

國立清華大學 103 學年度碩士班考試入學試題

系所班組別：生醫工程與環境科學系 乙組（環境分子科學組）

考試科目（代碼）：環境科學與工程 (2402)

共 2 頁，第 1 頁 *請在【答案卷、卡】作答

1. Draw the structural formula for the following compounds and briefly describe their application or occurrence in the environment: (a) acetaldehyde, (b) putescine, (c) *p,p'*-DDT (dichlorodiphenyltrichloroethane), (d) BTEX, (e) PCBs (polychlorinated biphenyls). (20%)
2. Describe the biogeochemical cycle of nitrogen in the aqueous environment with a figure. List and explain the major pathways in the nitrogen cycle, the chemical species that are transformed in each, and the species that accomplish each of the transformations. Explain why photochemical reactions have important implications for nitrogen availability in many aquatic ecosystems. (10%)
3. Bituminous coal has a heat of combustion of 31.4 MJ/kg. A coal-fired power plant produces an average of 2.2 kWh of electrical energy per kilogram of bituminous coal burned. What is the average overall efficiency of this production of electricity? The electrical power output of the plant is 1000 MW. The other energy content of the fuel is rejected to the environment as waste heat. About 15% of the waste heat goes up the smokestack and the other 85% is taken away by cooling water that is drawn from a nearby river. The river has an upstream flow of 100.0 m³/s and a temperature of 20.0 °C. What would be the river temperature just after it receives the heated cooling water? (20%)
4. Schematic of a typical municipal wastewater treatment plant showing pretreatment, primary treatment, secondary treatment, and tertiary treatment. Please label all of the parts and explain their functions. (10%)

國立清華大學 103 學年度碩士班考試入學試題

系所班組別：生醫工程與環境科學系 乙組（環境分子科學組）

考試科目（代碼）：環境科學與工程 (2402)

共 2 頁，第 2 頁 *請在【答案卷、卡】作答

5. For a completely mixed activated-sludge process with cellular recycle and washing from the recycle line (an aeration tank and secondary clarifier), please (a) draw a schematic for the system and define each term you will use, then (b) derive the following equation under steady-state conditions:

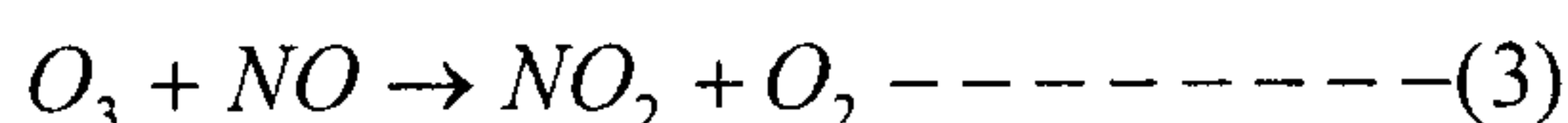
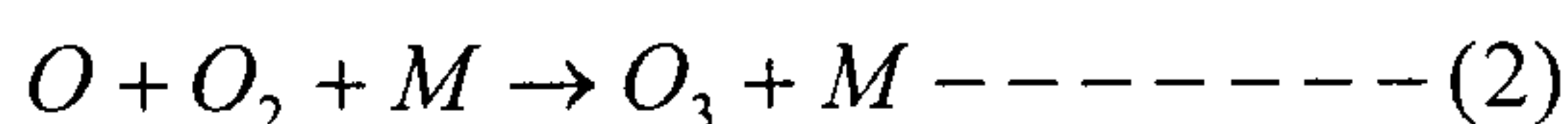
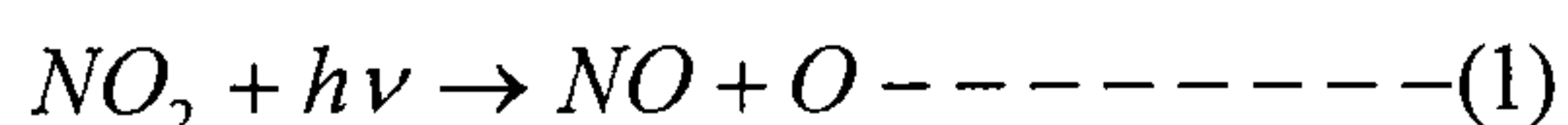
$$\frac{1}{\theta_c} = \mu - k_d$$

and (c) using the above relationship show the aeration tank volume (V) can be represented as:

$$V = \frac{\theta_c Y Q (S_0 - S)}{X(1 + k_d \theta_c)}$$

where θ_c is mean cell residence time (MCRT or solids retention time), μ is specific growth rate, k_d is endogenous decay coefficient, X is the mass concentration of microorganisms in the reactor, S_0 is concentration of substrate in influent wastewater, S is concentration of substrate in effluent flow, Q is rate of influent wastewater flow, and Y is biomass production rate (maximum yield coefficient). (20%)

6. NO, NO₂, CO, and ozone are major pollutants in a crowded city. Which of the previous compounds are primary pollutants? Which are secondary pollutants? When NO and NO₂ are present in sunlight, ozone formation occurs as a result of the photolysis of NO₂:



where j_1 , k_2 , and k_3 are the rate constants of equation 1, 2, and 3, respectively. Consider the dynamics of a system in which only these reactions are taking place. Find a steady-state expression for the ozone concentration. If VOC (volatile organic compounds) exists in the system, could you explain the role of volatile organic compounds in varying the ozone concentration? (20%)