

QP Code : 6447

(3 Hours)

[Total Marks : 80

- N.B. :
1. Q.No.1 is compulsory
 2. Attempt any three from remaining five
 3. Assume any suitable data if required

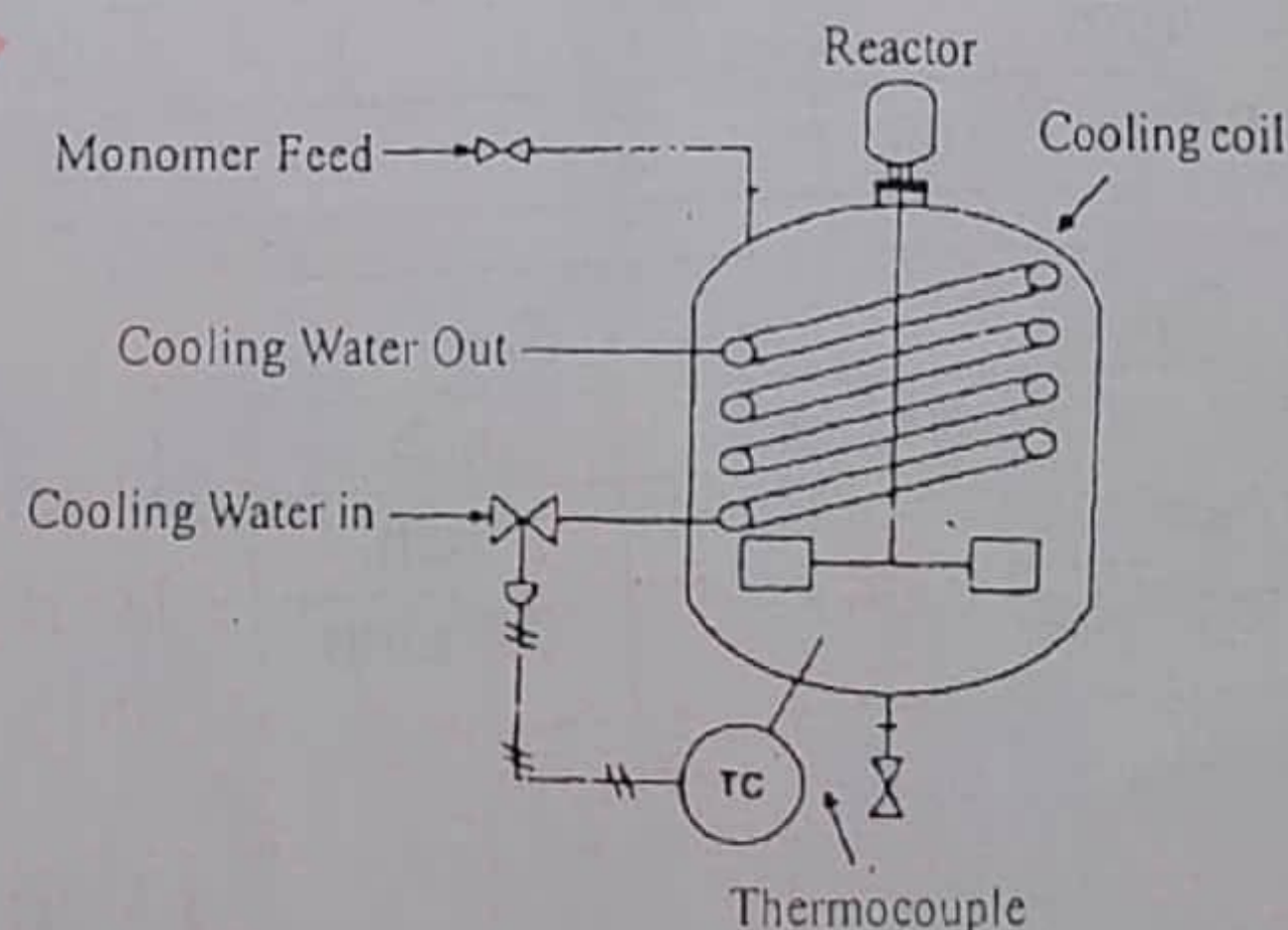
1. Answer the following (any FIVE)

