KATHMANDU UNIVERSITY
End-Semester Examination
March/April, 2017

MAR 3 0 2017

Level : B. Tech.
Year : IV
Time : 2 hrs. 30 mins.

Course : ENVE 432
Semester: I
F.M. : 55

SECTION "D"
(5 Q.×4=20 marks)

Answer the following questions. Make logical assumptions for any missing data or information.

1. Discuss the underlying principles of the given statement and provide examples for each application areas specified. "Knowledge of mass and energy transfer in pollution control and remediation is essential to: understand the process, design the preventive measures, design the treatment units and design the remediation activities."

2. Draw a conceptual flow diagram of an activated sludge system designed to remove carbonaceous BOD. Provide a list of design parameters and operational parameters relevant to the activated sludge system.

3. The activated sludge unit mentioned in Question (2) needs to be modified to accommodate additional aeration basin and a clarifier in order to remove nitrogen from the wastewater stream. Draw the modified flow diagram and indicate the mechanism of removal of nitrogen.

4. Assuming that the terminal velocity of a particle settling in a settling basin is v_0, prove

$$v_0 = \frac{Q}{A}$$

where Q is the incoming flow and A is the surface area of the basin.

5. Determine the F/M ratio and mean cell residence time (sludge age) in an activated sludge system with the following data.

Influent flow rate (Q) = 150 m^3/day
Influent BOD_5 (S_o) = 200 mg/L
Mixed liquor suspended solids (MLSS) = 2700 mg/L
Recycle suspended solids (RSS) = 9000 mg/L
Waste rate (Q_w) = 5 m^3/day
Aeration basin volume (V) = 40 m^3

SECTION "E"
(5 Q.×7=35 marks)

Answer the following questions. Make logical assumptions for any missing data or information.

6. A schematic diagram of an activated sludge process with an arrangement of wasting sludge from the aeration tank is shown in the Fig. 1 below. Considering a system boundary including the aeration tank and the secondary clarifier, answer the followings.

(i) Write word and equation statements for microorganisms mass balance in the system.

(ii) Considering the assumptions, derive an expression for the sludge retention time (θ_c).

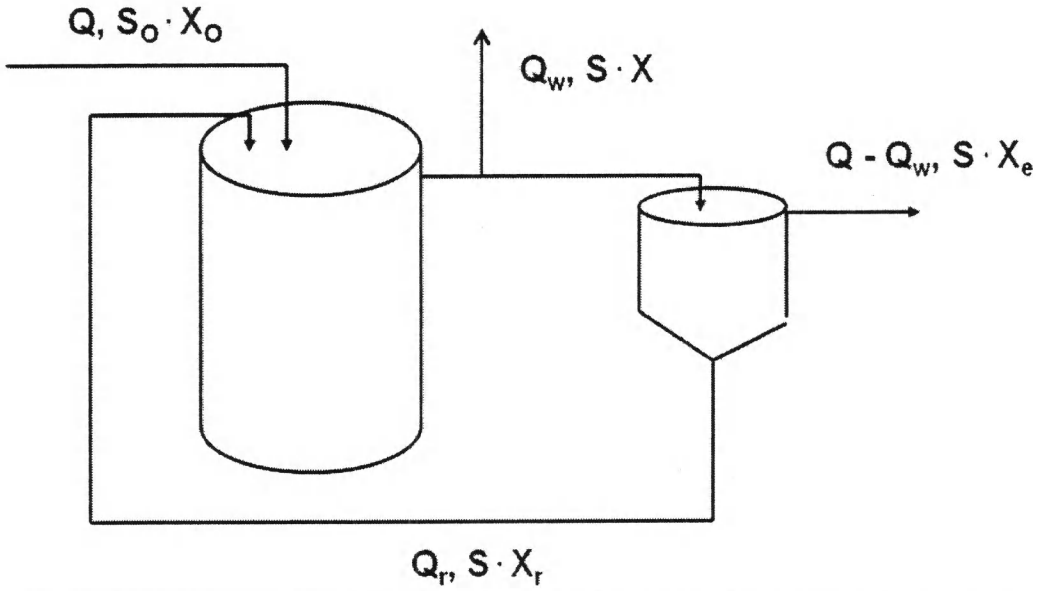

Fig. 1 : Schematic diagram of Activated Sludge System with wasting from aeration tank

7.(a) Estimate the weight of net solids (sludge) produced per day in an activated sludge aeration system in which the influent BOD is reduced from 250 to 30 mg/L. The flow, Q = 4000 m^3/day, aeration tank volume = 700 m^3 and MLSS = 3000 mg/L. Assume Y = 0.5 and k_d = 0.09 day^{-1}. Also compute θ_c and F/M.

You may use the formulas below.

