

# Indian Institute of Technology Kharagpur

Department/Center/School: Chemical Engineering

Mid-Autumn Semester Examination 2022

Date of Examination: 23/09/2022

Duration: 2 Hrs

Session: (FN)

Full Marks:30

Subject No. : CH 62007

Subject: Industrial Pollution Control

Answer all the questions. (Assume suitable data whenever necessary with justification)

1. a) Explain the sampling technique for measurement of particulate matters ( $PM_{2.5}$ ) and  $NO_x$  in the ambient air.
- b) Derive lapse rate expression under adiabatic conditions.
- c) What are the types of inversion? How inversion affect the dispersion of air pollutants.
- d) Explain how Gaussian Dispersion Model can be used to calculate pollutant concentration at any point.
- e) A multi-tray settling chamber having 8 trays including the bottom surface, handles  $25,000 \text{ M}^3/\text{hr}$  of contaminated dust laden gas at  $75^\circ\text{C}$  and  $0.15 \text{ kg/cm}^2$  gauge pressure. The particle size distribution is given in the following table. The trays are spaced 30 cm apart and the chamber is to be 1.2 m wide and 3.5 m long. The viscosity of the gas is  $0.0184 \text{ cp}$ .  
Calculate  
I)  $D_{p, \text{Min}}$  for particle of density  $2350 \text{ kg/m}^3$ .  
II) Efficiency of the settling chamber for  $35 \mu\text{m}$  particles.  
III) Overall collection efficiency

Size range( $\mu\text{m}$ )	Wt. (gm)
0-10	5
10-20	10
20-40	8
40-60	9
60-90	22
90-125	18
125-150	8
>150	10

[ 2 + 2 + 1 + 2 + 4 = 11 ]

2. A 1200 MW coal-fired power plant burns 480 tones of coal per hour and an ESP is used to collect the fly-ash from power plant with an working efficiency of 99.9% which is located in an industrial cluster of Korba, C.C.. The coal has a sulfur content 0.4 % and total amount of fly ash generated is 5 kg /ton of coal burnt. The physical stack height is 270 m and inside diameter of 3.2 m with a stack gas velocity of 6 m/s. The stack gas leaves at  $140^\circ\text{C}$ . The ambient temperature  $30^\circ\text{C}$ , and barometric pressure of 890 milibars. A neutral plume is found at the exit of the chimney. The wind velocity measured at 5 meter height from the ground and the average wind velocity recorded as 3 m/s. The values of exponent p for various stability classes is given below.

Stability Class	A	B	C	D	E	F
Rural	0.07	0.08	0.10	0.15	0.35	0.55
Urban	0.15	0.17	0.20	0.25	0.30	0.35

Calculate:

- i) Effective stack height
- ii) Draw  $SO_2$  concentration profile upto a distance of 15 km from the stack.
- iii) The maximum concentration of fly-ash and  $SO_2$  and how far is this from the plant will occur. Is it acceptable as per NAAQS?
- iv) Draw Fly-ash concentration profile upto a distance of 20 km from the stack

[1+3+4+3= 11]

3. a) A waste water contains 100 of mg/l glucose, 50 of mg/l methyl alcohol and 80 mg/l isophorone ( $C_9H_{14}O$ ). Isophorene is a non-degradable compound. Estimate the COD, TOC and the  $BOD_5$  assuming the  $k_{10}$  for the mixed waste water is 0.25/d.

b) The survey of the discharge from a pharmaceutical plant showed the following data:

Time	Flow (gallons per hour)	COD (mg/l)
7.00AM	1025	80
11AM	720	95
2PM	1620	39
6PM	720	138
10PM	600	146
2AM	550	55

Compute the volume of equalization tank on constant discharge rate. Discharge rate can be assumed as mean inflow rate.

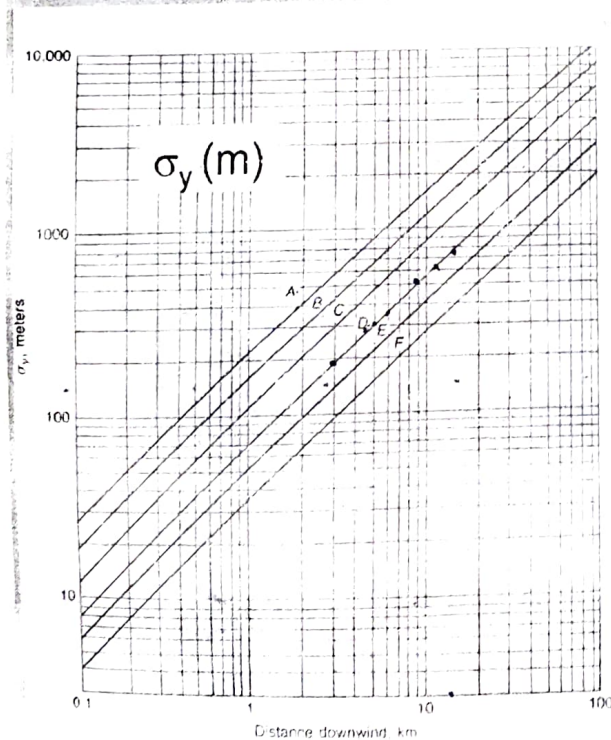
c) An effluent from paper mill shows below characteristics:

suspended solids: 1000 mg/l, Oil/grease content: 10 mg/L, pH: 7-8, Temperature: 29 °C and Heavy metal content: 0.001 mg/L

State pre-treatments methods needs to be used before introducing this effluent water to secondary treatment process.

**[4 + 2 + 2 = 8]**

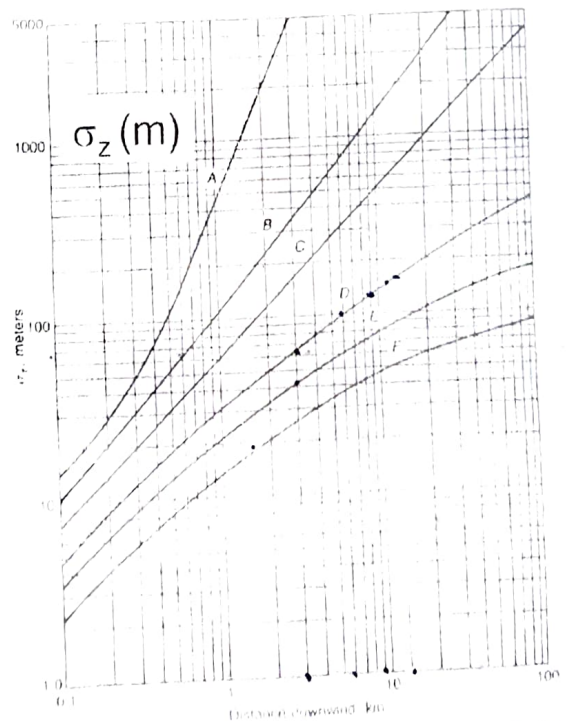
### Horizontal and vertical dispersion coefficients



Stability class

Definition

- |   |                   |
|---|-------------------|
| A | very unstable     |
| B | unstable          |
| C | slightly unstable |



Stability class

Definition

- |   |                 |
|---|-----------------|
| D | neutral         |
| E | slightly stable |
| F | stable          |