Indian Institute of Technology Kharagpur

Department of Chemical Engineering

END SEMESTER EXAMINATION 2018 (AUTUMN)

Industrial Pollution Control (CH 62007)

FULL MARKS - 50 **TIME: 3 HRS**

(Answer Part-A and Part-B in one place. Assume suitable data whenever necessary with justification)

PART-A

1. a) Explain in-depth the scale-up design procedure of a high efficiency conventional cyclone for particulate removal from a polluted gas stream with design equations.

b) A conventional cyclone of diameter of 1.50 m is used to treat the flue gas containing particulate at 175 ^{o}C and 1.0 atm. pressure. The Inlet gas velocity is 17.4 m/s and number of turn in the cyclone is 5.0. Data: Density of particle is 2350 kg/m^3. Viscosity of gas= 0.0118 cp

Calculate :

I) Cut Size particle diameter.

II) Overall collection efficiency of the cyclone.

The particle size distribution is as follows:

Particle Size (μm)	>50	50-40	40-30	30-20	20-15	15-10	10-5	<5
% by wt.	35	15	20	9	6	5	6	4

[3+ 5 = 8]

2. a) Give a comprehensive analysis for selection of filter media used in bughouse with their application limitations. Explain the online cleaning methods of bag filter system.

b) A parallel plate type ESP having dimension as 4 m high, 5 depth with spacing between the plates as 30 cm separate dust from a flue gas at a temperature of 320 ^{o}C and 1.03 kg/cm^2 with an efficiency of 99.6% for 54.5 micron particle. The gas containing dusts of 2500 mg/m^3 flows through the precipitator at a rate of 65,000 m^3/hr where a voltage 66,000 V is applied. The particle size analysis shows the following distribution

D_p(Micron)	0.05	0.1	0.2	0.4	0.8	1.2	5.0
% Weight	3	17	25	35	10	8	2

Calculate :

a) Outlet concentration of dust in the flue gas

b) Particle migration velocity

c) Overall collection efficiency

d) Overall collection efficiency , If the temperature of the flue gas increased to 490 ^{o}C due to malfunctioning of heat recovery system

e) if spacing is increased by 10 cm what would be % change in overall collection efficiency keeping all other parameters constant?

[3 +5 =8]

3. a) Explain the working principle of a Venturi Scrubber. Discuss the design procedure of any wet scrubber of your choice to treat 80,000 m^3/hr of NH_3 from the off gases.

b) A 500 TPD sponge iron plant has installed bag filter as pollution control device without providing sufficient suction in Cooler Discharge Unit containing 516 bags of 30 cm ID and 3 m length. The capacity of ID Fan provided is 120, 000 m^3/hr with 18 hoods of 550 mm x 850 mm in size. The Pressure drop across the bag filter is 110 mm of water. Hoods are connected with main duct of ID 40 cm and branch duct of ID 25 Cm and length 70 m and 15 m respectively. The velocity of the gas in main dust is 8.5 m/s . Prepare a ducting layout of the plant and calculate air to cloth ratio, minimum and maximum number of bags. State whether the capacity of ID fan is adequate to handles inlet dust (Sp. Gv. 2.4) of average particle diameter 10 micron with an efficiency of 99.6% or not.

[3+ 6 = 9]

PART-B

1. a) For effective design and control of the biological treatment processes an understanding of the bacterial growth pattern is essential. Describe the growth pattern showing the different phases with a diagram.
b) List the advantages of attached growth process over activated sludge process for treatment of waste water..
c) A trickling filter has been designed to accept a hydraulic loading of 20 m^3/hr. It will process an influent of BOD 500 mg/L. The depth of the filter is 4 m. The following technical data are given as follows:
Temperature: 25 ^oC
Empirical Constant m=n=1, K25 =0.15 m/d
Packing media are rocks with porosity 0.45, sphericity 0.75. and geometric mean size of 75 mm. The acceptable BOD of the Effluent has to be 25 mg/l or less. Suggest if the trickling filter is satisfactory enough to meet the effluent quality.

[3+3+5]

2. a) Describe the Activated sludge treatment plant with the help of a flow diagram.
b) Describe with the help of schematic diagram the types of Suspended growth system for secondary wastewater treatment.
c) List the major design criteria of Activated Sludge treatment plant.

[2+2+2]

3 a).Depict schematically the sequence of operations for sludge treatment for disposal.
b) The effluent from a typical secondary treatment of paper plant contains 30-40 mg/l suspended solid and 30-40 mg/l of BOD which may be objectionable to release in some stream. What further treatment would you recommend for treating such effluent?
c) A completely mixed activated sludge process is to be used to treat wastewater flow of 550 m^3/hr having a soluble BOD_5 of 250 mg/ml. The concentration of soluble BOD_5 escaping treatment is 15 mg/L Design criteria are as follows: Y (yield Coefficient) 0.5, k = 5/day, Kd = 0.05 /day, Ks =100 mg/L and the concentration of MLVSS (X)=20000 mg/L
Compute the following:
1. The treatment efficiency
2. The mean cell residence time
3. The volume of the aeration tank

[2+2+4]