

系所組別： 環境工程學系甲組

考試科目： 衛生工程

考試日期： 0223，節次： 1

※ 考生請注意：本試題不可使用計算機

### Problem Sets for Sanitary Engineering

**Water Softening.** The goal of a lime-soda softening plant is to remove hardness from the water by precipitation of  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$  ions, respectively. However, this is achieved by adding lime (calcium hydroxide) and soda ash (sodium carbonate) to the water. So, if one of the goals is to remove  $\text{Ca}^{2+}$ , why is calcium in the form of lime added to the water? (15 pts).

**Membrane Filtration.** Please define the cut-off sizes (in  $\mu\text{m}$ ) for the following membranes: microfiltration (MF), ultrafiltration (UF), nanofiltration (NF), and reverse osmosis (RO). If you are designing membrane filtration systems for the following contaminants, what types of membrane you will use for the optimal operation (considering contaminant removal efficiency, fouling issues, and cleaning frequency). (1) virus, (2) *Cryptosporidium parvum* and *Giardia lamblia* (3) Hardness, (4) endotoxins produced by microalgae. (20 pts).

**Sedimentation Process.** Please compare the differences (based on design principles, functions, and important design and operational parameters) between sedimentation tank used in water treatment plant and primary and secondary sedimentation units used in wastewater treatment plant. (15 pts)

**Activated Sludge System.** A completely mixed activated sludge reactor is designed to treat a petrochemical industrial wastewater having a negligible suspended solids content and a COD of 960 mg/L. The design MLSS is 3000 mg/L. The effluent COD must be less than 120 mg/L. Pilot-scale studies have been conducted and it was found that the biochemical reaction is pseudo-first order. The rate constant based on MLVSS is 0.548 L/g/hr at 18°C. The MLVSS is 70% of the MLSS, and the nonbiodegradable COD is 95 mg/L. The flowsheet is as shown in figure below. The influent flowrate (Q) is  $18.9 \times 10^6$  L/d. Determine the hydraulic reaction time,  $\theta$  (V/Q), and the reactor volume, V. (15 pt)

**Biological Nutrient Removal.** A wastewater with BOD = 200 mg/L, TKN 30 mg/L and total phosphorus = 40 mg-P/L. Sketch a treatment process flowsheet you might propose if (a) the phosphorus limitation is 1 mg/L and ammonia oxidation is required. (b) to remove nitrogen to 2 mg-N/L and phosphorus to 1 mg-P/L (please provide explanations). (15 pts)

**Anaerobic Digestion.** Please briefly describe fundamentals of anaerobic decomposition including mechanisms, metabolic pathways, and microbiology, as well as important indicators of anaerobic sludge digestion and their significance to anaerobic digester operation. (20 pts)