

PRINCE OF SONGKLA UNIVERSITY
FACULTY OF ENGINEERING

Midterm Examination: Semester II

Academic Year: 2008

Date: December 21, 2008

Time: 13:30-16:30

Subject: 230-544 Air Pollution Control Technology
for Gaseous and Particulate Emissions

Room: R201

อนุญาตให้นำเอกสารและเครื่องคำนวณทุกชนิดเข้าห้องสอบได้
ทุจริตในการสอบโทษขั้นต่ำคือปรับตกในรายวิชาที่ทุจริต
และพักการศึกษา 1 ภาคการศึกษา

Name _____ Student No. _____

Please do all 8 questions. Show all your work to receive full or partial credit.
Final score is 100. (Total page = 13, including first page)

Question #	Total Score	Score
1	10	
2	10	
3	20	
4	10	
5	10	
6	20	
7	10	
8	10	
Total	100	

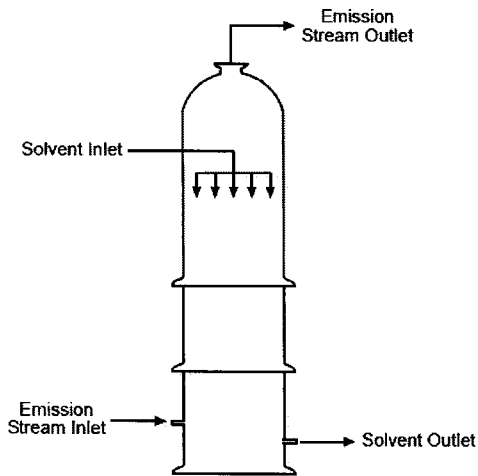
Asst. Prof. Chayanoot Sangwichien

12 December 2008

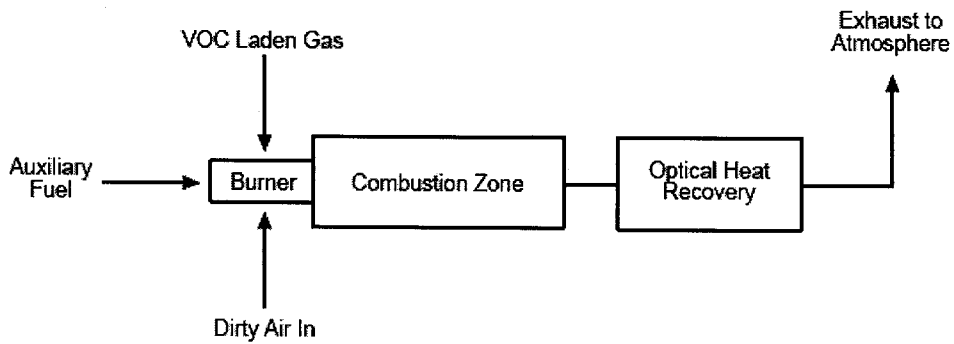
1. (10 points) Match the control technology with the device that is displayed and answer the questions in the spaces provided.

- A. Electrostatic Precipitator
- B. Catalytic Incinerator
- C. Contact Condenser
- D. Carbon Adsorber
- E. Cyclone Collector
- F. Elevated Flare System

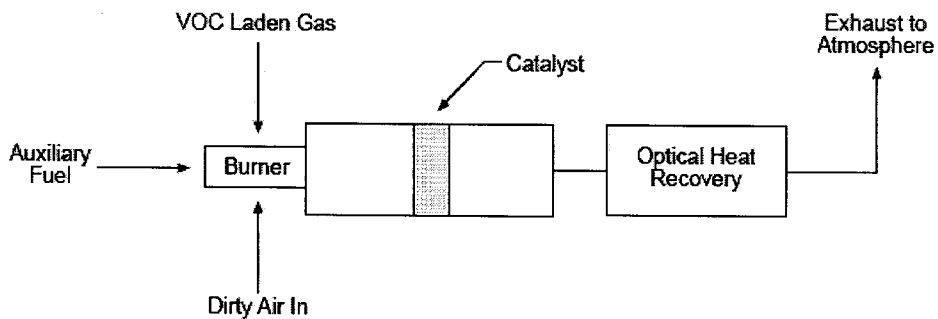
- G. Packed Column Absorber
- H. Fabric Filter
- I. Thermal Incinerator
- J. Adsorption System
- K. Settling Chamber
- L. Venturi Scrubber



