2008

10000

CHEMICAL ENGINEERING (Optional)

रासायनिक अभियांत्रिकी (वैकल्पिक)

Time : 3 hours **Maximum Marks : 200**

Note :

(i) *In all attempt **Five** questions.*

(ii) *Question number **1** is **compulsory**.*

(iii) *Of the remaining questions, attempt **Any four** by selecting **one question** from each section.*

(iv) *Numbers of optional questions upto the prescribed number in the order in which questions have been solved will only be assessed and excess answers of the question/s will not be assessed.*

(v) *Candidate should not write roll number, any names (including his/her own), signature, address or any indication of his/her identity anywhere inside the answer book otherwise he/she will be penalised.*

1. Answer *any four* of the following :

(a) Water is flowing through a pipeline of inside diameter 50 mm. Volumetric flow rate of water is 0.00063 m^3/sec. Calculate the mass flow rate and mass velocity of water. **10**

Density of water = 1000 kg/m^3.

(b) 80% of liquid reactant reacts in 15 minutes in an isothermal batch reactor operation. The reaction follows first order kinetics. If the reaction is carried out in a plug flow reactor and a CSTR, how much time will be required to achieve the same conversion ? **10**

(c) Derive an expression for heat transfer through a cylindrical wall. **10**

(d) Explain the salient features of fermentation for production of alcohol. **10**

(e) Explain the difference between various flowmeters used for flow measurement, of non compressible fluids and suggest an expression for calculation of coefficient of discharge for any one of them. **10**

P.T.O.

SECTION - A

2. (a) Define terminal settling velocity of a particle and derive an expression for drag force on spherical particle at different Reynolds number. **10**

(b) In an operation of a ammonia plant 1:3 nitrogen-hydrogen mixture is fed to the converter, resulting in a 30% conversion to ammonia. Ammonia formed is separated by condensation and the unconverted gases are recycled to the reactor. The initial nitrogen-hydrogen mixture contains 0.25 parts of argon to 100 parts of N_2 - H_2 mixture. The toleration limit of argon entering the reactor is assumed to be 8 parts to 100 parts of N_2 and H_2 by volume. Estimate the fraction of the recycle that must be continuously purged. **20**

(c) Explain the laws of crushing and grinding and the operation of a ballmill for fine grinding. **10**

3. (a) Explain the Navier - Stoke's equation and its important applications. **10**

(b) A gas mixture has the following composition by weight percentage. $CH_4 = 30\%$; $C_2H_6 = 25\%$; $O_2 = 10\%$; $N_2 = 35\%$ Calculate the composition by mole%, volume% and the density of gas mixture at 730 mm Hg and 30°C. **20**

Molecular weight of $CH_4 = 16$; $C_2H_6 = 30$; $O_2 = 32$; $N_2 = 28$.

(c) A plate and frame filter press is used for filtration, produces a total 8 m^3 of filtrate in 1800 seconds and 11 m^3 in 3600 seconds, when filtration is stopped. Estimate the washing time in seconds if 3 m^3 of wash water is used. The resistance of the cloth can be neglected. Constant pressure is used throughout the operation. **10**

SECTION - B

4. (a) Explain the theory of crystallization and how to calculate the crystal yield ? **20**

(b) A vapour phase decomposition reaction $P \rightarrow R + S$ is carried out in a mixed reactor. Initial composition of P is 0.003 mol per litre. The following data is available for different runs. **10**

Run No.	1	2	3	4	5
τ (sec.)	0.4	5.0	14	45	195
x_A	0.2	0.60	0.76	0.9	0.97

Determine a suitable rate equation for vapour phase decomposition reaction.

(c) What do you mean by an azeotrope ? Explain the maximum boiling azeotropes and the minimum boiling azeotropes. **10**

5. (a) Explain the concept of drying rate, drying conditions and the operation of a single drum dryer for drying. **20**

(b) Explain the shrinking core model for gas-solid reaction and how to estimate the time for complete conversion when gas-film is the controlling resistance. **10**

(c) A refrigeration machine operating at a condensation temperature of 290 K needs 1 kW of power per ton of refrigeration. Determine C.O.P, heat rejected to condenser and the lowest temperature that can be maintained. **10**

SECTION - C

6. (a) Explain the difference between filmwise condensation and dropwise condensation and suggest suitable correlation for calculating heat transfer coefficient for condensing vapour on vertical plate and horizontal surface. **10**

(b) Write down the names of temperature and pressure measuring instruments and explain the principle of operation of any one pressure measuring instrument. **20**

(c) What is the criteria for selection of materials for process equipments and why are polymeric materials gaining more importance for chemical process industries. **10**

7. (a) Explain the classification of evaporators and their selection criteria. **10**

(b) Explain the applications of controllers and the advantages and disadvantages of pneumatic controllers over digital controllers. **20**

(c) What are the forms of corrosion and how cathodic protection system helps in corrosion prevention ? **10**

SECTION - D

8. (a) What is depreciation and how is depreciation calculated by various methods ? **10**

(b) Explain the salient features of industrial process for the production of ammonia. **20**

(c) Explain the classification of primary and secondary air pollutants and the meaning of lapse rate and temperature inversion. **10**

9. (a) Explain the considerations in plant location and plant layout. **10**

(b) Explain the salient features of addition polymerization and ethylene polymer produced by this technique. **20**

(c) Explain the fire and explosion hazards and importance of personnel safety in chemical process industries. **10**

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