Roll No. .....

National Institute of Technology Hamirpur

B. Tech. (Chemical Engineering) – 5th Semester

End Semester 2020-2021

CHD-315: Industrial Safety and Hazard Management

Duration: 2 Hours **Max. Marks: 50**

- Each question carrying 10 marks
- Make suitable assumptions if necessary, by clearly stating them.
- Marks will be deducted for omitting steps.
- Copying may reduce marks.
- Submit answer sheets within 15 minutes (12:15 PM) of examination time in classroom link.
- Answer sheet will not be considered after the submission time (12:15 PM).
- Write roll number at the top of answer sheet.
- Do signature with date at the bottom of each page.

1) Determine the followings:

   a) Estimate the LFL and the UFL for hexane.

   b) Estimate the LOC for butane (C_4H_{10}).

$$C_6H_{14} + zO_2 \longrightarrow mCO_2 + 0.5x\ H_2O$$

$$C_4H_{10} + 6.5O_2 \longrightarrow 4CO_2 + 5H_2O$$

   c) What are the LFL and UFL of a gas mixture composed of 0.8% hexane, 2.0% methane and 0.5% ethylene by volume?

Compound	**Volume %**	**Mole Fraction on Combustible Basis**	**LFL (vol. %)**	**UFL (vol. %)**
Hexane	0.8	0.24	1.2	7.5
Methane	2.0	0.61	5.0	15
Ethylene	0.5	0.15	2.7	36
Total Combustibles	3.3			
Air	96.7			

2) Details the case study of any two disasters

   a) BHOPAL, INDIA

   b) FLIXBOROUGH, UK

   c) SEVESO, ITALY

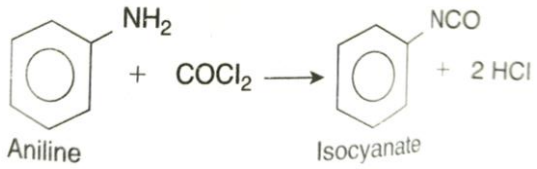
3) Sound intensity level varies for a variety of common activities, hence determine whether the following noise level permissible with no additional control features or not.

Noise level (dBA)	Duration (hr)	Maximum allowed (hr)
85	3.6	16
95	3.0	4
110	0.5	0.5

4) Determine the mixture TLV of the vapor liquid equilibrium compounds at 25^{o}C and 1 atm pressure of a mixture derived from the following liquid:

Component	Mole percent	Species TLV (ppm)
Heptane	50	400
Toluene	50	20

5) Consider the laboratory reactor system (shown in Figure below). This system is designed to react phosgene ($COCl_2$) with aniline to produce isocyanate and HCl. The reaction is shown below. The isocyanate is used for the production of forms and plastics.

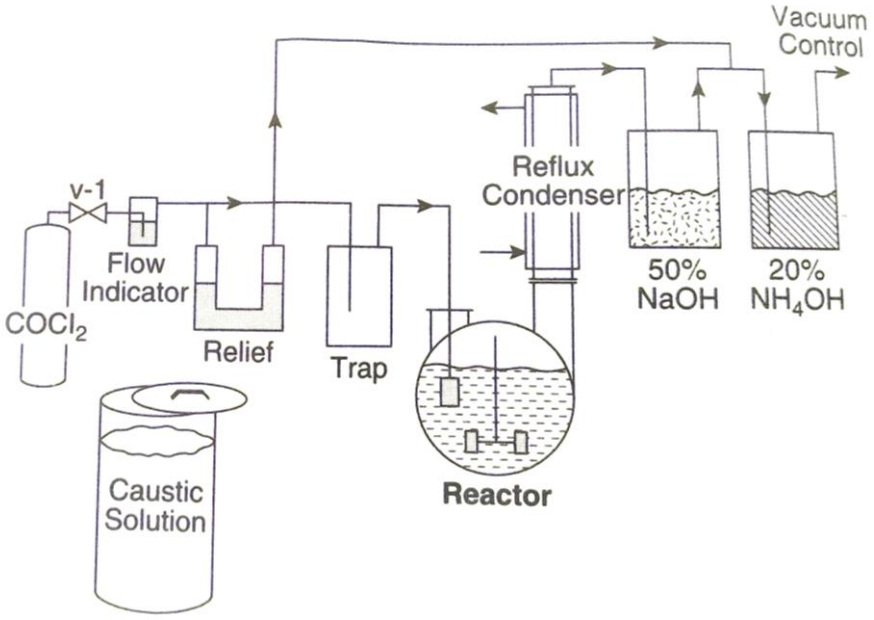


Phosgene is a colorless vapor with a boiling point of 46.8^{o}F. Thus, it is normally stored as a liquid in a container under pressure above its normal boiling point temperature. The TLV for phosgene is 0.1 ppm, and its odor threshold is 0.5-1 ppm, well above the TLV.

Aniline is a liquid with a boiling point of 364^{o}F. Its TLV is 2 ppm. It is absorbed through the skin.

The process shown in Fig below the phosgene is fed from the container through a valve into a fritted glass bubbler in the reactor. The reflux condenser aniline vapor and returns them to the reactor. A caustic scrubber is used to remove the phosgene and HCl vapor from the exit vent stream. The complete process is contained in a hood.

Conduct an informal and formal safety review of this process.


Vacuum
Control
Reflux
Condenser
v-1
Flow
Indicator
$COCl_2$
Relief
Trap
50%
NaOH
20%
NH_4OH
Caustic
Solution
Reactor