- (a) One kilogram of TNT is exploded. Compute the overpressure at a distance of 30m from the explosion.
- (b) Estimate the LOC for butane C_4H_{10}
- (c) Determine the 8-hr TWA worker exposure if the worker is exposed to toluene vapors as follows

Duration of exposure (hr)	Measured concentration (ppm)
2	110
2	330
4	90

- (d) Explain why steam used for heating should be dry and saturated. Why superheated steam as well as wet steam is bad for process heating?
- (e) Draw a P-V Diagram for two stage imperfect inter cooler.
- (f) Explain the distribution of steam in a process plant.
- (g) What are the different relief devices used?
- (h) What do you mean by the additive property of the technique of the analysis of variance? Explain how this technique is superior in comparison to sampling.

- 2.(a) Consider the reactor system given below. The reaction is exothermic, so a cooling system is provided to remove the excess energy of reaction. In the event that the cooling function is lost, the temperature of the reactor would increase. This would lead to an increase in reaction rate, leading to additional energy release. The result would be a runaway reaction with pressures exceeding the bursting pressure of the reactor vessel. The temperature within the reactor is measured and is used to control the cooling water flow rate by a valve. Perform a HAZOP study on this unit to improve the safety of the process. Use as study nodes the cooling coil (process parameter: flow and temperature) and the stirrer (process parameter: agitation).