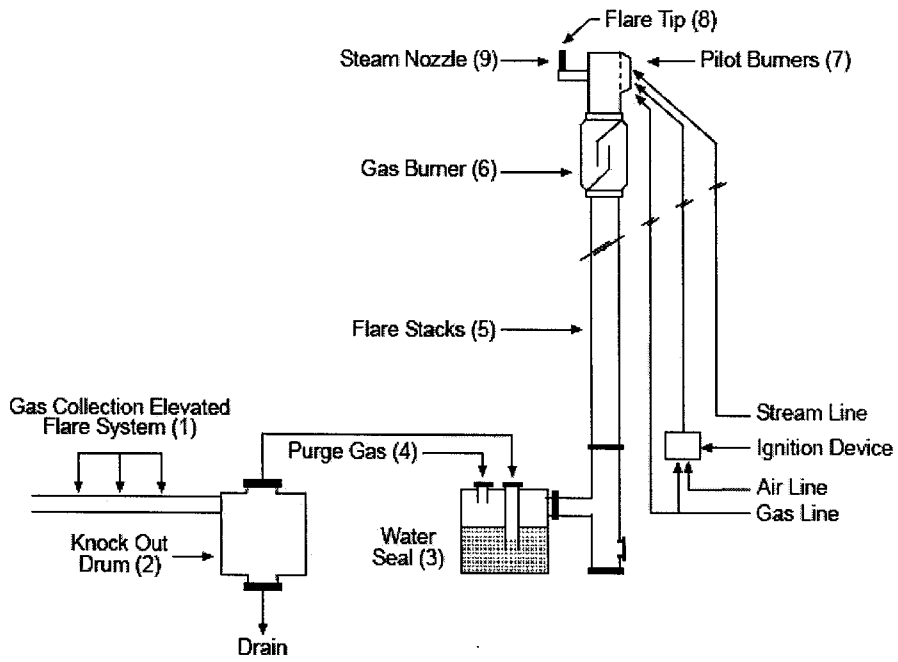
Answer.....



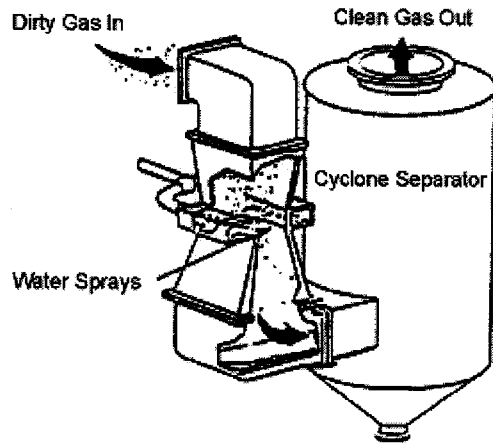
Answer.....



Answer.....



Answer.....



Answer.....

2. (10 points): Read each question and choose the best answer. Write the letter of your answer in the space provided.

2.1 The following are all principles used to control gaseous emissions, except _____.

- a. impaction
- b. condensation
- c. absorption
- d. adsorption
- e. combustion

2.1 _____

2.2 Absorbers collect gaseous pollutants by _____.

- a. trapping them in a carbon reagent
- b. transferring them from the gas stream into the liquid reagent
- c. freezing or condensing the pollutant into a more solid substance
- d. heating the pollutant to hasten disposal through combustion
- e. catalytic means that consumes the pollutant

2.2 _____

2.3 Contact Condensers are _____.

- a. used to control nitrogen oxide emissions
- b. control devices in which coolants come in direct contact with vapors
- c. sometimes referred to as shell and tube heat exchangers
- d. control devices that are always used before adsorbers for VOC control
- e. allow exhaust gases and coolant to exit separately

2.3 _____

2.4 Each of the following is a direct effect of air pollution on the respiratory system, except _____.

- a. pulmonary emphysema
- b. lung cancer
- c. pneumoconiosis
- d. chest pain
- e. blood poisoning

2.4 _____

2.5 _____ accounts for most of the total SO₂ emissions.

