

B.E. Chemical Engineering 4<sup>th</sup> year 2<sup>nd</sup> Semester Exam 2024  
 CHEMICAL PROCESS SAFETY & RISK MANAGEMENT(HONS.)

Answer all questions  
 Assume any missing data

Problem 1:

(a) A flammable vapour flows through a 5 cm inner diameter insulated pipe at a flow rate of 4 m<sup>3</sup>/min. A lagging fire started and heated a 1.5m length of pipe at 65 °C, which is above the ignition temperature of vapour. The ignition time delay of the vapour,  $t_d$  is given by

$$\ln(t_d) = \frac{250}{T} + 0.5 \text{ where } T \text{ is in } ^\circ\text{R.}$$

Will ignition take place?

(b) Calculate the liquid burning rate of a butane ground pool. The pool has a diameter of 0.5 m and a depth of 3 cm. Also calculate the total burning time of the butane pool.

Data:

Liquid burning rate for a pool of infinite diameter (cm/min) = 0.79. the magnitude of constant = 0.027. The latent heat of vaporization of butane may be assumed to be 20 kJ/mol. The heat of combustion is 3000 kJ/mol.

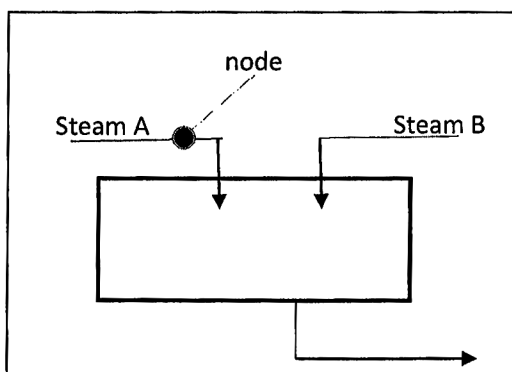
(c) State the classifications of fire, the materials in a particular classification. Also state how each class of fire can be extinguished. [5 + 10 + 10] [CO-2]

Problem 2:

(a) State the causes of plant fires

(b) What are the potential hazards from (i) reactors (ii) pressure vessels (iii) mass transfer unit operations (iv) utilities

(c) State the guidelines for plant layout and equipment [7+ 10 +8] [CO-1]



Problem 3:

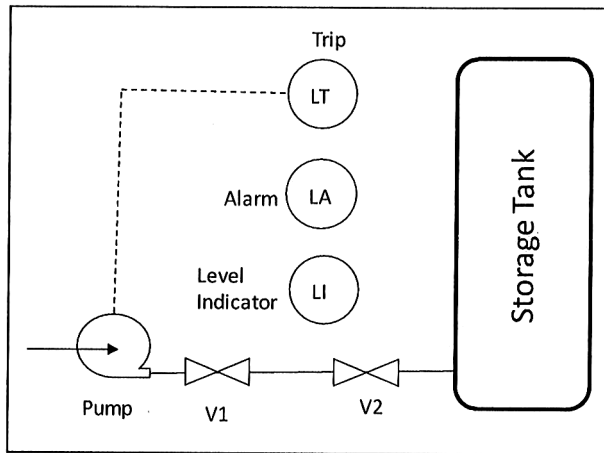
(a) The flow sheet shows raw material streams A and B transferred to a reactor through a pump. Do a hazop study at node 1 in the pipeline using relevant guide words. Process variables are temperature and flow rate.

[ Turn over

(b) State the possible causes for (i) level deviation (ii) blockage of equipment. [15 + 10]  
[CO-4]

Problem 4:

A liquid storage tank is filled by pump. It has a level indicator, LI, a level alarm, LA and a trip LT. It has two independent shut off valves both of which are operator actuated. LT automatically trips the pump. The normal procedure is that the operator observes LI and closes V1 when level reaches LI. Should V1 fail the operator can use V2. If the operator fails to take action an alarm will sound at LA and again the operator can close V1 or V2. The ultimate protection is provided by LT by tripping the pump. Construct the fault tree and estimate the



probability of overflow. [25] [CO-3]

probability of overflow.

The probability of failure for the various events are:

Valve V1 stuck open	0.01	Valve V2 stuck open	0.01
Level indicator fails low	0.01	Level alarm fails	0.0005
Pump trip fails	0.005	Operator fails to respond to LI	0.03
Operator fails to respond to LA	0.01		