

KATHMANDU UNIVERSITY
End Semester Examination
July/August, 2024

Marks Scored:

Level : B.Sc./B.Tech.

Year : III

Exam Roll No. :

Time: 30 mins.

Registration No.:

Course : ENVE 303

Semester : II

F. M. : 20

Date : 30 JUL 2024

SECTION "A"

[20 Q. × 1 = 20 marks]

Choose and encircle in the most appropriate option from each set of choices

- Which is the secondary pollutant formed in the atmosphere?
a. NO₂ b. NO c. HC d. SO₂
- Which of the following is NOT a criteria pollutant?
a. Sulfur oxides b. Ozone c. Mercury d. Lead
- Industrial accident is an example of:
a. Long-term, high concentration b. Short-term, high concentration
c. Long-term, low concentration d. Short-term, low concentration
- Enforceability of emission taxes is:
a. Unknown b. Excellent c. Fair d. Poor
- Which of the following is a well defined sources for emission testing?
a. Powerplant stack b. Road dust from an unpaved road
c. CO from a forest fire d. Methane from wetland
- If coal flow rate is 179 ton/h and emission factor is 10A, where A is ash content equal to 8.7, what is the particulate emission rate (ton/h)?
a. 294.4 b. 2.9 c. 108.8 d. 7.8
- What is the overall efficiency of four collectors in series with 93% individual efficiency?
a. 0.999976 b. 0.99976 c. 2.40×10^{-4} d. 2.40×10^{-5}
- Which of the following is NOT the logical approach to improve dispersion(dilution)?
a. Tall stacks b. Intermittent control schemes
c. Close the plant d. Relocate the plant
- Which model is used by Deutsch-Anderson equation?
a. laminar flow b. block flow c. counterflow d. mixed flow
- What is another name for separation number in depth filters?
a. impaction parameter b. target efficiency
c. interception parameter d. target number
- What do you call the range of particle distribution if particles have size around 0.01 μ?
a. Aitken nuclei b. Accumulation c. mechanical d. homogeneous

12. When do you use Cunningham correction factor in Stokes' law?
a. when particles are very small b. when particles are wet
c. when particles are very big d. when particles coagulate
13. VOC are probably the _____ widespread emissions:
a. most b. second-most c. third-most d. fourth-most
14. The water content of air that is in equilibrium with pure water at 20°C and partial pressure of 0.023 atm is:
a. 0.023 b. 0.230 c. 23.0 d. 0.0023
15. The vast majority of the sulfur exists in the form of?
a. Sulphur Dioxide b. Sulphates
c. Hydrogen Sulphide d. Sulfur Trioxide
16. Which technology provides thoroughly mixing, together with excess air, and prevents there ever being any fuel-rich part of the flame, in which prompt NO can form?
a. FGD b. FGR c. SCR d. SNCR
17. Which one has the highest global warming potential among the following?
a. CO₂ b. N₂O c. CFC-12 d. CH₄
18. Which one is a hazardous air pollutant?
a. NO_x b. CO c. asbestos d. PM_{2.5}
19. A sound has pressure of 15 Pa. The sound level will be:
a. 117.5 dB b. 57 dB c. 5.7 dB d. 11.4 dB
20. If a sound has level of 40 dB, pressure exerted by the sound will be:
a. 0.5×10^{-4} Pa b. 1×10^{-4} Pa c. 1.5×10^{-4} Pa d. 2×10^{-2} Pa

KATHMANDU UNIVERSITY
End Semester Examination
July/August, 2024

Level : B.Sc./B.Tech.
Year : III
Time : 2 hrs. 30mins.

30 JUL 2024

Course : ENVE 303
Semester : II
F. M. : 55

SECTION "B"
[55 marks]

Answer *ALL* the questions. The data or information not given in the questions should be assumed properly.