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

$$S = \frac{K_S (1 + k_d \theta_c)}{\mu_m \theta_c - k_d \theta_c - 1}$$

$$\theta_c = \frac{V X}{Q_w X_r}$$

(b) An activated sludge system treating domestic wastewater is operated at a solids retention time of 10 days with a mixed-liquor temperature of 20°C. For many weeks nitrification has occurred, with an effluent NH_4-N concentration reported less than 1.0 mg/L. After some times the nitrification performance declines with effluent NH_4-N concentration exceeding 10mg/L. As the city engineer you are requested to investigate the cause of the decline in performance and to make recommendation for actions that will get the discharge quality back in compliance. Describe possible causes for the decline in nitrification efficiency and how you would evaluate the problem.

(4+3)

8. Fig. 2 describes a result of an experiment related to coagulation.

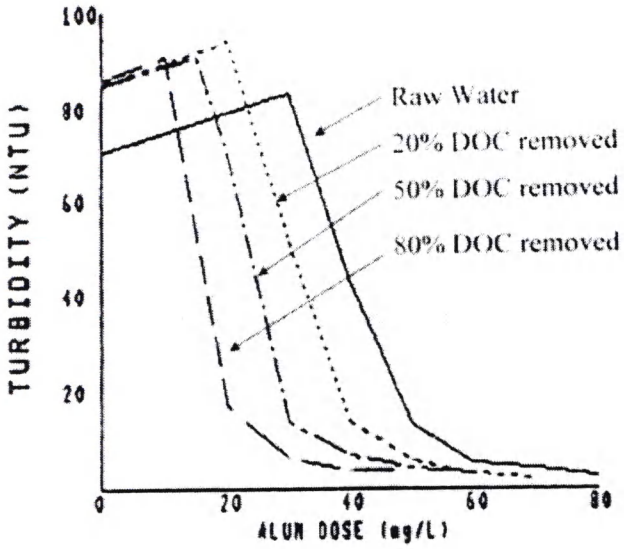

Fig. 2 : XYZ

(a) Suggest an appropriate caption of the Fig. 1 .
(b) Write the conclusions which you can draw from Fig. 1.
(c) Discuss why there is an initial rise of turbidity values for the dotted curves.
(d) Turbidity threshold of 20 NTU is used for treated (finished) waters. For a water supply project like Melamchi (Treatment Plant Capacity -85 MLD), estimate annual savings in costs by removing NOM in raw water. Take the market price of Alum as Rs 200 per Kg in Kathmandu.

(1+3+3)

9. A plain sedimentation tank is to be designed for a water supply project serving a city with a population of 200,000. Assuming a per capita water consumption of 120 lpcd, design a rectangular sedimentation tank and check the operational parameter as given in the Box 1. Check if the overflow rate and horizontal velocities are within the range provided.

Box 1 : General dimensions of sedimentation basin

Material : concrete

Shape : rectangular

Length : Width = (3 ~ 8) : 1 , Length <100 m

Depth = 3 ~ 4 m

Number : at least two tanks

Retention time : 8 hr or more (plain sedimentation)
3 ~ 5 hr (floc sedimentation)

Horizontal velocity : less than 30 cm / min (plain)
less than 40 cm (floc)

Overflow rate : 8 ~ 25 m^3 / m^2.d (plain)
15 ~ 25 m^3 / m^2.d (floc)

Depth of the sludge zone : 30 cm or more

Free board : 30 cm or more

(4+3)

10. Table 1 describes the results of groundwater sampling and analysis in Kathmandu Valley.

Table 1 : Comparison with WHO guideline values

Parameters	WHO guideline value (WHO, 1996)	No. of samples exceeding the guideline*	Highest concentration observed
NH_3, mgN/L	1.3	19	62.0
NO_3^- , mgN/L	12	5	25.0
Fe, mg/L	0.3	12	12.1
Mn, mg/L	0.1	17	1.17
As, µg/L	10	4	73.8
Hg, µg/L	1	23	303.0
DOC, mg/L	0.2 - 15**	5	63.6

* Total number of samples = 31, ** Typical range in groundwater (Thurman, 1985)

(a) Construct two water samples with water quality parameter values of all the parameters shown in Table 1 as follows. (i) Sample 1 - Ammonia, Nitrate, and Iron exceeding the WHO guideline Value but within the highest concentration observed. Other parameters are within the WHO guideline value. (ii) Sample 2 - Highest concentration values of Mercury, Manganese and Nitrate but other parameters are in between the WHO guideline and Highest concentration values.

(b) A deep well in Kopundole is found to have Ammonia as 60 mg/L, Iron as 10 mg/L and DOC as 58 mg/L, Write possible reasons for this.

(c) Suggest treatment options for the ground water described in 10 (b).