BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS: M.TECH **SEMESTER : I**
BRANCH: CHEM ENGG **SESSION : MO/19**

SUBJECT: CL513 PROCESS SAFETY AND MANAGEMENT

TIME: 3 HOURS **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
***4*. Before attempting the question paper, be sure that you have got the correct question paper.**
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

Q.1(a) What is the role of industrial Hygienists? What is threshold limit values (TLVs)? Explain different types of TLVs. [5]

Q.1(b) How to use the hierarchy of control? Discuss in detail. [5]

Q.2(a) A gas cylinder contains 22.7 kg propane. The cylinder accidentally falls over and ruptures, vaporizing the entire contents of the cylinder. The cloud is ignited and an explosion occurs. Calculate the overpressure from this explosion 30.5 m away. Assuming a nominal explosion efficiency of 5%. The Heat of combustion of propane is 46,434 KJ/Kg and energy of explosion of TNT is 4686 KJ/kg TNT. [5]

Q.2(b) What is the purpose of flare stacks and scrubbers? Calculate the stack height required to give a heat intensity of 1500 Btu/hr/ft^2 at a distance of 410 ft from the base of the flare. The flare diameter is 4 ft, the flare load is 970,000 lb/hr and the molecular weight of vapour is 44. [2+3]

Q.3 A storage tank is vented to the atmosphere. If a hole develops in the tank, the liquid level $\mathbf{h}_L$ is given by the following differential equation: [10]

$$\frac{dh_L}{dt} = -\frac{C_o A}{A_t}\sqrt{2gh_L}$$

where $\mathbf{h}_L$ is the liquid level height above the leak, $\boldsymbol{C}_o$ is discharge coefficient (=0.61), $\boldsymbol{A}$ is the cross-sectional area of the leak, $\boldsymbol{A}_t$ is the cross-sectional area of the tank, and $\boldsymbol{g}$ is the acceleration due to gravity.

(a) Integrate the equation to determine an expression for the liquid level height as a function of time. Assume an initial liquid level above the leak of h_L^o.

(b) what is the driving force that pushes the water out of the hole in the tank?

(c) A cylindrical tank 10 ft high and 20 ft in diameter is used to store water. The liquid level in the tank is initially at 7 ft. If a 1-inch puncture occurs 2 ft off the bottom of the tank, how long will it take for the water to drain down to the leak? What is the total amount of liquid discharged?

(d) What would be the significance of the leak if the liquid were flammable or toxic?

Q.4(a) Your plant is considering the installation of a new railcar tank unloading facility. The facility will unload nominal 25,000- gal tank cars containing either butadiene or cyclohexane. The unloading system will be equipped with an emergency shutdown system with remotely operated block valves. The unloading operation will be done by computer control. The railcars are inerted with nitrogen to a pressure of 40 psig, and the railcar relief system has a set pressure of 75 psig. The unloading operating instructions are written and have been reviewed by the corporate technical staff. A reactive chemical review has already been completed on the proposed facility. Combustible gas detectors will be located at the unloading station. A deluge system will be installed at the unloading site with an excellent water supply. A diking system will surround three sides of the facility, with any spills directed to a covered impounding area. [3]

Determine the DOW Fire and Explosion Index (F&EI) for this operation. Based on F & EI value, comment on the degree of hazard.

Given, General Process Hazards Factor (F_1) = 1.5; Special Process Hazards Factor (F_2) = 2.94; Material factor for butadiene = 24; Material factor for Cyclohexane = 16.

PTO

Q.4(b) A heat exchanger is used to heat flammable, volatile solvents as shown in Figure 1. The temperature of the outlet stream is measured by a thermocouple, and a controller valve manipulates the amount of steam to the heat exchanger to achieve the desired set point temperature. [7]
(a) Identify the study nodes of the process.
(b) Perform a HAZOP study on the intention "hot solvent from heat exchanger" and recommend possible modifications to improve the safety of the process.
Use Process parameters : FLOW and deviation guide words: NO, MORE and LESS.

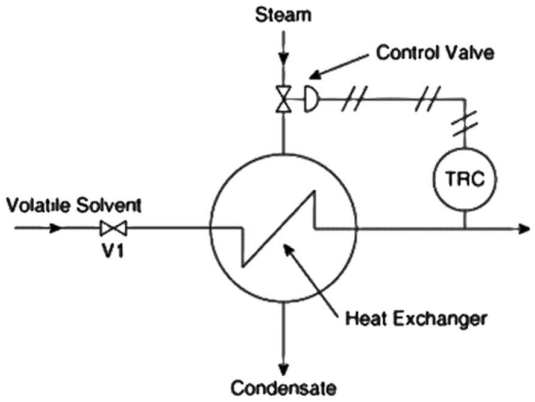

Figure 1: Volatile solvent heating system

Q.5(a) Explain the role of safety audit? Discuss different safety audits. [5]
Q.5(b) Discuss techniques to measure safety performance. [5]

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