1.
 - a. Describe resource recovery and the ultimate fate of pollutant with one example of each. [3]
 - b. A gas stream contains two sizes of particles, 60 wt% large and 40 wt% small. We pass this gas stream through two collection devices in series. The collection efficiencies are shown in the following table. What overall weight fraction of the particles is collected? [3]

	First Collector	Second Collector
Collection efficiency for small particles	0.40	0.30
Collection efficiency for large particles	0.80	0.55

2.
 - a. Calculate the total collection area for a 99% efficient ESP that is treating 12000 m³/min of air. The effective drift velocity is 5 m/min. [3]
 - b. Consider a cyclone with a body diameter of 1.0 m, inlet height of 0.5 m and inlet width of 0.25 m. For air with a flow rate of 150 m³/min, containing particles with a density of 1600 kg/m³, calculate the cut diameter of the cyclone. Take viscosity as 0.075 kg/m·hr and density of air as 1.01 kg/m³. [3]

3. A plant is required to treat the exhaust fume generated from the plant. The ash generated from the system is collected at the bottom of the baghouse. The exhaust gas flow of 350,000 ft³/min enters the baghouse with a loading of 6.0 gr/ft³. 7000 gr = 1 lb. The air-to-cloth ratio is 8.0 ft³/min·ft², and the operating particulate collection efficiency is 99.3%. The maximum allowable pressure drop is 10 in. H₂O. The empirical equation for the pressure drop is given by $\Delta P = 0.3 v + 4.0 c v^2 t$ where ΔP is pressure drop in inches of water, v is filtration velocity in ft/min, c is dust concentration in lb/ft³ of gas, t is time in minutes since bags were cleaned.
 - a. How many cylindrical bags, 12 in. in diameter and 30 ft high, will be needed? [3]
 - b. The system is designed to begin cleaning when the pressure drop reaches 10.0 in. H₂O, its maximum allowable value. How frequently should the bags be cleaned? [3]

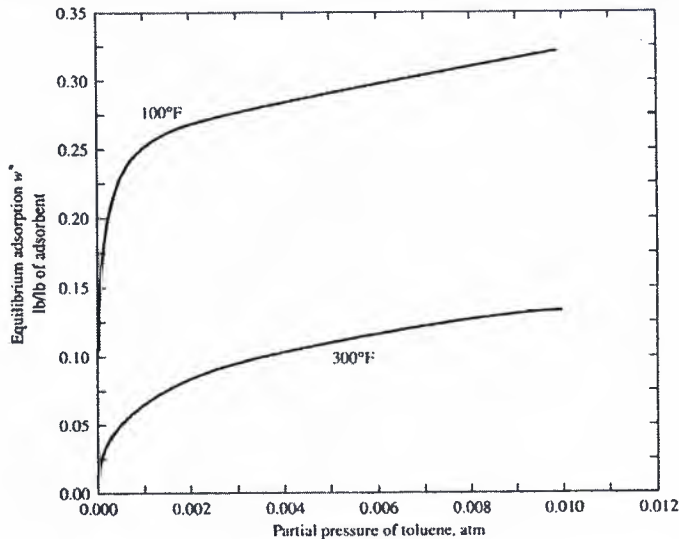
4. A sample contains 78% N₂ and 4% O₂ that is held at 2000 K. If Zeldovich thermal mechanism is applied, how long would the gas have to be held at that temperature for the calculated thermal NO concentration to be 1500 ppm? Take [NO]_e = 3530 ppm. $R = 1.987$ cal/mol·K, molar density of any ideal gas is 6.1×10^{-6} mol/cm³. Use the formulae: $k_b = 4.1 \times 10^{13} \exp(-91600/RT)$ and $[NO]/[NO]_e = (1 - \exp(-at))/(1 + \exp(-at))$ where $a = 2[NO]_e \cdot k_b / [O_2]^{1/2}$ [5]

5.
 - a. What are the FOUR philosophies of air pollution control? [2]
 - b. What are the advantages and disadvantages of the air quality standard philosophy? [3]

P.T.O.

