



Name :

Roll No. :

Invigilator's Signature :

CS/B.Tech (CHE)/NEW/SEM-6/CHE-605 B/2013

2013

INDUSTRIAL SAFETY AND HAZARD ANALYSIS

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) OSHA stands for
 - a) Organization of Safety and Health Administration
 - b) Occupational Safety and Health Administration
 - c) Organization of Safety and Health agency
 - d) Occupational Safety and Health Agency.
- ii) The first layer of safety protection is
 - a) inclusion of control system
 - b) inclusion of interlocks
 - c) the process design
 - d) inclusion of safety shut-down system.



- iii) A process has a reported FAR of 2. If an employee works a standard 8 hr shift 300 days per year, the death per person per year will be
- a) 4.8×10^{-5} b) 2.4×10^{-5}
c) 1.2×10^{-5} d) 2.4×10^{-6} .
- iv) The Risk Management Plan document is updated when
- a) there is a serious accident in the plant
b) the process or chemistry changes
c) a government audit requests an update
d) both (b) and (c).
- v) Flash point of a liquid
- a) increases with increase in pressure
b) increases with decrease in pressure
c) is independent of pressure
d) may increase or decrease with pressure depending on the type of liquid.
- vi) Deflagration is an explosion in which the reaction front
- a) is stationary
b) moves with a supersonic speed
c) moves with a subsonic speed
d) none of these.



- vii) Below the lower flammability limit
- vapour-air mixture will burn spontaneously
 - vapour-air mixture will not burn
 - vapour-air mixture will burn if the pressure is increased
 - vapour-air mixture will burn spontaneously if pressure is reduced.
- viii) Lower Flammability Limit of a mixture is given by
- $LFL_{mix} = \frac{1}{\sum \frac{y_i}{LFL_i}}$
 - $LFL_{mix} = \sum \frac{y_i}{LFL_i}$
 - $LFL_{mix} = \sum \frac{LFL_i}{y_i}$
 - none of these.
- ix) A worker year means
- 20 hrs
 - 200 hrs
 - 2000 hrs
 - 20,000 hrs.
- x) In safety program, the most important part is
- safety system
 - company principle
 - attitude of the employee
 - person working (you).



- xi) In detonation, the reaction front moves at a speed
- greater than the speed of sound
 - lesser than the speed of sound
 - equal to the speed of sound
 - none of these.
- xii) If two intermediate combination events $Q = A + B$ and $R = A + C$ are connected by AND gate, the probability (P) of the final event will be
- $P = A + B + C$
 - $P = A.B.C$
 - $P = A.B + C$
 - $P = A + B.C$

GROUP – B

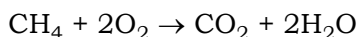
(Short Answer Type Questions)

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

- Define the following : 5×1
 - Hazard
 - Risk
 - FAR
 - Fire triangle
 - Detonation.
- Distinguish between fire and explosion. Briefly discuss about BLEVE. $3 + 2$



4. Estimate the limiting oxygen concentration for methane for the reaction



Given that the lower flammability limit for methane is 0.8% by volume.

5. Write a short note on Wind Rose.
6. Write a note on Intensification and Attenuation of hazardous materials.

GROUP – C

(Long Answer Type Questions)

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

7. Define the term 'process safety'. State the major approaches to inherent safety in process industry. Describe in detail the inherent safety techniques used in process industry. 4 + 4 + 7
8. State the objective of HAZOP. What are the documentations required for HAZOP ? Discuss briefly the procedure followed for HAZOP. 4 + 4 + 7
9. A diagram of the safety systems in a certain chemical reactor is shown in Figure 1. The reactor contains a high-pressure alarm to alert the operator in the event of dangerous reactor pressures. It consists of a pressure switch within the reactor



connected to an alarm light indicator. For additional safety an automatic high pressure reactor shutdown system is installed. This system is activated at a pressure somewhat higher than the alarm system and consists of a pressure switch connected to a solenoid valve in the reactor feed line. The automatic system stops the flow of reactant in the event of dangerous pressures. Compute the overall failure rate, the failure probability, the reliability, and the MTBF for a high pressure condition. Assume a 1-yr period of operation. The failure rates (μ) (faults/yr) of pressure switch, alarm indicator and solenoid valve are 0.14, 0.044 and 0.42, respectively.

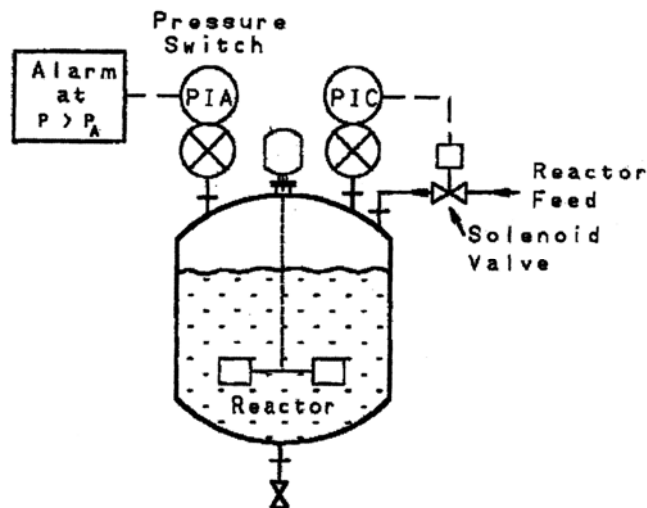
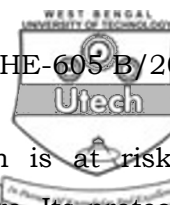


Figure 1 Chemical reactor with an alarm and an inlet feed solenoid

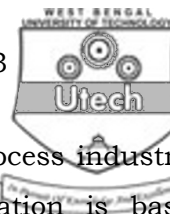


10. A reactor effecting an exothermic reaction is at risk of thermal runaway in the event of coolant failure. Its protective trip system is intended to open a dump valve which empties the reactor if low coolant flow or high reaction temperature is detected. Draw a fault tree which summarizes the failure logic analysis given below. Calculate the frequency of the runaway reaction.

Failure Logic Analysis :

Runway reaction occurs if cooling water failure occurs whilst the protective system is inoperative. Cooling water failure can occur because of pump failure, line blockage or an exhausted water supply. The protective system may be inoperative when either the shutdown system fails because the dump valve fails shut, or because the detection system fails.

Failure	Failure rate
Pump failure	0.2 yr^{-1}
Line blocked	0.01 yr^{-1}
Supply tank empty	0.1 yr^{-1}
Dump valve fails shut	$0.001/\text{demand}$
Low flow trip failure	$0.01/\text{demand}$
High temperature trip failure	$0.01/\text{demand}$



11. a) Why is ventilation done in chemical process industry ?
State the principles on which ventilation is based.
Describe in detail any one method of ventilation used in
industry. 2 + 3 + 3
- 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 gm/min. The ventilation rate is
2.832 m³/min. The temperature is 26.67°C and the
pressure is 1 atm. Estimate the concentration of toluene
vapour in the enclosure.

Data : The non-ideal mixing factor (k) = 0.5 7
