Department of Civil Engineering, IIT Delhi

CEL212 Environmental Engineering

II[nd] Semester 2007-08

Major Examination | Max Marks= 40 | Time = 2 hr

Note: - Assume the missing data/ information (if any) and state it clearly.
- Please do not ask any doubts during the examination.
- Exchange of calculators, pens, pencils etc is not allowed.

Q.1 In some of the aetivated sludge proeess based wastewater treatment systems, bulking sludge conditions develop, which defines a eondition in the aetivated sludge elarifier that can cause high effluent suspended solids and poor treatment performance. In a bulking sludge condition, the MLSS (mixed liquor suspended solids) floc does not settle down, and floc particles arc diseharged in the elarifier effluent. Two prineipal types of bulking problems have been identified. One type, filamentous bulking is caused by the growth of organisms that grow in the filamentous form under adverse conditions. The other type, viseous bulking, is caused by an exeessive amount of extra-eellular biopolymer, which produees sludge with a slimy, jellylike consisteney. As the biopolymers are hydrophilie, the aetivated sludge is highly water retentive, and this eondition known as hydrous bulking. In this eontext answer the following questions:

a. Draw a typieal growth curve for filamentous and non-filamentous organisms as a function of substrate eoncentration. [2]
b. Explain in brief the role of the following in controlling and prevention of the problem of sludge bulking (i) dissolve oxygen concentration, (ii) wastewater eharaeteristies. (iii) process loading, and (iv) return and waste sludge pumping rate. [4]
c. Suggest a methodology for identification, eontrol and prevention of the problem of sludge bulking. [2]

Q 2 A water treatment plant is designed to process 100 ML/d. The flocculator is 30 m long, 15 m wide, and 5 m deep. Revolving paddles are attaehed to four horizontal shafts that rotate at 1.5 rpm. Eaeh shaft supports four paddles that are 200 mm wide. 15 m long and centered 2 m from the shaft. Assume the mean water velocity to be 70% less than paddle velocity and $C_D = 1.8$. All paddles remain submerged all the time. Find: (a) the difference in velocity between paddles and water, (b) the value of G and (e) the Camp number (i.e., G x t). [6]

Q. 3 Suppose that within a square eity, 15 km on a side, there are 200,000 cars on the road, each being driven 30 km between 4 pm to 6 pm, and each emitting 3 g/km of CO. It is a clear winter evening with a radiation inversion that restriets mixing to estimated 20 m, and the wind is bringing clear air in at steady rate of 1 m/s along an edge of the city. Use a box model to estimate the incremental CO eoncentration at 6 pm due to this source. Assume that CO is eonservative and there is eomplete and instantaneous mixing in the box. [5]

Q. 4 Suppose the atmospheric temperature profile is isothermal (constant temperature) at 20°C and the estimated maximum daily surface temperature is 25°C. The whether station anemometer is at height of 10 m in the eity. It indieates an average windspeed of 3m/s. Estimate the mixing depth and the ventilation eoefficient. [5]

Multiple Choice Questions:

Note: Correct answer of each of the MCQ will give you 1 mark and a wrong answer to the MCQ will give you - 1 mark. Please note that there is more than one correct answer for some of the MCQs.

MCQ.1 Sewerage system is designed for

a. maximum flow only
b. minimum flow only
c. average flow only
d. maximum and minimum flow

MCQ.2 The rate of Biochemical Oxygen Demand (BOD) exerted at any time is

a. directly proportional to BOD satisfied
b. directly proportional to BOD remaining
c. inversely proportional to BOD satisfied
d. inversely proportional to BOD remaining

MCQ.3 The following data pertain to a sewage sample:

Initial Dissolved Oxygen (DO) = 10 mg/l
Final Dissolved Oxygen (DO) = 2 mg/l
Dilution to 1%

