KATHMANDU UNIVERSITY
End Semester Examination
December, 2024

Marks Scored:

Level : B.E.
Year : IV

Course : CHEG 410
Semester : I

Exam Roll No. :

Time: 30 mins.

F. M. : 10

Registration No.:

Date : 2024-12-~~27~~ 20

SECTION "A"

[20Q. × 0.5 = 10 marks]

Choose the most appropriate answer and **encircle**.

1. Which of the following is not a primary pollutant?
   a. CO b. NO c. O_3 d. SO_2

2. Which philosophy of air pollution control uses the prediction of future pollutant concentrations?
   a. Air quality standard b. Emission standard
   c. Cost-benefit analysis d. Emission taxes

3. Dose response curve is studied for:
   a. Primary pollutants b. Secondary pollutants
   c. Individual pollutants d. Heterogenous pollutants

4. Countercurrent packed flow absorbers are more efficient than spray towers because of the packed tower's increased
   a. Pressure drops to collect the gas b. Diameter
   c. Tower height d. Gas–liquid interfacial area

5. The three variables on which the formation of thermal nitric oxide depend are:
   a. Time, temperature and type of fuel b. Temperature, type of fuel and turbulence
   c. Time, temperature and turbulence d. Type of fuel, oxygen content and time

6. The adsorbent most often used to control organic vapors is:
   a. Molecular sieves b. Activated carbon c. Silica gel d. Zeolites

7. Which method involves reducing pollution through better dispersion?
   a. Using tall stacks for emissions b. Installing scrubbers in stacks
   c. Replacing fossil fuels with renewables d. Burning waste to produce energy

8. The term used to describe the size of a particle that is removed with 50% efficiency is the
   a. Mean diameter b. Critical diameter c. Cut diameter d. Mode

9. As the collection area of an electrostatic precipitator increases, its efficiency generally
   a. Decreases b. Remains the same c. Increases d. Varies

10. The efficiency of a venturi scrubber is 99.32%. Calculate the penetration, in percent, for the unit.
a. 0.68 b. 0.0068 c. 0.0118 d. 0.9932

11. The unit of emission factor is:
a. Tonnes/year b. Btu/lb c. lb/ton d. lb/Btu

12. Consider a 1 μ particle in a circular gas flow with velocity of 10 m/s and radius of 0.5 m. what is the terminal velocity of the particle in cm/s? Take viscosity as 1.8×10^{-5} kg/m.s and density of particle is 2000 kg/m^3.
a. 0.02 b. 0.1234 c. 0.037 d. 1.02

13. Which catalyst is needed to produce SO_3 during the removal of SO_2 from rich waste gases?
a. Nickel b. Tungsten c. Vanadium d. Calcium sulfate

14. What is the primary cause of VOC emissions?
a. Incomplete combustion of organic materials
b. High industrial temperatures
c. Increased pressure in cooling systems
d. Poor air dispersion methods

15. What is the primary source of sulfur oxides in the atmosphere?
a. Natural forest emissions b. Burning of fossil fuels
c. Vehicle exhaust d. Agricultural runoff

16. What is a major approach to reducing NOx emissions in industrial processes?
a. Using low-NOx burners
b. Employing biofiltration
c. Increasing combustion temperatures
d. Adding more oxygen to the combustion process

17. Cunningham correction factor has on calculations involving
a. Stokes' law b. Intermediate law
c. Newton's law d. Overall collection efficiency

18. The larger the mean particle size of a dust flowing through a gravity settler, the higher (generally) the value of the
a. Pressure drop b. Inlet velocity c. Dust concentration d. Efficiency

19. Which control device employs a shake mechanism for cleaning?
a. Venturi scrubber b. Cyclone
c. Baghouse d. Electrostatic precipitator

20. A particle collector has 88% efficiency. If four such collectors are in series, what is the overall efficiency?
a. 99.98% b. 60% c. 88% d. 99.80%

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Level : B.E.
Year : IV
Time : 2 hrs. 30mins.

2024-12-20 ~~27~~

Course : CHEG 410
Semester : I
F. M. : 40

SECTION "B"
[8 Q. × 5 = 40 marks]

Attempt *ALL* questions.

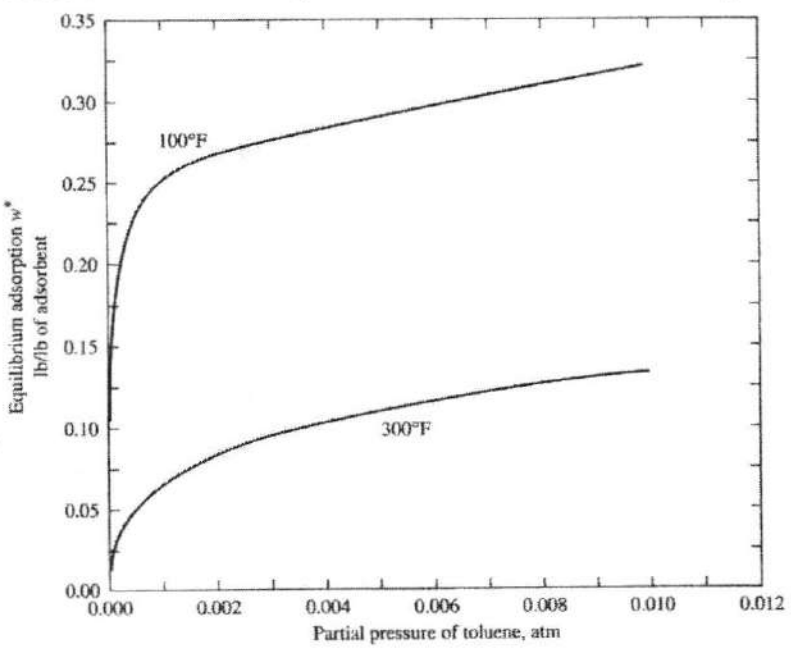
1. How would you implement the air quality standard philosophy in Nepal? Explain it with the air quality management process. [5]

