

Chemical Engineering Department

CHL 275, Major Exam, 08 May 2016 1-3 PM

M. Marks: 40

Time: 2 Hour

1. A worker splash-fills 400 liters of tetrahydrofuran (THF) ( $C_4H_8O$ ) over a 5 min period into a reactor vessel of 1500 liters volume. The filling is done through a manway of 0.5 m diameter. The local ventilation rate is  $0.5 \text{ m}^3/\text{s}$ , the ambient pressure is 1 atm and the temperature is  $25^\circ\text{C}$ . Estimate the total concentration of the THF, in ppm. What statement can you make regarding the worker's exposure to THF.

Physical property data for THF:

Vapor pressure: 114 mm Hg    Liquid density:  $888 \text{ kg/m}^3$     TLV-TWA: 50 ppm    (8)

2. Calculate the explosive energy of 1 kg.mole of air at 200 atm gauge and  $20^\circ\text{C}$  using isentropic expansion method. Assume the heat capacity ratio as 1.4. Determine the equivalent amount of TNT. (8)

3. An operator was told to control the temperature of the reactor at  $60^\circ\text{C}$ . He set the set point of the temperature controller at 60. The scale actually indicated 0-100% of a temperature range of 0-  $200^\circ\text{C}$ . This caused a runaway reaction that over-pressured the reactor. Liquid was discharged and injured the operator. What was the set point temperature the operator actually set. (4)

4. Liquid levels in the storage tanks are frequently determined by measuring the pressure at the bottom of the tank. In one such tank the material stored in the tank was changed and an overflow resulted. Why? (4)

5. A drum contains 42 gallons of toluene. If the lid of the drum is left opened (lid diameter = 3 ft) determine the time required to evaporate all of the toluene in the drum. Temperature is  $85^\circ\text{F}$  and pressure is 1 atm. Estimate the concentration of toluene in ppm near the drum if the local ventilation rate is  $1000 \text{ ft}^3/\text{min}$ . Saturation vap pressure of toluene is 28.2 mm Hg. Sp. Gravity of toluene is 0.8. (8)

6. A vessel of volume 50,000 gallon is being filled with toluene. Compute Q and J during the filling operation when the vessel is half- full and where

$F = 100 \text{ gpm}$

$I_s = 1.5 \times 10^{-7} \text{ amp}$

Liquid conductivity =  $10^{-14} \text{ mho/cm}$

Dielectric constant = 2.4

(8)