- a. Petroleum refining
- b. Sulfuric Acid Manufacturing
- c. Fuel combustion
- d. Smelting
- e. Coating Industry

2.5 _____

Directions: Match each of the following with the proper control technology

Control Technology

- A. Scrubbers
- B. Condensers
- C. Adsorbers
- D. SNCR
- E. Biofiltration

2.6 Can be used for condensable gases and vapors. _____

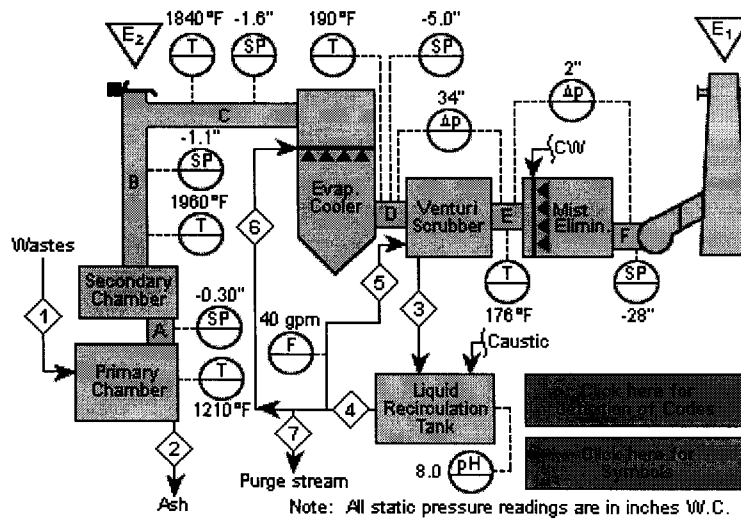
2.7 For collecting a mixture of volatile organic gases _____

2.8 Effluents can create water pollution problems. _____

2.9 Effective for NO_x removal. _____

2.10 The phenomena “ammonia slip” can occur if the gas stream is too hot. _____

3. (20 points) Use the flowchart to answer the following questions.



- i. Draw a temperature profile for the readings provided in the process.
- ii. Do any readings appear inconsistent with the process? Explain.
- iii. Draw a static pressure profile for the readings provided in the process.
- iv. Do any readings appear inconsistent with the process?

4. (10 points) Calculate the furthest distance that a flanged hood with dimensions of 6 in. by 12 in., can be placed from the contaminant source and still maintain the capture velocity of 300 fpm and a volumetric flow rate of 2000 ACFM. The equation for a flanged hood is provided below.