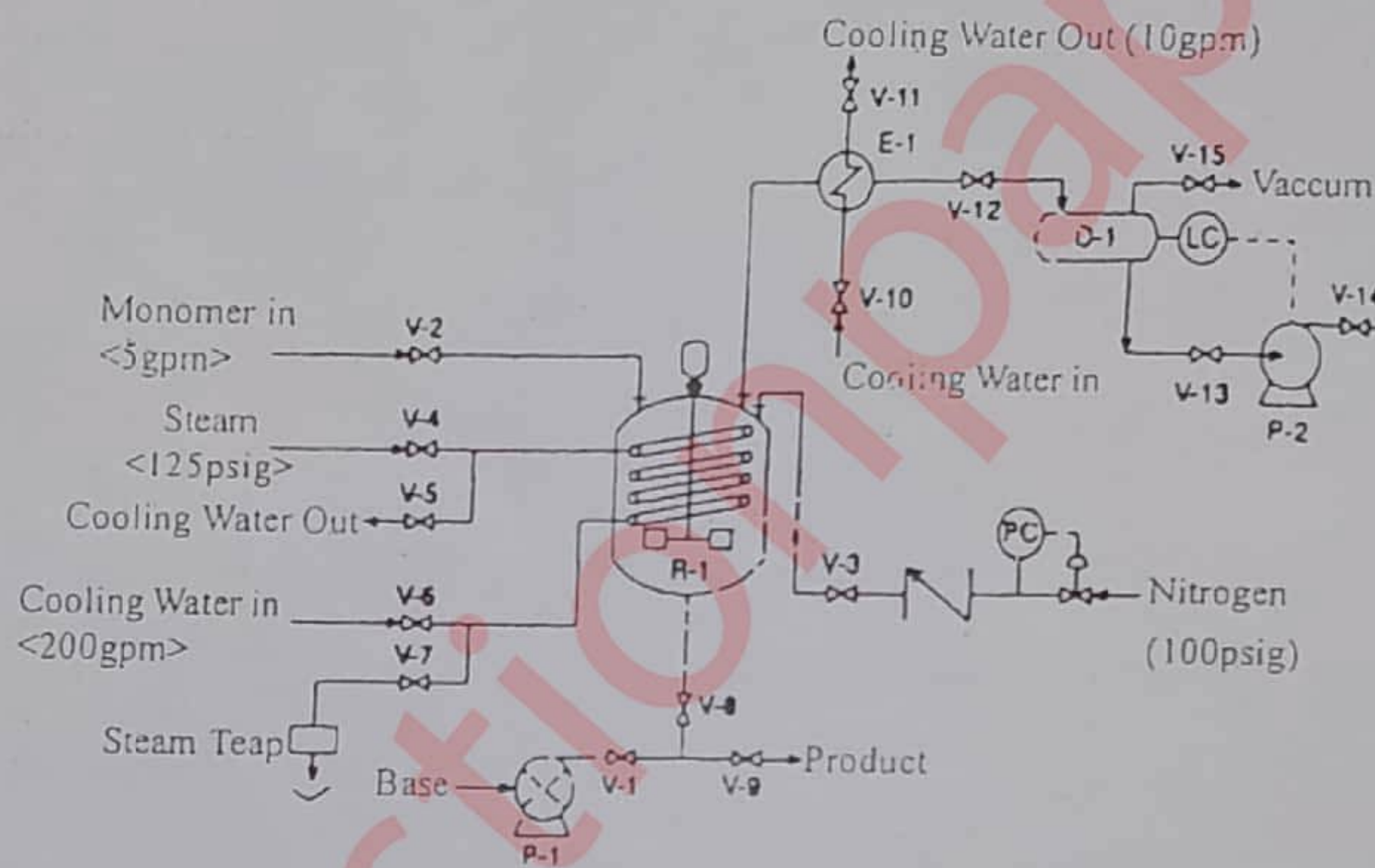


2. (b) What is the difference between boiler mountings and boiler accessories? Give examples. 5

3. (a) Specify the locations of reliefs in the simple polymerization reactor system given below. Redraw the polymerization reactor with the safety reliefs. The major steps in this polymerisation process include 15

1. Pumping 100 lb of initiator in to the reactor R-1
2. Heating to the reaction temperature of 240 F
3. Adding monomer for a period of 3 hours
4. Stripping the residual monomer by means of vacuum using valve V-15.

Because the reaction is exothermic, cooling during monomer addition with cooling water is necessary.



Name	Description	Max. Psig	Gpm at 50psig
D-1	100 Gal Drum	50	—
R-1	1000 Gal Reactor	50	—
P-1	Gear Pump	100	100
P-2	Centrifugal Pump	50	20

Piping	Size
Steam and Water Lines	2inch
Nitrogen	1 inch
Vapor Lines	0.5 inch

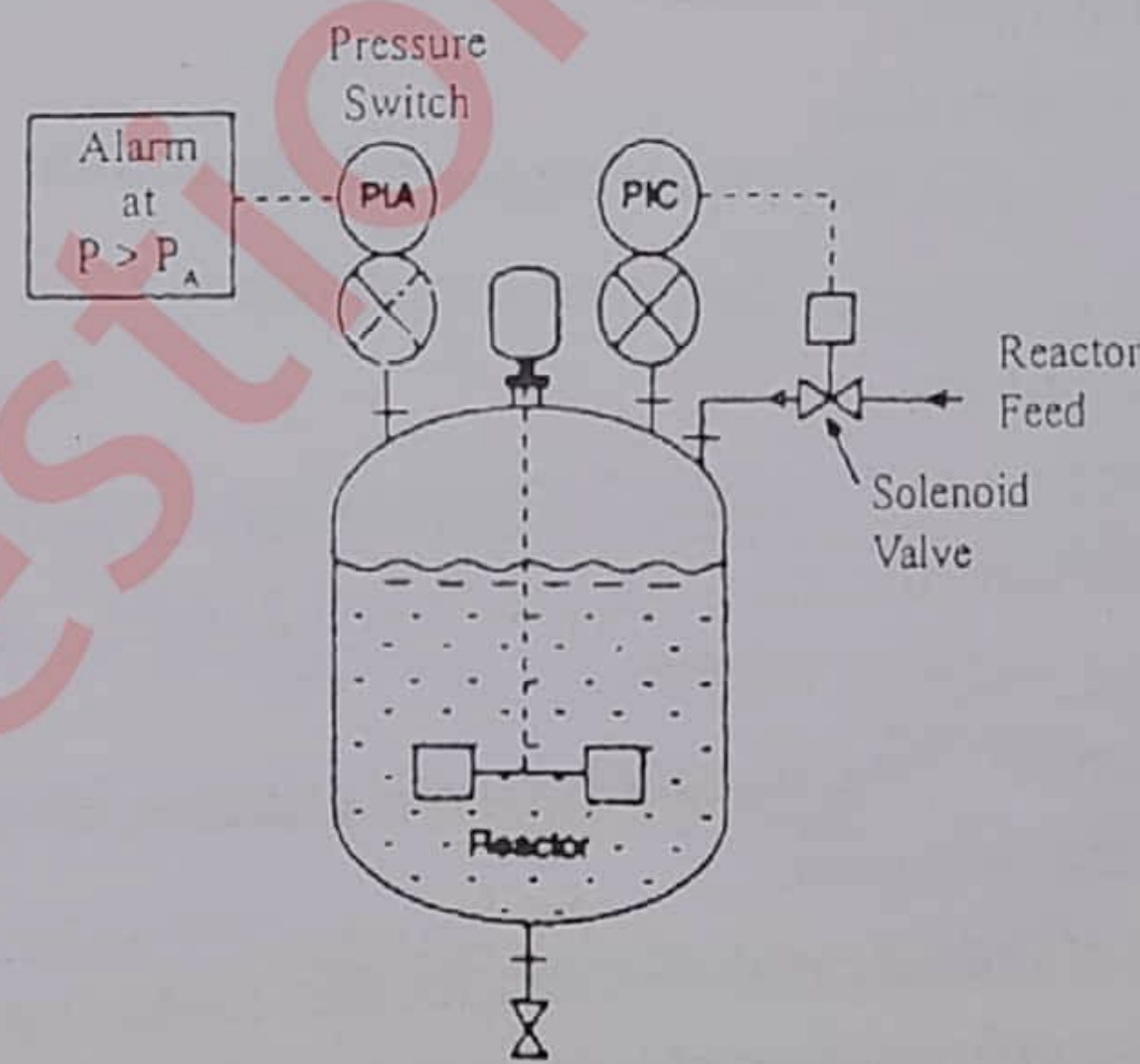
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- 3 (b) The capacity of a refrigerator is 500 tones when working between -6°C and 10°C . Determine the mass of ice produced per day at 0°C from water at 35°C . Assume that the cycle operates on reversed Carnot cycle. Latent enthalpy of ice is 335 KJ/Kg . C_p for water is 4.187 KJ/Kg K . 5

