

1. Assuming suitable design criteria and following characteristics of domestic wastewater, design a upflow anaerobic sludge blanket reactor system to treat an average 5 MLD of wastewater. Assume up flow velocity is 0.5 m/h. Assume 80% BOD removal; for new cells production 15% of BOD removed and 50% fraction of influent VSS is as biodegradable; depth of reactor 6 m, 3 m depth of sludge blanket for 0.5 m/h upflow velocity.  $60 \text{ kg/m}^3$  sludge concentration is in sludge blanket. Efficiency factor is 0.8. The reactor is rectangular shape and width is 17 m. [25]

Given data: Influent BOD : 300 mg/l,  
 Influent COD : 700 mg/l  
 Influent TSS : 400 mg/l  
 Influent VSS : 300 mg/l  
 Desired effluent BOD: 100 mg/l or less.

Or

Assuming suitable criteria, design a facultative waste stabilization pond to treat 4 MLD flow of sewage having 300 mg/L  $\text{BOD}_5$ ; Desired effluent  $\text{BOD}_5$  is 30 mg/L. Assume BOD removal rate constant as  $0.1 \text{ d}^{-1}$  at  $20^\circ\text{C}$ . The ponds are to operate at an altitude of 1000 m and  $30^\circ$  latitude in India. The wastewater temperature is  $15^\circ\text{C}$ . Individual pond area and depth should not be more than 3 hectares and 1.5 m respectively. Organic loading rate is 182 kg  $\text{BOD/ha/d}$ . Hydraulic retention time 60 days on the basis of summer and winter conditions. Determine pond area, volume of pond, pond surface area and number of ponds. [25]

2. Design a conventional activated sludge plant to treat 20000 kl/d of settled solid of BOD is 200 mg/l. The effluent BOD is 30 mg/l. F/M ratio is 0.22, MLSS is 3000 mg/l. Adopt diffusion aeration system  $\text{SVI} = 90$ . Air required is  $100 \text{ m}^3/\text{d/kg}$  of BOD removed. Standard diffusion plates of 0.3 m x 0.3 m x 25 mm and pore size is 0.3 mm. [15]
3. Briefly describe the mechanism of biodegradation pathways of aliphatic and aromatic compounds. What are the environmental factors that can affect biodegradation. Write down difference between intrinsic and accelerated bioremediation [10+10+10+5]
4. Briefly describe biomarkers and its application. Briefly describe the upflow anaerobic sludge blanket reactor [15+10]