# CHE F411 – Environmental Pollution Control
# MID SEM Regular Examination
# Total Marks: 60 Duration: 90 minutes

**Your name:** **Date: 12/10/2023**

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***Important:*** ***Please note that there are 5 question in this exam.*** *This is a* ***Closed book*** *exam. Please READ THE QUESTIONS CAREFULLY, AND KNOW WHAT IS BEING ASKED. No electronic gadgets except non-programmable calculators are allowed. You should carry all necessary items such as pen, pencil, eraser, calculators for taking the test. Answer all questions CLEARLY, TO THE POINT and in such a way that I can understand your answers.* ***Assume any missing data and state your assumption clearly****.*

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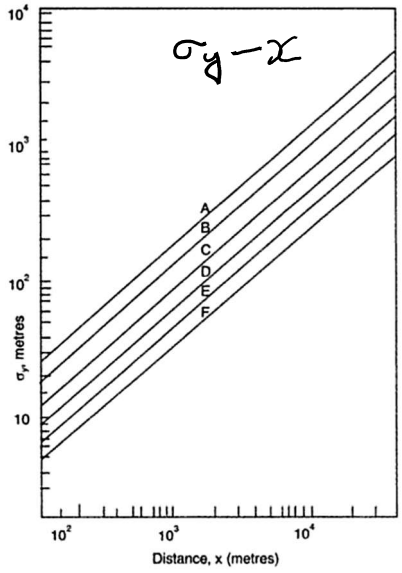
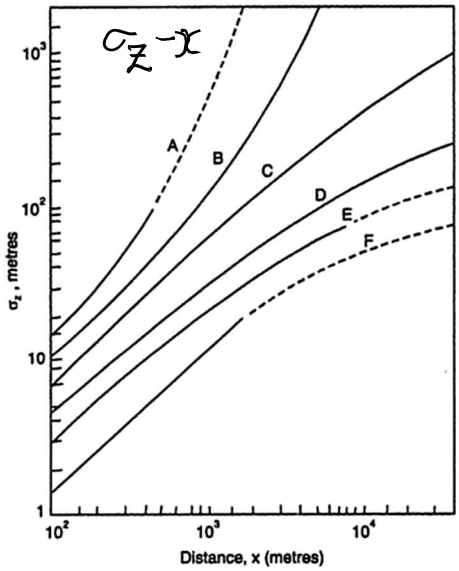
**Q1.** A coal fired power plant is emitting 640 g/s $SO_2$ from a stack of effective height 300m on a cloudy summer afternoon. An anemometer situated at 10 m height measures the wind speed to be 2.5 m/s. Estimate (a) the ground level concentration of $SO_2$ in ppm at a distance of 4km from the stack base and (b)The distance from the stack base at which at maximum ground level concentration occurs. The data from the following graphs may be useful. The molecular weight of $SO_2$ is 64 g/mol and p=0.17. Assume standard temperature and pressure conditions. The following data may be used. [**12 marks**]

| Surface Wind Speed (m/sec)[d] | Sunshine | | |
|---|---|---|---|
| | Strong[e] | Moderate[e] | Slight |
| <2 | A | A-B | B |
| 2-3 | A-B | B | C |
| 3-5 | B | B-C | C |
| 5-6 | C | C-D | D |
| >6 | C | D | D |




**Q2.** A multi-tray settling chamber handles 0.6$m^3$/s of air at 200ºC. There are 8 trays including the bottom surface spaced 0.5m apart. The chamber is 6m long and 2m wide. The viscosity and density of air at 200ºC is 25µPa•s and 0.745 kg/$m^3$, respectively. For particles of density 2000 kg/$m^3$ and for size 50 µm, calculate the following [**15 marks**]

