BEL 715: Biological Waste Treatment

Major Examination

25th November 2014
15^{30} – 17^{30} Hrs.
Venue: WS - 209

Answer all questions. Maximum marks 40.

1. It is not desirable to have sulfur compounds in wastewaters being treated by the anaerobic route. Why?

(4 marks)

2. What is the concept behind:
   (i) Biological treatment of wastewaters containing xenobiotic compounds?
   (ii) Biological nitrogen removal from wastewaters?
   (iii) Sanitary landfilling of solid wastes?

(6 marks)

3. How could one design the process of sludge treatment through (a) anaerobic digestion and (b) aerobic digestion, operating in the thermophilic temperature range, to be energy-neutral? Explain

(6 marks)

4. A tower trickling filter with a square cross section and vertical flow plastic media is to be used to treat the effluent from an industry from an initial soluble BOD_5 of 10,000 $mg.l^{-1}$ to a BOD_5 value of 1000 $mg.l^{-1}$. The industry generates one million gallons of effluent per day. The minimum dosing rate (DR) required is given by the relation DR (in inches per pass) = Organic Loading Rate (OLR) x 0.12 where the OLR is in units of lb BOD_5 per 1000 ft^3 per day. The liquid is distributed at the top of the bed using a system of static nozzles with the liquid discharge rate being varied in a cyclic manner. The dosing rate in inches per cycle can be expressed as

$$DR = 0.8\ Q_t$$

where Q_t is the total hydraulic load on the filter in units of $gal.ft^{-2}.\ min^{-1}$.

The strength of the treated effluent in terms of its BOD_5 (s_e) is related to that of the influent to the filter (s_i) by the relation

$$s_e / s_i = \exp\{-k\ H\ Q_t^{-0.5}\}$$

$(\frac{4}{10}) \times 1000$

$4/10\ ft^3 \times \frac{1000}{10^3}$ 1 gal = 3.785 L

400 / 1000 ft^3 1 pound = 453.6 g

COD / g Biomass = 1.42

0.022 lb / L 0.0022 lb/L

0.022 lb / $10^{-3}\ m^3$

0.022 lb / m^3

1 ft = 12 inch

1 in = 2.54 cm

x 3.785 lb / gal

where H is the bed height in feet and k is the treatability constant in units of $(gal/min)^{0.5}$ ft^{-1}. If the value of k is 0.18 $(gal/min)^{0.5}$ ft^{-1} for a bed height of 20 feet and depends on the bed height by the relation

$$k_2 = k_1 (H_1/H_2)^{0.5}$$

(i) calculate the recycle ratios required for bed heights of 10, 20 and 40 feet.

(ii) If the maximum allowable OLR is 100 lb BOD_5 per 1000 ft^3 per day and the maximum allowable hydraulic loading rate is 1.2 $gal.ft^{-2}.\ min^{-1}$, calculate the minimum volume of filter required.

(12 marks)

5. A distillery produces 15 litres of spent wash (distillery effluent) for each litre of alcohol produced. The spent wash is treated in a UASB reactor and the gas produced is used to supplement furnace oil in a boiler. When furnace oil alone is used, the daily oil consumption is 5000 litres. When the distillery operates at its full installed capacity of 10,000 litres per day, the furnace oil consumption came down to 3000 litres per day. Calculate the BOD_5 of the treated effluent coming out of the UASB reactor. If this effluent has to be further treated, so as to bring down the residual BOD_5 to 30 $mg.l^{-1}$, using an activated sludge process with mechanical surface aerators, comment on the energy efficiency of the overall effluent treatment plant.

BOD_5 of spent wash = 45,000 $mg.l^{-1}$

Ratio of BOD_5 to ultimate BOD = 0.8

Calorific value of furnace oil = 30,000 $Btu.l^{-1}$

Calorific value of methane = 1000 Btu/ft^3(STP)

Observed growth yield of aerobic biomass = 0.5 $g.(g\ BOD_5)^{-1}$

Oxygen transfer by mechanical aerators = 5.274×10^{-4} kg Oxygen. per Btu

(12 marks)