2. A cyclone is used to collect particulates with an efficiency of 60%. A venturi scrubber is used as a second downstream control device. Given a required overall efficiency of 99.0%, determine the minimum operating efficiency of the venturi scrubber. Also calculate the penetration of venturi scrubber. [5]

3. A spherical particle with diameter 0.75 μ and specific gravity 3.4 is settling in still air.
   a. Find terminal settling velocity of this particle, according to Stokes' law [3]
   b. Find terminal settling velocity of this particle, according to Stokes' law, taking the Cunningham correction factor into account. [2]

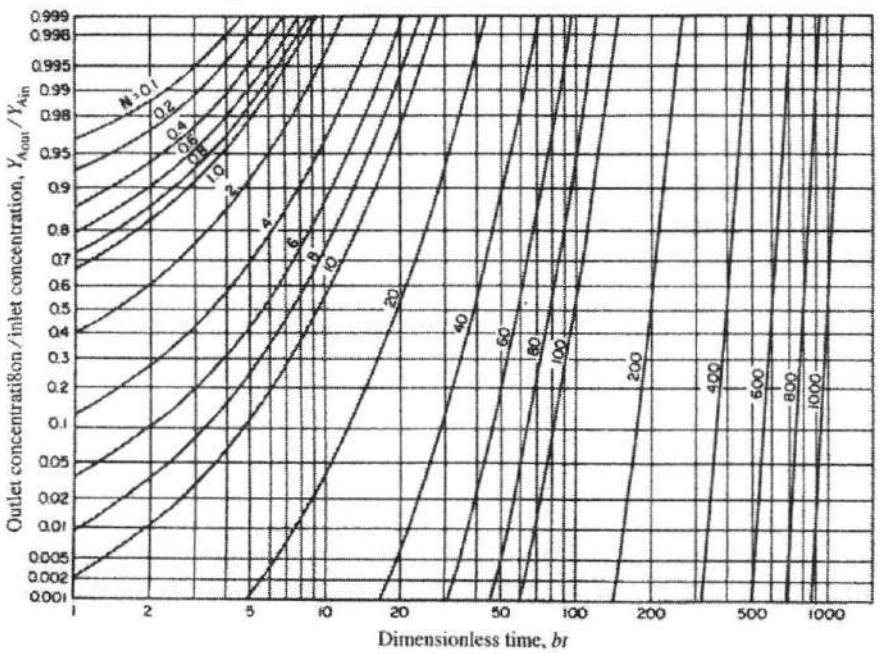
   Take viscosity as 1.8×10^{-5} kg/m.s, A as 1.728 and λ as 0.07 microns

4. We wish to treat an airstream containing 0.005 mol fraction toluene, moving at a flow rate of 1000 scfm at 100°F and 1 atm, so as to remove 99% of toluene. 1 scf = 2.595×10^{-3} lbmol. MW of toluene = 92 lb/lbmol. Total pressure = 1 atm
   a. If the bed must operate 8 h between regenerations, how many kg of activated carbon must it have if it is only used once and then thrown away? [3]



P.T.O.

b. Estimate the breakthrough time when the outlet concentration will become 1% of the inlet concentration if we started with clean adsorbent. Assume that the adsorbent used is activated carbon with bulk density of 30 lb/ft^3 and a particle diameter of 0.0128 ft. the volume of the bed is 66 ft^3. If we assume a cubically shaped bed, the sides of the bed will be 4 ft. Take a = 14.4/ft and b = 7.4/h. in the graph, N is called dimensionless bed thickness given by ax. [2]



5. Describe the process of adsorption and its application in controlling VOC emissions. [5]

OR

Explain how the VOCs can be controlled by oxidation.

6. Calculate the drift velocity for a 0.5 μ diameter particle with dielectric constant of 5 and A/Q of 0.06 s/m, that has reached its equilibrium charge in an ESP at a place where the field strength is 300 kV/m. Also calculate the efficiency of the ESP for block flow and mixed flow. Use permittivity of free space as 8.85×10^{-12} C/(V.m), viscosity as 1.8×10^{-5} kg/m.s

7. What are thermal, prompt and fuel NO_x? Explain the Zeldovich kinetics for NO_x formation.

8. Natural gas is flowing at 40 std m^3/s, and has 1.2% of H_2S. it is treated in a scrubber to reduce H_2S to 3.5 ppm at pressure of 120 atm and 23°C. If water is used for scrubbing, find the required water flow rate in kg/s. The Henry's law constant for H_2S at 23°C is 493 atm. Assume that the H_2S mole fraction in equilibrium with the liquid at the outlet liquid, y_i^*, is 80% of the mole fraction of H_2S in the gas stream, y_i.