

JK Lakshmipat University Jaipur

INSTITUTE OF ENGINEERING AND TECHNOLOGY

End Term Examination, May, 2019

M.Tech in Health, Safety and Environmental Engineering, Semester Second

Roll No.....

Course Code : MTHSE214

Time: 3:0 hours

Max. Marks: 40

Course Name: Safety in Chemical Industry

Instructions to students:

1. Do not write anything other than your roll number on question paper.
2. Assume suitable data wherever required and mention it clearly.
3. Writing appropriate units, nomenclature, and drawing neat sketches/schematics/ flow chart wherever, required are an integral part of the answer.

Q.1

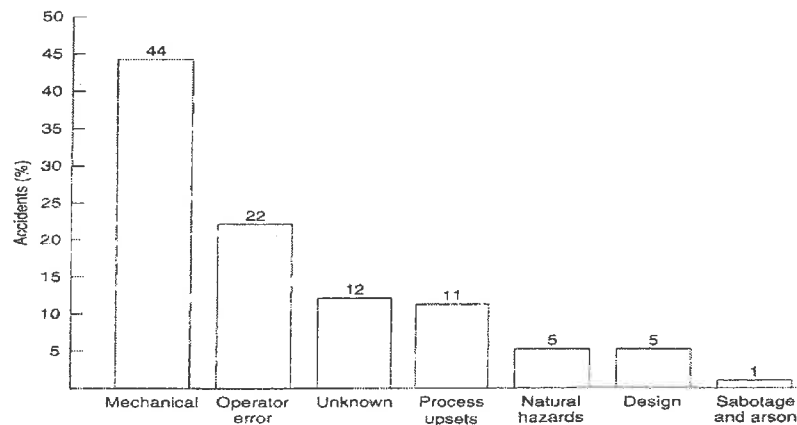


Figure-1: Causes of losses in the largest hydrocarbon-chemical plant accidents

The causes of the largest losses are shown in figure-1, what would you emphasize in a safety program?

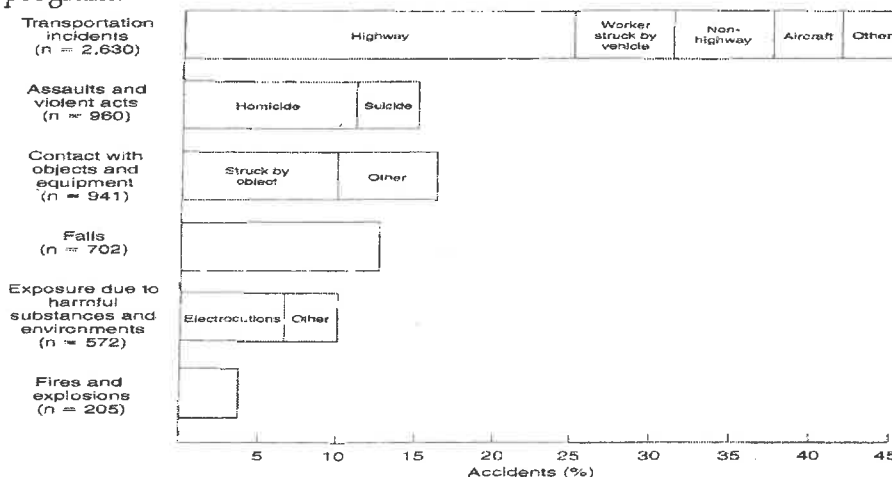


Figure-2: The manner in which workplace fatalities occurred in 1998. The total number of workplace fatalities was 6026. The workplace fatalities are shown in figure-2 and assuming you are responsible for a safety program of an organization, what would you emphasize?

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Q.2



Figure-3: Loss distribution for onshore accidents for 5-year intervals over a 30-year period
What conclusions can you derive from figure-3.

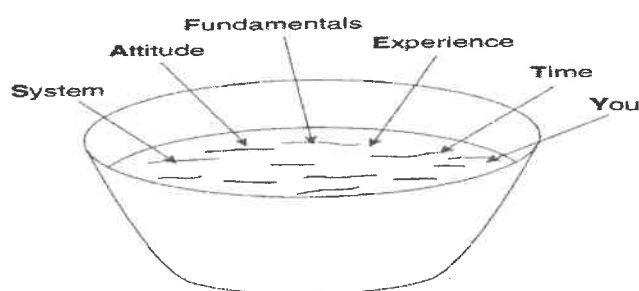


Figure-4: safety Ingredients

Explain the importance of each ingredients for a successful safety programs in the figure-4.

Q.3

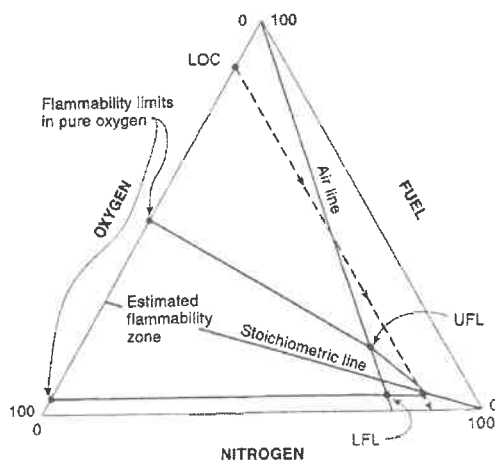


Figure-6: Flammability diagram

Estimate the Method for the flammability limits in air, the LOC, and flammability limit in pure oxygen.