The BOD of the given sewage sample is

a. 8 mg/l
b. 10 mg/l
c. 80 mg/l
d. 800 mg/l

MCQ.4 Fresh sludge has moisture content of 98% and, after thickening; its moisture content is reduced to 96%. The reduction in the volume of sludge will be

a. 2%
b. 4%
c. 50%
d. 100%

MCQ.5 At 20°C, the 5 day BOD was 50 mg/L and the reaction rate constant was 0.22/day. What would be the 3 day 27°C BOD of this wastewater?

a. 30 mg/L
b. 40 mg/L
c. 50 mg/L
d. none of these

MCQ.6 In case of a river, effect of increase in temperature causes the critical point (where dissolved oxygen, DO level reaches a minimum) to be

a. reached sooner and minimum value of DO will be lower
b. reached sooner and minimum value of DO will be higher
c. reached later and minimum value of DO will be lower
d. reached later and minimum value of DO will be higher

MCQ.7 For a given discharge, the efficiency of sedimentation tank can be increased by

a. increasing the depth of tank
b. decreasing the depth of tank
c. increasing the surface areas of tank
d. decreasing the surface areas of tank

MCQ.8 The dispersion of air pollutants should be studied for the most critical meteorological conditions. Which season can be taken, as a representative season?

a. monsoon
b. winter
c. summer
d. all of the above

MCQ.9 Dry adiabatic lapse rate is practically equal to

a. 9.76 °C/ 1 km
b. 9.76 °C/ 100 m
c. 0.976 °C/ 1 km
d. None of the above, it depends upon the atmospheric conditions

MCQ.10 In the downwind direction from an air pollution source, with the increasing distance. the Gaussian dispersion coefficients will

a. remain constant
b. decrease
c. increase
d. initially increase and then decrease
e. Can't say, it depends upon the atmospheric conditions

MCQ 11. The purpose of adding ammonia to potable water is to:

a. adjust pH
b. form combined chlorine residual
c. remove turbidity
d. protect teeth

MCQ 12. The correct order of unit operations in a water treatment plant (e.g., Sonia Vihar Water Treatment Plant, Delhi) where the source is surface water is:

a. filtration, disinfection, softening, and coagulation
b. sedimentation, flocculation, softening, and coagulation
c. coagulation, flocculation, sedimentation, and filtration
d. flocculation, coagulation, filtration, and sedimentation
e. flocculation, coagulation, filtration, and sedimentation
f. None of these, the correct sequence is

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MCQ 13. Optimum flocculation requires.

a. gentle agitation
b. very rapid mixing
c. low pH
d. high pH

MCQ 14. Which of the following conditions most affect coagulation performance?

a. velocity, chlorine dosage, detention time, and air temperature
b. velocity, water temperature, detention time and coagulant dosage
c. water temperature, detention time, air temperature, and chlorine dosage
d. detention time, velocity, air temperature, and chlorine dosage

MCQ 15. Which of the following parameter(s) would be the best indicator(s) that the filter should be backwashed?

a. filter serviee hours
b. head loss
c. filter effluent turbidity
d. filter encrustation

MCQ 16. The most crucial operational element of effective filter performance is:

a. water temperature
b. media density
c. effective size of the filter media
d. proper backwashing

Some Useful Formulas

$C(t) = (\frac{q_s L}{uH} + C_{in})(1 - e^{-ut/L}) + C(o)e^{-ut/L}$	Where, C(t) = concentration of the pollutant at time t; q_s= emission rate per unit area; L and W are the length and width of the airshed respectively; u = average wind speed; C_{in} = concentration in the incoming air.
$P = \frac{C_D A \rho v^3}{2}$	Where, P = Power required; A= paddlc area, C_D=coefficient of drag $C_D = \frac{24}{Re} + \frac{3}{Re^{0.5}} + 0.34$ ν is *Kinematic viscosity* , which is really μ/ρ and results in a value of $10^{-6} m^2 s^{-1}$ at 20C
$G = \left(\frac{P}{\forall \mu}\right)^{0.5}$	Where, ∀= tank volume; μ= viscosity;
Camp no. = G x t	Where, t = retention time of the flocculator Normal range of camp No. is 20,000 and 200,000

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