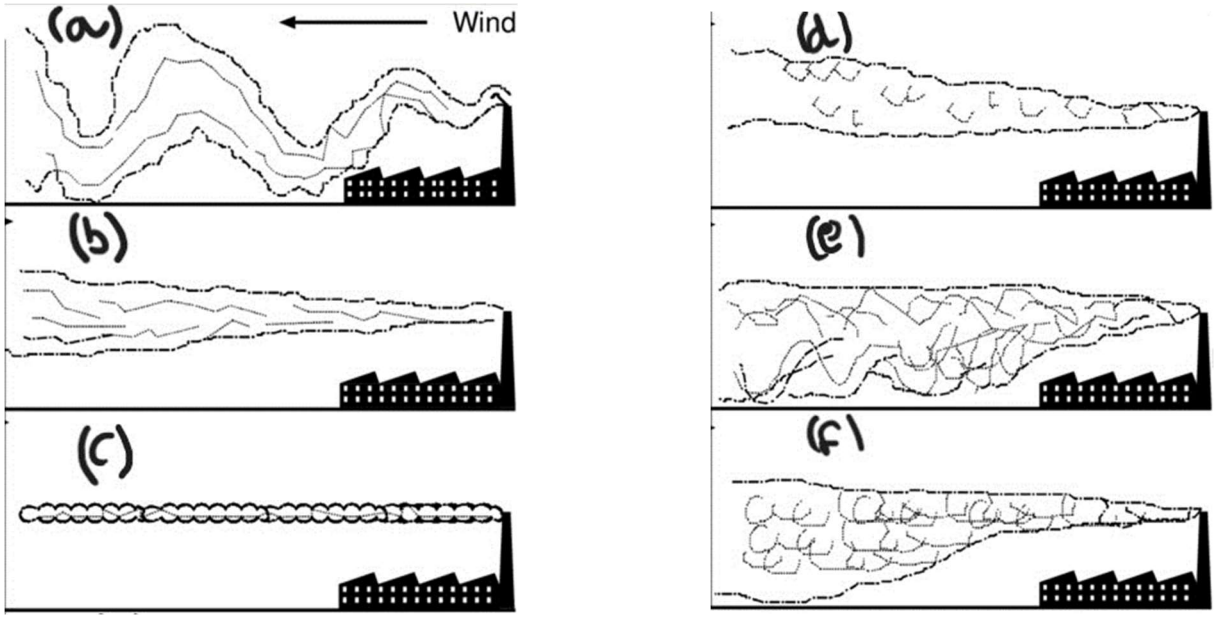
a) The residence time
b) The distance settled
c) Efficiency of collection
d) Efficiency of collection if air flow rate is increased to 6 $m^3$/s

**Q3.** Calculate the venturi throat area required to achieve 90% removal of 1.25 µm radius particle having a density of 1400 kg/$m^3$ for the following air stream and venturi characteristics. The density of air is 1.2 kg/$m^3$ and the viscosity of air is 1.85x$10^{-5}$ kg/m-s at the operating conditions. [**9 marks**]

*Gas flow rate = 10 $m^3$/s , Droplet diameter = 100 µm, Liquid flow rate = 0.1 $m^3$/s, Venturi Coefficient, K = 200, Cunningham Correction Factor = 1*

**Formulae:** $\eta = 1 - \exp(-KR\sqrt{\psi})$, $\psi = \dfrac{C\rho_p v_r (d_p)^2}{18 d_d \mu}$, $v_r = v_G - v_L$

**Q4**. For the following plume behaviors, (a) name the plume type and (b) sketch altitude – temperature plot showing clearly the ELR and DALR prevailing for the observed plume behavior. [**12 marks**]




**Q5.** The concentrations of various air pollutants in a city are as follows:

- Particulate Matter ($PM_{2.5}$): 45 µg/m³
- Nitrogen Dioxide ($NO_2$): 35 ppb (parts per billion)
- Carbon Monoxide (CO): 3 ppm (parts per million)

Determine the (a) AQI based on $PM_{2.5}$ (b) AQI based on $NO_2$ (c) AQI based on CO and (d) Overall AQI of the city. Assume standard temperature and pressure conditions. The following data may be used. [12 **marks**]

| AQI Category (Range) | $PM_{2.5}$ 24-hr | $NO_2$ 24-hr | $O_3$ 8-hr | CO 8-hr | $SO_2$ 24-hr |
|---|---|---|---|---|---|
| Good (0–50) | 0–30 | 0–40 | 0–50 | 0–1.0 | 0–40 |
| Satisfactory (51–100) | 31–60 | 41–80 | 51–100 | 1.1–2.0 | 41–80 |
| Moderate (101–200) | 61–90 | 81–180 | 101–168 | 2.1–10 | 81–380 |
| Poor (201–300) | 91–120 | 181–280 | 169–208 | 10.1–17 | 381–800 |
| Very Poor (301–400) | 121–250 | 281–400 | 209–748 | 17.1–34 | 801–1600 |
| Severe (401–500) | 250+ | 400+ | 748+ | 34+ | 1600+ |

Note: While CO concentrations are expressed in mg $m^{-3}$; the other pollutants are expressed in µg $m^{-3}$.

**Formulae:**

$\mathbf{I_p = [IH_i - IL_o / BPH_i - BPL_o] (Cp - BPL_o) + IL_o}$ ,

$$\rho_p = \frac{M_p y_{ppm} \; X \; 10^3}{24.45}$$

END OF QUESTION PAPER