$$Q = v_h (0.75)(10X^2 + A)$$

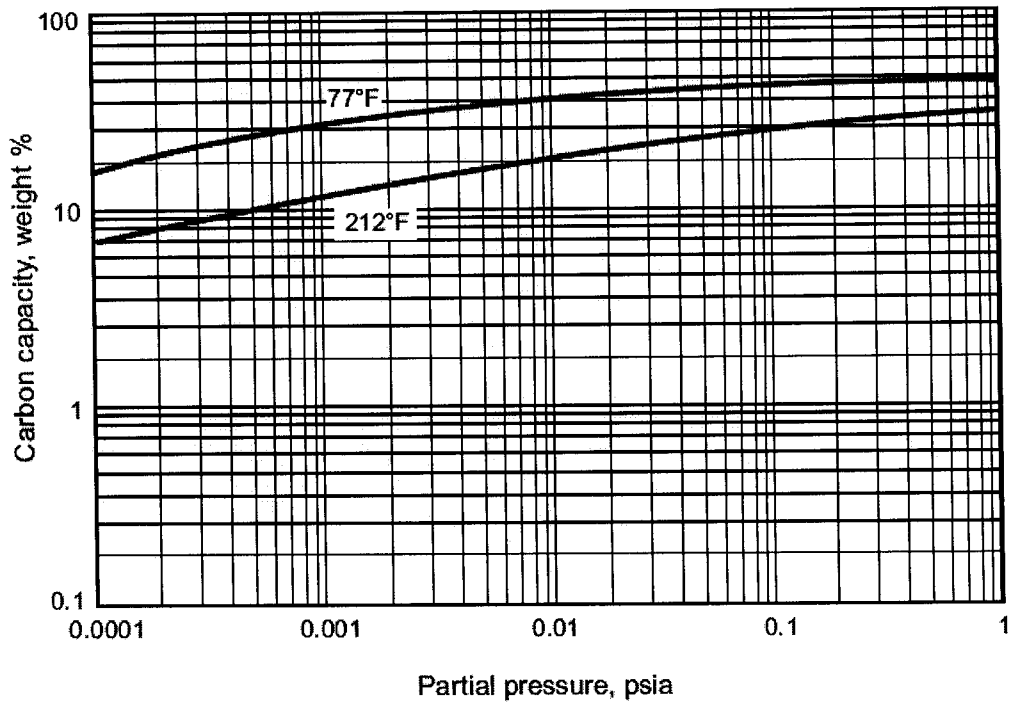
5. (10 points) At a fan speed of 700 rpm, the static pressure drop across the system at the fan inlet is -8 in. W.C. and the gas flow rate is 6,500 ACFM. Estimate the gas flow rate in ACFM if the fan speed changes and the new static pressure drop is -5.5 in. W.C. Assume that the rest of the system remains the same.

6. (20 points) Use the following figure (Toluene Isotherm) to answer the following questions.

Given: Molecular weight of toluene = 92.1

Activated carbon density = 30 lb_m/ft³

- i. What is the saturation capacity of activated carbon for toluene at a temperature of 212 °F , 1 atm and a toluene concentration of 6800 ppm?

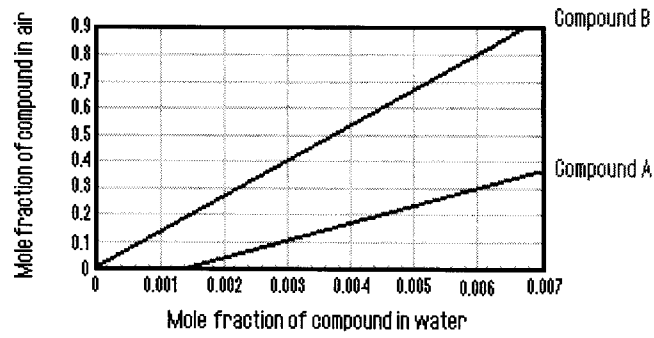


ii. How much activated carbon would be needed in a three bed regenerative system to treat a gas stream having a toluene concentration 6800 ppm and a gas flow rate of 20,000 SCFM? Assume that each bed is desorbed every fifth hour. Assume that the working capacity is 75 % of the saturation capacity.

iii. Determine the gas flow rate in ACFM if the absolute SP of gas stream is 412 in. W.C. (1 lb mole = 385.4 scf)

iv. Estimate the bed depth based on a 100 ft/min maximum velocity.

7. (10 points) The solubility graph for two gases (Compound A and Compound B) in water at 20°C is shown below. Determine Henry's law constant for each compound. Which compound is most readily absorbed by water? (Density of Compound A and B are 80 and 62.4 lb_m/ft³ respectively.)



8. (10 points) Calculate the minimum liquid rate (gal/min) of pure water required to remove 90 % of Compound B (from Problem No. 7) from a gas stream of $95 \text{ m}^3/\text{min}$ containing 50,000 ppm Compound B by volume. The temperature is $20 \text{ }^\circ\text{C}$ and the pressure is 1 atm.

