

**BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI**  
**SEMESTER I, 2016-17**  
**CHE F413: PROCESS PLANT SAFETY**  
**MID-SEMSTER EXAMINATION**

**Date: 06/10/2016**

**Duration: 90 min**

**Day: Thursday**

**Max. Marks: 50**

**Instructions:**

- 1. Take suitable assumption wherever necessary.**
- 2. Use separate answer books for Closed/Open book section.**
- 3. Start a new answer on a new page.**
- 4. Numbers in square bracket to the right indicate marks allotted to that question.**

**CLOSED BOOK**

- Q.1)** A chemical plant has three process units which employs 1500 full-time workers. A worker on an average spends 20% of his time in process unit 1, 30% in process unit 2 and 50% in process unit 3. Assume an employee works for 8-hrs in a shift and 300 days in a year. Annual survey of the plant accidents revealed the following information: **[8]**

	Unit-1	Unit-2	Unit-3
Number of deaths	2	3	7
Number of injuries	10	15	25
Lost workdays	30		

Report the accident and loss statics in the following systems for the plant:

- i.) OSHA incidence rate
- ii.) Fatal accident rate
- iii.) Fatality rate

- Q.2)** Mostly the exposures to a toxicants in a chemical plant facility or a laboratory occurs through respiratory system by inhalation. Discuss what happens when a toxicant passes through respiratory system. Compare this route of toxicant entry to the possible modes. **[6]**

- Q.3)** Plastic and fibers producing plants often requires to keep a large inventory of raw material, xylene. A typical plastic manufacturing plant in Ankleshwar uses a cylindrical tank (Height: 6 m; Diameter: 1.5 m) to store xylene. To prevent buildup of oxygen beyond MOC, the tank is padded with an inert gas at a constant regulated pressure of 1 atm gauge. The liquid level in the tank is maintained at 5 m. An explosion in the nearby pump caused a hole of 1-inch in the bottom of xylene storage tank 1 m above the ground. **[18]**
- Estimate: (a) the volume of xylene spilled?  
(b) time required for the xylene to leak out? Is the time sufficient to stop the leak or to invoke an emergency procedure?  
(c) the maximum flow rate of xylene through the leak?

The Specific gravity of xylene at the given conditions is 0.87.

**Note: Derive the necessary expressions required in each part.**

**Q.4)**

- (A) List out the various parameters that affect the atmospheric dispersion of toxic materials. Which one of them you think is most significant. [3]
- (B) Compare and contrast:  
i.) A puff and a plume. Cite an example for each case (puff/plume release). [3]  
ii.) Detonation and deflagration (Schematic only). [3]

**OPEN BOOK**

- Q.5)** For vessels being filled with liquid, volatile emissions are generated from the evaporation of the liquid and the displacement of the vapor in the vapor space by the liquid filling the vessel. The concentration of vapors (in ppm) in an enclosure as a result of this operation is given by: [9]

$$C_{ppm} = \frac{P^{sat}}{kQ_v P} (\phi r_f V_c + KA) \times 10^6$$

The symbols used in the expression have their usual meanings.

Consider a reactor vessel of 16000 liters being splash filled with 400 liters of furfuryl alcohol ( $C_5H_6O_2$ ) over a 8-min period. The filling is done through a manway of 0.2 m diameter. In order to prevent the buildup of vapors local ventilation of  $0.6 \text{ m}^3/\text{s}$  is provided at ambient temperature and pressure. Is this ventilation sufficient to reduce the furfuryl alcohol vapor concentration below the TLV. Justify your answer. If no, what ventilation rate would you recommend. Assume the mass transfer coefficient of water is  $0.83 \text{ cm/s}$ .

Physical property data for furfuryl alcohol:

Molecular Weight:	98.1
Vapor pressure:	0.609 mm Hg
Liquid density:	$1130 \text{ kg/m}^3$
TLV-TWA:	50 ppm

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