4. (a) It is desired to compress 16 m^3 of air per minute from 1 bar and 294 K to 10.5 bar. Calculate 10
- The minimum power required to drive the compressor with two stage compression and compare it with the power required for single stage compression.
 - The maximum temperature in the two cases.
 - The heat to be removed in the inter cooler per minute.
 - The amount of cooling water required per minute if the inlet and outlet temperatures of cooling water to and from the intercooler are 15°C & 40°C .

Assume the value of index of compression process to be 1.35. Also assume proper inter cooler pressure for minimum work and perfect intercooling. $R=0.287\text{ KJ/Kg}$ and $C_p=1.0035\text{ KJ/KgK}$ for air.

4. (b) Consider the alarm indicator and emergency shutdown system given below. Draw a fault tree for this system. 10



5. (a) What are the statistical methods available to characterize accident and loss performance? If twice as many people used motorcycles for the same average 10

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amount of time each, what will happen to (i) the OSHA incidence rate, (ii) the FAR, (iii) the fatality rate, and (iv) the total number of fatalities? If all the riders used their motorcycles twice as much, what will happen to (i) the OSHA incidence rate, (ii) the FAR, (iii) the fatality rate, and (iv) the total number of fatalities?

5. (b) The following data refers to a boiler plant consisting of an economizer, a boiler and a super heater. Find the boiler efficiency. 10

Mass of water evaporated per hour = 5940 Kg

Mass of coal burnt per hour = 675 Kg

C.V. of Coal = 31600 KJ/Kg

Pressure of steam at steam stop valve = 14 bar

Temperature of feed water entering the economizer = 32°C

Temperature of feed water leaving the economizer = 115°C

Dryness fraction of steam entering the super heater = 0.96

Temperature of steam leaving the super heater = 260°C

Cp of superheated steam = 2.3 KJ/Kg

6. (a) Explain the following terms: - (Any FIVE) 10

- i. BLEVE
- ii. Unconfined explosion
- iii. Flammability limits
- iv. Equivalent evaporation
- v. FADM
- vi. COP
- vii. Degree of freedom

6. (b) In a random selection of 64 of the 2400 intersections in a small city, the mean number of scooter accidents per year was 3.2 and the sample standard deviation was 0.8. 10

- i. Make an estimate of the standard deviation of the population from the sample standard deviation.
- ii. Work out the standard error of mean for this finite population.
- iii. If the desired confidence level is 90, what will be the upper and lower limits of the confidence interval for the mean number of accidents per intersection per year?