Q.4

An open toluene container in an enclosure is weighed as a function of time, and it is determined that the average evaporation rate is $2.20 \times 10^{-4} \text{ lb}_m/\text{min}$. The ventilation rate is $100 \text{ ft}^3/\text{min}$. The temperature is 540°R and the pressure is 1 atm . Estimate the concentration of toluene vapor in the enclosure, and compare your answer to the TLV for toluene of 50 ppm. $R_g = 0.7302 \text{ ft}^3 \text{ atm} / \text{lb-mol } ^\circ\text{R}$

Q.5

The accident at Flixborough, England, occurred on a Saturday in June 1974. Although it was not reported to any great extent in the United States, it had a major impact on chemical engineering in the United Kingdom. As a result of the accident, safety achieved a much higher priority in that country.

The Flixborough Works of Nypro Limited was designed to produce 70,000 tons per year of caprolactam, a basic raw material for the production of nylon. The process uses cyclohexane, which has properties similar to gasoline. Under the process conditions in use at Flixborough (155°C and 7.9 atm), the cyclohexane volatilizes immediately when depressurized to atmospheric conditions.

The process where the accident occurred consisted of six reactors in series. In these reactors cyclohexane was oxidized to cyclohexanone and then to cyclohexanol using injected air in the presence of a catalyst. The liquid reaction mass was gravity-fed through the series of reactors. Each reactor normally contained about 20 tons of cyclohexane.

Several months before the accident occurred, reactor 5 in the series was found to be leaking. Inspection showed a vertical crack in its stainless steel structure. The decision was made to remove the reactor for repairs. An additional decision was made to continue operating by connecting reactor 4 directly to reactor 6 in the series. The loss of the reactor would reduce the yield but would enable continued production because unreacted cyclohexane is separated and recycled at a later stage.

The feed pipes connecting the reactors were 28 inches in diameter. Because only 20-inch pipe stock was available at the plant, the connections to reactor 4 and reactor 6 were made using flexible bellows-type piping, as shown in Figure. It is hypothesized that the bypass pipe section ruptured because of inadequate support and over flexing of the pipe section as a result of internal reactor pressures. Upon rupture of the bypass, an estimated 30 tons of cyclohexane volatilized and formed a large vapor cloud. The cloud was ignited by an

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unknown source an estimated 45 seconds after the release. The resulting explosion leveled the entire plant facility, including the administrative offices. Twenty-eight people died, and 36 others were injured. Eighteen of these fatalities occurred in the main control room when the ceiling collapsed. Loss of life would have been substantially greater had the accident occurred on a weekday when the administrative offices were filled with employees. Damage extended to 1821 nearby houses and 167 shops and factories. Fifty-three civilians were reported injured. The resulting fire in the plant burned for over 10 days.

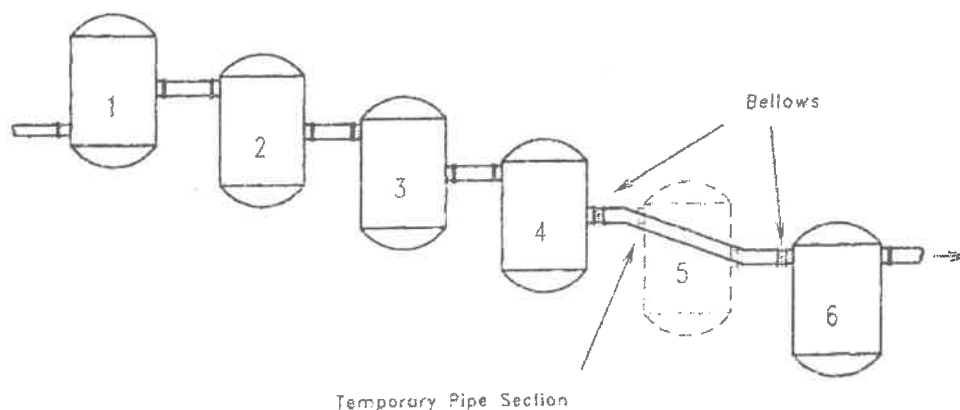


Figure-7: A failure of a temporary pipe section replacing reactor 5 caused the Flixborough accident

	Estimate the safety procedure to prevent this accidents. Identifying the causes of initiation propagation in this case.	
Q.6	You have just begun work at a chemical plant. After several weeks on the job you determine that the plant manager runs the plant with an iron fist. He is a few years away from retirement after working his way up from the very bottom. Also, a number of unsafe practices are performed at the plant, including some that could lead to catastrophic results. You bring up these problems to your immediate supervisor, but he decides to do nothing for fear that the plant manager will be upset. After all, he says, "We've operated this plant for 40 years without an accident." What would you do in this situation?	5
Q.7	A cylindrical tank 20 ft. high and 8 ft. in diameter is used to store benzene. The tank is padded with nitrogen to a constant regulated pressure of 1 atm gauge to prevent explosion. The liquid level within the tank is presently at 17 ft. A 1-in puncture occurs in the tank 5 ft off the ground because of the careless driving of a forklift truck. Estimate (a) the gallons of benzene spilled, (b) the time required for the benzene to leak out, and (c) the maximum mass flow rate of benzene through the leak. The specific gravity of benzene at these conditions is 0.8794.	5

*****All the Best*****