$$

   where P is the partial pressure of the gas in the mixture.

   At 1200°C the K_p for the reaction is 30 while at 1000°C it is 20. When burning 200 lb/hr of monochlorobenzene in a liquid injection incinerator with 10 percent excess air, how much more chlorine will be in the flue gas at the lower temperature?

4. A liquid injection incinerator has a stack gas which contains 7% oxygen by volume on a wet basis at standard conditions. The incinerator is burning toluene at a rate of 184 lb/hr with air.

   a.) What percent excess air is required?

   b.) If the stack gas had been on a dry basis, what would the excess air be?

   c.) What is the combustion efficiency of the system if the CO content of the flue gas is 500 ppmv?