Department of Chemical Engineering

End–Semester Examination, Semester-I, 2006-2007

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B. E. 3rd Year, Process utilities and industrial safety, (**CH-017**)

Time: 3.0 hrs. Max. Marks: 100

Note: **Attempt all questions and all parts of a question at one place. Assume suitable data, if required.**

Q.1 (a) Identify the initiation, propagation and termination steps for the following accident report. Suggest ways to prevent and contain the accidents.

An alkylation unit was being started up after shutdown because of an electrical outage. When adequate circulation could not be maintained in a deisobutanizer heater circuit, it was decided to clean the strainer. Workers had depressurized the pipe and removed all but three of the flange bolts when a pressure release blew a black material from the flange, followed by butane vapors. These vapors were carried to a furnace 100 ft away, where they ignited, flashing back to the flange. The ensuing fire exposed fractional tower and horizontal receiver drums. These drums exploded, rupturing pipelines, which added more fuel. The explosions and heat caused loss of insulation from the 8-ft × 122-ft fractionator tower, causing it to weaken and fall across two major pipelines, breaking piping- which added more fuel to the fire. Extinguishment, achieved basically by isolating the fuel sources, took 2.30 hours. 8

The fault was traced to a 10-in valve that had been prevented from closing the last 0.75 inch by a fine powder of carbon and iron oxide. When the flange was opened this powder blew out, allowing liquid butane to be released.

(b) The following observations were made in a boiler trial :

Coal used 250 kg of calorific value 29,800 kJ/kg, water evaporated 2000 kg, steam pressure 11.5 bar, dryness fraction of steam 0.95 and feed water temperature 34^{0}C. Calculate the equivalent evaporation "from and at 100^{0}C" per kg of coal and the efficiency of the boiler. 7

Q.2 (a) A large open tank with a 5-ft diameter contains toluene. Estimate the evaporation rate from this tank assuming a temperature of 77^{0}F and a pressure of 1 atm. If the ventilation rate is 3000 ft^3/min, estimate the concentration of toluene in this workplace enclosure. $P^{Sat}_{toulene}$ = 28.2 mm Hg, R = 0.7302 ft^3 atm/lb-mol ^{0}R 7

(b) Develop an equation to estimate the exposures on worker during vessel filling operation. 8

Q.3 (a) Benzene is stored in an inside storage area, 15 ft long and 15 ft wide with an 8-ft ceiling. This storage area has a ventilation system that changes the air in the room completely six times per hour. The storage area is also equipped with a flammable vapor detector that sounds an alarm when the flammable vapor concentration reaches 25% of the LFL for benzene. What is the minimum benzene spill rate, in lb/hr, that will set off the flammable vapor alarm in the room? Assume a pressure of 1 atm and a temperature of 80^{0}F. Also assume average ventilation conditions and LFL of benzene 1.4% (in volume). 12

P. T.O.

(b) Why the feed water treatment is necessary before supplying to the boiler? Describe the working of Lime-Soda process with a neat sketch giving different chemical reactions. 2 + 8

Q.4 (a) The TLV-TWA for a substance is 150 ppm. A worker begins a work shift at 8 A.M. and completes the shift at 5 P.M. A one-hour lunch break is included between 12 noon and 1 P.M., where it can be assumed that no exposure to the chemical occurs.
The data were taken in the work area at the times indicated. Has the worker exceeded the TLV specifications? 12

Time	Concentration (ppm)
8:10 A.M.	110
9:05A.M.	130
10:07 A.M.	143
11:20 A.M.	162
12:12 P.M.	142
1:17 P.M.	157
2:03 P.M.	159
3:13 P.M.	165
4:01 P.M.	153
5:00 P.M.	130

(b) How steam boilers are classified? What are the differentiating features between a water tube and a fire tube boiler? Explain the construction and working of a Lancashire boiler with the help of suitable sketches. 3 + 3 + 9

Q.5 (a) Explain the Bhopal accident. 8

(b) Classify air compressors. 3

(c) An employee works in a plant with a FAR of 4. If this employee works a 4-hr shift, 200 days per year, what is the expected deaths per person per year? 3

(d) A single acting reciprocating air compressor has cylinder diameter and stroke of 200 mm and 300 mm respectively. The compressor sucks air at 1 bar and 27^0C and delivers at 8 bar while running at 100 r.p.m. Calculate indicated power of the compressor. 7
The compressor follows the law $PV^{1.25} = C$, Take R = 287 J/kg-K

Note: ***See your evaluated answer book on 13/12/06 at 12.10 P.M. in Mass Transfer Lab.***