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**Answer all questions.**

**Answer all parts of a question together.**

1. If biodegradable organic matter, oxygen and microorganisms are placed in a closed bottle. The microorganism will use the oxygen in the process of oxidizing the organic matter. The bottle may be treated as batch reactor. Write the general mass balance equation for the bottle for the decay may be treated as first order reaction. Calculate the concentration of oxygen each day for a period of 5 days starting with concentration of 10 mg/l. Use a rate constant of 0.3 per day. Also calculate the concentration of oxygen each day for a period of 5 days starting with concentration of 10 mg/l with rate constant of 0.4 mg/l- day. Compare the results. (10)
  
2. An air stream with a flow rate of  $8 \text{ m}^3/\text{s}$  is passed through a cyclone of standard proportions. Determine the collection efficiency for the removal of  $10 \text{ }\mu\text{m}$  particle if a bank of 91 cyclones with diameter 36 cm is used instead of the single large unit. ( Air temperature is  $80^\circ \text{C}$ , density of particle is  $1.5 \text{ g/cm}^3$ , Gas viscosity at  $80^\circ \text{C}$  is  $2.1 \times 10^{-5} \text{ kg/m-s}$ , Number of turns are 6) (15)
  
3. Consider the following data for a municipal waste collection system:
  - i. Travel time , garage to route = 25 min
  - ii. Travel time , route to disposal site = 20 min
  - iii. Time to unload at disposal site = 15 min
  - iv. Time from disposal site to garage = 10 min
  - v. Time spent on worker breaks = 40 min/day
  - vi. Packer truck volume =  $40 \text{ m}^3$
  - vii. Compaction ratio = 2
  - viii. Curb volume per service =  $0.16 \text{ m}^3/\text{customer}$
  - ix. Travel time between stops = 30 sec
  - x. Customer served per stop = 4
  - xi. Time loading per stop = 1 min
  - a) How many hours per day would the crew have to work if it fills the truck twice per day?
  - b) Making two run per day , how many customer would be served per truck if each home has once per week service and the truck is used five days per week?
  - c) Suppose the cost of a crew for one truck is \$ 50 per hour for the first eight hours per day , plus \$ 70 per hour for any hours over that amount. Assume that the crew works 52 weeks per year. Furthermore, suppose a packer truck has an annualized cost of \$  $12,000 + \$ 4000 / \text{m}^3$ . What would be the annual cost of service ( crew plus truck ) per customer? (20)

4. Suppose an underground wastewater storage tank has been leaking for many years and causing a contamination to ground water. Wastewater tank has contaminant concentration of 0.4 mg/l. The contaminant is flowing at a rate of 1 m per day toward a public drinking water well 1.5 km away.
- (i). Estimate the steady-state pollutant concentration at the well.
- (ii) If the potency factor for the contaminant is  $0.03 \text{ (mg/kg-day)}^{-1}$ , estimate the cancer risk if a 70 kg person drank 2 litre of this water for 15 years.
- (Reaction rate coefficient =  $2.1 \times 10^{-4} \text{ /day}$ ) (10)
5. Write the short notes on the following: (2x10 = 20)
- Browns and Greens in composting
  - Chick's law of disinfection
  - Maturation stage in composting
  - Hazard Index
  - Spoon shape curve
  - Base line studies in EIA
  - PAN in Delhi Smog
  - Trapping plume behaviour
  - Langmuir isotherm in adsorption
  - Cause and effect of noise pollution in Industry
6. If twenty sound sources have equal pressure of 4000  $\mu\text{Pa}$ , determine the sound pressure in dB and compare with the sound pressure level of single source. And comment on the result. (5)

**Paper ends**