Ref. No.: Ex/Che/PC/H/T/413/2024

BACHELOR OF CHEMICAL ENGINEERING EXAMINATION, 2024

(4th Year, 1st Semester)

INDUSTRIAL POLLUTION CONTROL ENGINEERING (HONS.)

Full Marks: 100 Time: 3 hours

Assume any missing data

Answer **20 marks** from Q. No. 1, **15 marks** from Q. No. 2, **25 marks** from Q. No. 3, **10 marks** from Q. No. 4 and all from Q.No. 5

Q.No.	CO	Question	Marks
1.	2	a. Describe the lime-soda ash process as water softening technique. A raw water to be treated by the lime soda process to the minimum hardness possible has the following characteristics: CO_2: 22 mg/L, Ca^{2+}: 80mg/L, Mg^{2+}: 12mg/L, Na^{+}: 46 mg/L, HCO_3^{-}: 152.5 mg/L and SO_4^{2-}: 216 mg/L. For a flow of 25000 m^3/day, calculate the chemical requirements and mass of solids and volume of sludge produced. Assume, the used lime is 90% pure and soda ash used is 85% pure. Also, assume that the specific gravity of the sludge is 1.04.	5+15
		b. Find out a mathematical expression for active zone height in a fixed bed adsorber during breakthrough experiment. A breakthrough experiment is conducted for phenol producing results shown below: Determine the length δ of active zone. The diameter of the column used is 1inch and packed density of the bed is 721.58 kg/m^3. [C_0] is equal to 25 mg/L. used $\left(X/M\right)_{ultimate} = 0.02 \frac{kg\ phenol}{kg\ carbon}$.	5+15

C_0 (mg/L)	V (L)
0.06	1
1	1.24
6	1.31
10	1.43
15	1.48

		18 | 1.58 20 | 1.72 23 | 1.83 25 | 2.00	
2.	1	a. What is photochemical smog? How it causes formation of Peroxyacetyl nitrate (PAN)? b. What are the sources of lead in air as pollutant and what are the effects of it if present as air pollutant? c. What are different types of solid wastes? d. What are the effects of SOx on environment as Criteria Air Pollutant? e. What are the reasons of drop of dissolved oxygen (DO) in water? f. Discuss the types of NO_x which are available as air pollutant. g. Why and how primary treatment of wastewater is done?	3 3 3 3 3 3 3
3.	4	a. The results shown in the table below are to be used to design a standard conventional cyclone. The air stream is 21 m^3/s and the diameter of the cyclone is 2.0 m. The temperature is 77°C and the specific gravity of the particle is 2.0. Assume that β equals 0.90. What are the diameter and terminal settling velocity of those particles that are 100% removed? Determine the expected percent removal of the particles.	25

Particle Size (μm)	Wt%
0 - 10	8
10 - 20	10
20 - 30	12
30 - 40	15
40 - 50	19
50 - 60	14
60 - 70	13

		70 - 80 | 9 b. Measurement of the dust distribution of certain industrial operation yields the results in the table below. These results are to be used to design a plate type Electrostatic Precipitator (ESP). The air stream is 330 m^3/s and the plates are spaced 30 cm apart. The voltage drop between discharge and collector plate is 70,000 V. The aspect ratio (length/width) is 1.2. The plate width is 10m and there are 80 channels. The temperature is 650°C and specific gravity of the particle is 2.0. i) what are the diameter and terminal settling velocity of the particles? ii) determine the expected percent removal of particles. iii) what is the power requirement assuming that the corona current is 2.3 A? Assume, β is 0.9	25

Particle Size (μm)	Wt%
0 - 10	8
10 - 20	10
20 - 30	12
30 - 40	15
40 - 50	19
50 - 60	14
60 - 70	13
70 - 80	9

4.	3	a. Discuss the sequential steps of hard groundwater treatment to produce drinking water. b. What are the biological routes for solid waste treatment? Briefly discuss any one of them.	10 10
5	1	a. A perfectly mixed aeration pond with no recycle (return line)	15

		serves as the biological reactor for a small community. The pond receives 30 m3/d of influent with a BOD5 of 350 mg/L that must be reduced 20 mg/L before discharge. It has been found that the kinetic constants for the system are Ks = 100 mg/L BOD5, kd = 0.1 d-1, μm = 1.6 d-1, and Y is 0.6 mg VSS/mg BOD5. (i) What must the hydraulic detention time be in aeration pond? (ii) What mass of microbes will be produced in the pond each day?	
		b. Derive the following for a centrifuge: $$t = \frac{18\mu}{D_P^2\omega^2(\rho_S - \rho)} \cdot \frac{h}{R}$$ Where, t = minimum retention time of solid having size >D_P ω: angular velocity h: thickness of liquid layer in centrifuge bowl R: radius of centrifuge bowl Explain the scale-up criteria of a centrifuge.	15