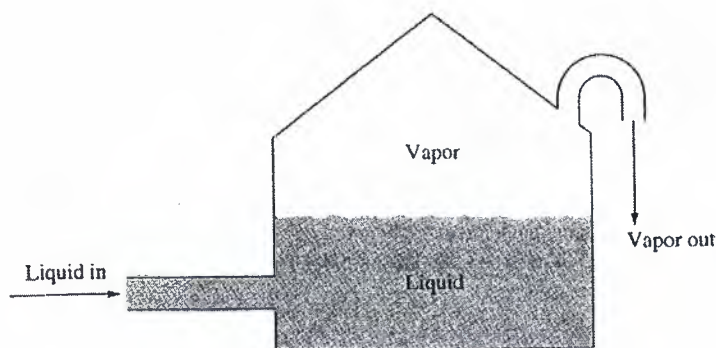
6. We wish to treat an airstream containing 0.005 mol fraction (0.5%, 5000 ppm) toluene, moving at a flow rate of 1000 scfm at 100°F and 1 atm, so as to remove practically all of the toluene. 1 scf = 2.595×10^{-3} lbmol. MW of toluene = 92 lb/lbmol. Total pressure = 14.7 psi.

- a. If the bed must operate 8 h between regenerations, how many pounds of activated carbon must it have if it is only used once and then thrown away? [2]



We now shut off this bed from the stream it is treating and regenerate it by pulling a vacuum in it. We reduce the pressure in the bed to 0.1 atm. Then we allow a small steady stream of purge air to pass through the bed while our vacuum pumps continue to hold the pressure at 0.1 atm.

- b. If that air comes to equilibrium with the toluene on the carbon in the bed, what will the mol fraction of toluene in this purge air be? [2]
 c. If we continue until the concentration in this purge air falls to 0.01 mol fraction (1 mol %), what will the toluene concentration in the bed (lb toluene/lb adsorbent) be? [2]
7. a. Describe briefly THREE types of VOC losses based on the figure below. [3]



- b. The tank in the figure contains pure liquid benzene at 20 °C which is in equilibrium with the air-benzene vapor in its headspace. If we now pump in liquid benzene, how much (in kg) benzene will be emitted in the vent gas per m³ of benzene liquid pumped in? [2]
 c. What fraction is this of the liquid benzene pumped into the tank? Vapor pressure of benzene at 20 °C is 1.45 psi and density of benzene is 865 kg/m³. [1 psi = 6894.76 Pa] [1]

8. a. A typical person at rest produces 0.007 mL (NTP)/min of CO, which is exhaled. The typical human diet in wealthy countries like the United States is about 600 g/day of food (dry basis). What is the emission factor (g CO/g food) for a person? [3]
- b. In a source test, the stack was divided into four sectors, each of which had the same cross-sectional area. The following velocities and pollutant concentrations were measured in these sectors:

Sector number	Velocity (m/s)	Concentration c , mg/m ³
1	10	500
2	12	600
3	14	650
4	15	675

What is the average concentration in the gas flowing in this stack? [2]

9. A spherical particle with diameter 0.98 μ and specific gravity 4.3 is settling in still air. Viscosity is 1.8×10^{-5} kg/m \cdot s.
- a. What is the terminal settling velocity of this particle, according to Stokes' law? [3]
- b. What will be the corrected settling velocity? Take $A = 1.728$, $\lambda = 0.07 \mu$. [2]
10. A flow of 32.8 m³/s of natural gas which contains 1% of H₂S, is treated absorption tower with water to reduce the H₂S concentration to 4 ppm. The gas is scrubbed at a pressure of 100 atm and 20 °C. Estimate the required water flow rate. Henry's constant for H₂S at 20 °C = 483 atm. Assume 80% of equilibrium value is achieved. [5]

100-20-35

