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BSC ENGINEERING SECOND SEMESTER EXAMINATIONS: 2015/2016

SCHOOL OF ENGINEERING SCIENCES
FPEN 308: ENVIRONMENTAL ENGINEERING IN FOOD PROCESSING
(2 CREDITS)

INSTRUCTIONS:
ANSWER THREE (3) QUESTIONS

TIME ALLOWED: TWO (2) HOURS

1. a. With the aid of a diagram show the components and activities involved in solid waste management.

   b. State the different ways in which solid waste in the food industry could be avoided or minimized.

   c. A mango juice factory generates 5250 kg of solid waste per month. The factory has a staff population of 150 people. In an average month each staff purchases and brings into their house approximately 100 kg of consumer goods (food, magazine, newspapers, appliances, furniture, and associated packaging). Of this amount, 60 % is consumed as food. Half of the food is used for biological maintenance and ultimately released as CO_2; the remainder is discharged into the sewer system. Each staff recycles approximately 25% of the solid waste generated. Approximately 3 kg accumulates in the house.

      i. Estimate the amount of solid waste generated per year at the factory and the total number of staff.

      ii. X% of the total solid waste generated in a year determined under i. above is reused, followed by a diversion of 3X% of the solid waste for composting before sending the rest to the landfill site. Determine X% if the landfill site is 148 m^3. Assume the density of the solid waste is 400kg/m^3.

2. a. The raw wastewater from a brewery is discharged into a municipal wastewater treatment plant for processing with domestic wastewater. The characteristics of both the brewery and domestic wastewater are given in the table below:

Characteristics of brewery and domestic wastewaters

Parameter	Brewery Wastewater	Domestic Wastewater
BOD, mg/l	920	300
Suspended solids, mg/l	698	250
Ammonia (NH_3), mg/l	2	30
Phosphate (PO_4), mg/l	1	9

If the required $BOD/NH_3/PO_4$ weight ratio is 100/3/1, what is the minimum quantity of domestic wastewater required per 1000 gallons of brewery wastewater to provide adequate nutrients for biological treatment and the concentration of the suspended solids of the combined wastewater.

b. What addition of NH_4OH and H_3PO_4 would be required in pounds per million gallons of wastewater to provide the necessary nutrient levels for the treatment of brewery wastewater described above if the domestic wastewater had not been combined with it.
H=1, O = 16, N = 14, P = 31 1 mg/l = 8.34 lb/million gallons

3. a. State the environmental issues associated with incineration of solid waste and brief explain how they can be managed.

b. A volume of 100 m^3 of sludge at 95% moisture content is dewatered to P% moisture. The relative density of the solids and the dewatered sludge are 1.5 and 1.32 respectively. Determine the volume occupied by the sludge when dewatered and the P% moisture. If the wet weight concentration of lead present in the sludge is 4mg/kg what would be its dry weight concentration?

c. The air pollution equipment on a waste incinerator includes a fabric filter particle collector (baghouse). The baghouse contains 424 cloth bags arranged in parallel that is 1/424 of the flow goes through each bag. The gas flow rate into and out of the bag is 57 m^3/s, and the concentration of particles entering the baghouse is 18 g/m^3.

i. Calculate the fraction of particulate matter that remains in the collector and the efficiency of particulate removal if the baghouse particulate discharge is 22 mg/m^3.

ii. Calculate the concentration of particulate matter exited from the baghouse collector if two of the cloth bags out of the total cloth bags were mistakenly not replaced into the baghouse collector after the bags were removed for cleaning purposes.

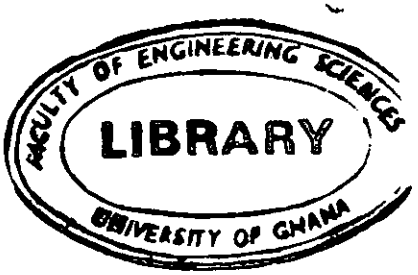
iii. Would the concentration determine in (ii) meet the Environmental Protection Agency guideline value of 50 mg/m^3 for particulate matter.

4. a. State the role of environmental engineer in the food factory.

b. Name the three main effects considered in the treatment of water for drinking purposes.

c. An industrial wastewater flow of 1 m^3/s containing 450 mg/l suspended solids (SS) and 690 mg/l of biochemical oxygen demand (BOD) is given sedimentation to remove 40% of the SS before discharging it into the town domestic wastewater treatment plant. The town wastewater is also sent to wastewater treatment plant. The treated wastewater from the town wastewater treatment plant is discharged in a nearby river.

i. The sludge produced is drawn of the sedimentation tank at 4% of solids and dewatered before sending it to a landfill site. Determine the yearly volume of produced and volume of dewatered sludge that is sent to the landfill site. Assume the relative densities of the solids and dewater sludge are 1.5 and 1.364 respectively.

ii. Determine the SS concentration of the treated wastewater and the percent purification of the domestic wastewater treatment plant. The town has a population of 60,000 and its wastewater flow is 120 litres per person per day and its total suspended solids is 0.042 kg per person per day. The river upstream is $3m^3/s$ with SS of 10 mg/l. After mixing with the treated wastewater the river has SS of 7055 kg/day.

iii. Does the treated wastewater SS concentration satisfy the Environmental Protection Guideline value of 50mg/l for SS for the discharge of wastewater into receiving water bodies?