09-MMP-B4
Occupational Health, Safety and Loss Management

Open Book Exam and Calculator Permitted

3 Hours Duration

Notes:

1. An attempt is made to provide all relevant data, but in case of doubt the student is allowed to make assumption, however he/she is urged to submit with the answer paper a clear statement of any assumptions made while solving a problem.

2. Answer any five of the six questions.

3. Only the first five questions as they appear in your answer book will be marked.

4. Weight and expected time to complete of each question is mentioned just below the question.

Question # 1

a) Define the term "acceptable risk" and the risk acceptance criteria ALARP.

(5%, 10 minutes)

b) A worker is exposed to benzene concentration as per following schedule, is the work place safe?

Exposure (hours)	Concentration, ppm
1	300
2	200
4	100
1	300
½	450
½	400
TLV-TWA 225 ppm; TLV-STEL 350 ppm; TLV-C 400 ppm	

(15%, 25 minutes)

Question # 2

a) A mineral process facility has 1200 full time employees. In a particular year facility reported 38 lost-time injuries with a resulting 274 lost work days. Compute the OSHA incidence rate based on injuries and lost workdays.

(10%, 15 minutes)

b) List the main steps involve in risk assessment and management.

(5%, 10 minutes)

c) Determine the number of vacuum purges required to reduce a vessel's oxygen concentration from 21% to 1% if the inert gas contain 9000 *ppm* of oxygen?

(5%, 10 minutes)

Question # 3

a) Normal air contains about 21% oxygen by volume. The human body is sensitive to reductions in oxygen concentration; concentrations below 19.5% are dangerous, and concentrations below 16% can cause distress. Respiratory equipment without self-contained air supplies must never be used in atmospheres below 19.5% oxygen. A storage tank of 1000 ft^3 capacity must be cleaned before reuse. Proper procedures must be used to ensure that the oxygen concentration of the air within the tank is adequate.

Compute the cubic feet of additional nitrogen at 77^OF and 1 atm that will reduce the oxygen concentration within the tank to (i) 19.5% and (ii) 16%. Oxygen concentrations within tanks and enclosures can be reduced significantly by small amounts of inert elements!

(10%, 20 minutes)

b) In a processing facility Ammonia, is stored under pressure (pressure 2000 psig and temperature 80 ^{o}F). A consequence analysis has determined that crack of 0.1 inch diameter is likely to form in the tank as a result of poor maintenance. Estimate the mass flow rate through this crack.

(10%, 15 minutes)

Question # 4

Liquefied petroleum gas (LPG) is highly flammable gas used for household cooking. It is transported in tankers. Due to improper connection, a tanker downloading LPG start leaking at the rate of 0.23 m^3/s from the connecting point. This leak remains undetected for 5 minutes. Estimate the downwind distance, which are likely to be unsafe for fire hazard (concentration higher than LFL). The LFL of LPG is 3% vapor concentration. The wind speed in the area is 11 m/s, liquid density of LPG is 450 kg/m^3, vapor density is 1.8 kg/m^3.

(20%, 35 minutes)

You may consider the following
- Solvent is released at ground level
- You may ignore the dense gas effect and consider this release and dispersion to be lighter than air.
- Consider the release area to be rural
- The atmospheric stability condition as Stable (Pasquill Gifford stability Class F)

Question # 5

a) Steam is supplied to the heating coils of a reactor vessel at 125 psig, saturated. The coils are 0.5-in schedule 80 pipe (internal diameter = 0.546). The steam is supplied from a main header through similar pipe with an equivalent length of 53 ft. The heating coils consist of 20 ft of the pipe wound in a coil within the reactor.

b) If heating coil pipe shears accidentally, the reactor vessel will be exposed to the full 125-psig pressure of the steam, exceeding the vessel's pressure rating. As a result, the reactor must be equipped with a relief system to discharge the steam in the event of a coil shear. Compute the maximum mass flow rate of steam from the sheared coils using adiabatic flow through the pipe.

(20%, 35 minutes)

Question # 6

a) In a Ni ore refining facility solvent *RXP* is used to extract Ni. The solvent *RXP* is a volatile chemical. Through fugitive emission about 3.0 gal of solvent evaporates in an 8 hour shift. The ventilation condition in the processing facility is average (k=1/5). Determine the rate of dilution air required to maintain the process area safe for workers (time weighted threshold limit value of Solvent *A* is 50 ppm).
Temperature =77 °F
Pressure =1 atm
Specific gravity of solvent RXP =0.85
Molecular weight of solvent A =145

(10%, 20 minutes)

a) Explain the main steps involved in Risk Management (you may use a flowchart). Explain with example how Risk Management is used in hazardous operation.

(10%, 15 minutes)

Marking Scheme   09-MMP-B4, May 2014

1. **(a)** 5 marks

   (b) 15 marks:

2. **(a) 10 marks**

   (b) 5 marks

   (c) 5 marks

3. **(a)** 10 marks

   (b) 10 marks

4. 20 marks total

5. (a) 15

   (b) 3 marks

   (c) 2 marks

6. (a) 10 marks

   (b) 10 marks