Duration :3 hours **Total Marks:80**

N.B. (1) Question No.1 is compulsory.

(2) Attempt any **three** questions from remaining.

(3) Assume suitable data wherever necessary with proper justification

Q.1 a) Explain Pulse input experiment for RTD measurement. (05)

b) Explain Tank in series model in brief. (05)

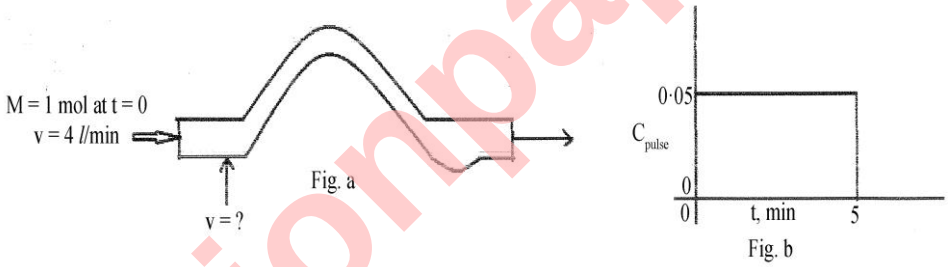
c) Define the following terms (i) Effectiveness factor (ii) Mean residence time (iii) True density (iv) Apparent density (v) Bulk density (05)

d) Derive design equation of CSTR containing porous catalyst (05)

Q.2.a) The result of pulse input to a vessel are shown in following fig a & b (10)

i) Check the material balance with the experimental tracer curve to see whether the results are consistent or not

ii) If so evaluate $\bar{t}$ and V



Q.2.b) The data given below represent a continuous response to a pulse input into a closed vessel which is to be used as a chemical reactor. Calculate the mean residence time of fluid in the vessel. Tabulate and construct the E curve. (10)

t, min	0	5	10	15	20	25	30	35
C_{pulse}, *g/l* (tracer output concentration)	0	3	5	5	4	2	1	0

Q.3 a) Calculate the time required to burn to completion spherical particles of graphite (*radius 12 mm, bulk density 2.4 g/cc*) in a 12% oxygen stream at 900°C and 1 atm. Assume gas film resistance to be negligible. Surface reaction rate constant = k" = 25 cm/s (10)

Q.3.b) An ore of uniform size particles is to be roasted in a fluidized bed reactor. The time required for complete conversion of solid particles is 20 min and the mean residence time of particles in bed is 48 min. The solids remain unchanged in size during reaction. Calculate the fraction of original ore remaining unconverted assuming: (i) the chemical reaction step to be rate controlling (ii) the ash diffusion step to be rate controlling. (10)

Q.4.a) Write short note on fixed bed reactor (05)

Q.4.b) The catalytic reaction A → 3R is run in a packed bed reactor at 3.5 atm and 115^0 C. It is desired to treat 1500 mol/h of pure A at 3.5 atm to 32% conversion. The following rate – concentration data are available: (15)

CA, mol/l	0.04	0.06	0.075	0.09
$-r_A$,mol A/(h.kg catalyst)	3.5	5.7	7.2	8.8

Determine the amount of catalyst needed in a packed bed reactor.

Q.5) We plan to remove about 80% of A present in a gas stream by absorption in water containing reactant B as per the following reaction (20)

A (g → l) + B(l) → R(l)

The reaction is extremely rapid so k= ∞. Determine the height of tower for countercurrent operation using following data.

Data: the gas and Liquid flow rates are:

F_g/A_{cs} = 1 x 10^5mol/hr.m^2 at 10^5 Pa

F_l/A_{cs} = 7 x 10^5mol/hr.m^2

H_A = 12.5 Pa.m^3/mol

The molar density of liquid under all conditions is C_T = 56000 mol/m^3

PA in = 100 Pa

$k_{Ag}a$ = 0.32 mol/hr.m^3. Pa

$k_{Al}a$ = 0.1 hr^{-1}

C_B in = concentration of B in water entering the tower= 800 mol/m^3.

Assume diffusivities of A and B in water are the same.

Q.6.a) Explain Brunner Emmett Teller method for determination of surface area. (10)

Q.6.b) An 8.01 gm sample of Glaucosil is studied with N_2 adsorption at -195.8ºC. (10)
The following data are obtained:

Pressure, mmHg	6	25	140	230	285	320	430	505
Volume adsorbed, cm^3 (at 0ºC & 1 atm)	61	127	170	197	215	230	277	335

The vapor pressure of N_2 at -195.8 ºC is 1 atm. Estimate the surface area in m^2/gm of the sample. The density of N_2 is 0.808 gm/cc.

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