Name : ....

Roll No. : ....

Invigilator's Signature : ....

CS/B.TECH(CHE)/SEM-8/CHE-804 D/2012

2012
SAFETY IN CHEMICAL PROCESS INDUSTRIES

Time Allotted : 3 Hours   *Full Marks* : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words
as far as practicable.

GROUP – A
(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following :

                                                    10 × 1 = 10

    i)   Fatal Accident Rate (FAR) is based on entire life of

         a)   100 workers   b)   1000 workers

         c)   10 workers   d)   20,000 workers.

    ii) LTIR means

         a)   Last-time incident rate

         b)   lost-time injury rate

         c)   lost-time incident rate

         d)   least-time incident rate.

8367   [Turn over

iii) Fire triangle consists of

   a) Fuel, oxidizer and source of ignition

   b) Fuel, oxygen and temperature

   c) Coal, oxygen and temperature

   d) Hydrogen, oxygen and source of ignition.

iv) Class A fire means

   a) Fire of solid fuels

   b) Fire of gaseous fuels

   c) Fire of conventional fuels in presence of electrical wiring

   d) Fire of metals.

v) Toxicants enter biological body through mouth into stomach is called

   a) Ingestion   b) Inhalation

   c) Injection   d) Dermal absorption.

vi) TNT means

   a) trinitro toluene   b) tetranitro toluene

   c) tertiary nitro toluene   d) none of these.

vii) In HAZOP study, the guide word "as well as" means

   a) Quantitative decrease   b) Quantitative increase

   c) Complate substitution   d) No change.

viii) IDLH means

   a) Immediately dangerous to life or health

   b) Instantaneous death and lethal to health

   c) Intense dark light house

   d) Immune deficiency lethal home.

ix) The probability of failure an event which is dependent on the outcome of two simultaneous event occurring (of probabilities 0.1 and 0.01 respectively) is

   a) 0.11

   b) 0.001

   c) 0.89

   d) 0.999.

x) The reliability of an event occurring from the outcome of either one of two preceding event occurring having the success rate of 0.2 and 0.5 respectively is

   a) 0.1

   b) 0.9

   c) 0.7

   d) 0.3.

xi) The Bhopal accident, one of the major disasters in chemical industries, is linked with

   a) MIC leakage on 3rd December, 1984

   b) Killed 2000 civilian and injured an estimated 20,000 more

   c) 25 tons of toxic MIC vapor released

   d) all of these.

xii) LFL_{mix} of a mixture of gaseous fuels may be estimated as

a) $1/\Sigma(M_i/LFL_i)$

b) $1/\Sigma(p_i/LFL_i)$

c) $1/\Sigma(y_i/LFL_i)$

d) none of these.

(Here, M = Mol. wt. ; p = % ; y = mol. fraction ; & i = any
component)

GROUP – B
(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

2. Assuming that a car travels at an average speed of 50 miles/hr, how many miles must be driven before a fatality is expected ? Fatal accident rate (FAR) of car driving is 57.

3. Define the term, 'safety', 'hazards', 'fire', 'explosion' and 'risk'.

4. What are the basic ingredients of a safety programme ? Discuss them in brief.

5. Write short notes on Detonation and Deflagration.

6. Write short notes on BLEVE.

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

7. a) In case of worker exposures to toxic vapors, prove that

$C_{ppm} = (Q_m RT / k' Q_v PM) \times 10^6,$

where C_{ppm}, concentration of volatiles vapor in the enclosure in ppm ; Q_m, evolution rate of volatile material (mass/time) ; Q_v, ventilation rate (volume/time) ; R, the gas constant ; T, absolute temperature ; P, absolute pressure ; k', non ideal mixing factor and M, the molecular weight of the volatile species.

   b) An open toluene container in an enclosure is weighed as a function of time and it is determined that the average evaporation rate is 0.1 g/min. The ventilation rate is 100 ft^3 / min. The temperature is 80°F and the pressure is 1 atm. Estimate the concentration of toluene vapor in the enclosure and compare your answer to the *TLV* for toluene of 50 ppm. Mol. wt. of toluene is 92, $R = 0.7302$ ft^3 atm / 1b-mol °R.   7 + 8

8. Consider the reactor system as shown in Fig. The reaction is exothermic, so a cooling system is provided to remove the excess energy of reaction. In the event that the cooling function is lost, the temperature of the reactor would increase. This would lead to an increase in reaction rate, leading to additional energy release. The result would be a runway reaction with pressure exceeding the bursting
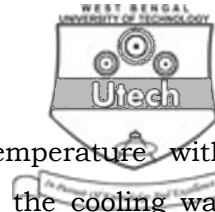
pressure of the reactor vessel. The temperature within reactor is measured and used to control the cooling water flow rate. Perform HAZOP study on this unit to improve the safety of the process. Use as study nodes the cooling coil (process parameter : flow and temperature) and the stirrer (process parameter : agitation).
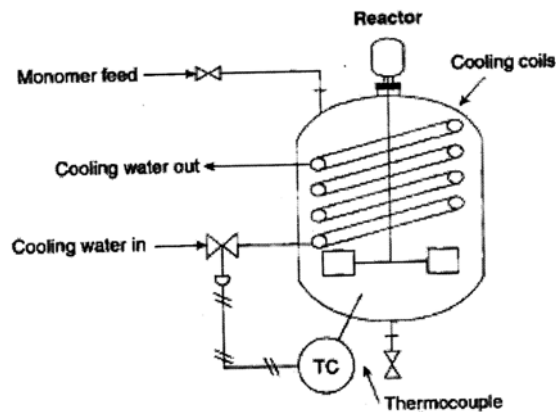

Fig. An exothermic reaction controlled by cooling water

9. If a building fire occurs, a smoke alarm sounds with probability 0.9. The sprinkler system functions with probability 0.7 whether or not the smoke alarm sounds. The consequences are minor fire damage (alarm sounds, sprinkler works), moderate fire damage with few injuries (alarm sounds, sprinkler fails), moderate fire damage with many injuries (alarm fails, sprinkler works), and major fire damage with many injuries (alarm fails, sprinkler fails). Construct an event tree and indicate the probabilities for each of the four consequences.

10. a) Outline the key safety factors considered in the layout of a new plant.

b) Discuss the major steps for a disaster management.

8 + 7

11. a) Discuss the different tools for risk analysis.

b) What are the LFL and UFL of a gas mixture composed of 0.8% hexane, 2.0% methane and 0.5 % ethylene by volume ? Is the mixture flammable ? The LFL and UFL of the gases are given as ;

Components	LFL (vol %)	UFL (vol %)
Hexane	1.2	7.5
Methane	5.3	15.0
Ethylene	3.1	32.0

7 + 8