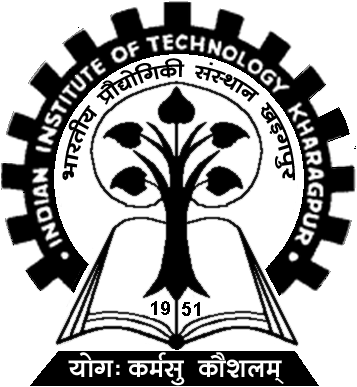
**INDIAN INSTITUTE OF TECHNOLOGY KHARAGPUR**



**End-Autumn Semester 2017-18**

**Date of Examination : 23.11.2017 Session (FN/AN) FN Duration 3 hrs Full Marks: 50**

**Subject No. :**  **CH31009 Subject : REACTION ENGINEERING   
Department/Center/School : CHEMICAL ENGINEERING**

**Specific charts, graph paper, log book etc., required:** Graph papers

**Special Instructions (if any) :** attempt all questions. Assume the missing parameters.

**Use Separate answer Scripts for Part A and Part B**

**Part-A**

**Q1.** At 953 K, the gas phase catalytic reaction A→ 3R is carried out on a solid catalyst of 2 mm size. The rate equation is kmol/(min)(kg-cat). Feed containing 50% A and 50% inert is passed through the catalyst bed at 8.33 mol/min. Assuming a plug flow behavior, design a packed-bed reactor (Wt. of catalyst) to be used under 5 atm pressure and isothermal condition for 90% conversion. [8]

**Q2.** One hundred moles of A per hour are available in a concentration of 0.1mol/liter by a previous process. This stream is to be reacted with B to produce R and S by the following aqueous-phase elementary reaction in a mixed flow reactor:

A + B  R + S, k = 5 liters/(mol.hr)

The amount of R required is 95 mol/hr. In extracting R from the reacted mixture A and B are destroyed, hence recycle of unused reactants is of out of question. B costs Rs. 100/mol in crystalline form. It is highly soluble in the aqueous solution and even when present in large amounts does not change the concentration of A in solution. Capital and operating costs is Rs. 0.25/hr.liter for mixed flow reactor.

Calculate the optimum concentration of B in feed and optimum reactor size for this process. [6+3]

**Q3.**  a) Liquid reactant A decomposes as per the following reaction scheme:

|  |
| --- |
|  |
|  |

An aqueous feed containing A with CA0 = 40 mol/m3 enters a reactor, decomposes and a mixture of A, R and S leaves the reactor. Find the operating condition i.e. XA , τ (space time) and CA which maximizes CR in a mixed flow reactor.

b) How the variance can be estimated using the response to a pulse input for a closed vessel? [5+3]

**Part-B**

**Q4.** a) What do you mean by effectiveness factor for a solid catalytic reaction?

b) What are the probable parameters which determine the value of Thiele modulus? State how Thiele modulus depends on those parameters.

c) Write the physical significance of Thiele modulus.

d) What type of reaction has higher effectiveness factor for a same catalytic system- reversible or irreversible? Why?

e) Explain – Heat of reaction has effect on effectiveness factor of a solid catalytic reaction.

[1+(2+4)+2+(1+2)+2=14]

**Q5.** a) What is bidispersed pore in a solid catalyst?

b) Write in brief the determination of pore volume for a bidispersed catalyst.

c) Show with proper figure how pelleting pressure affects pore radius.

d) Low temperature (-195.8C) nitrogen adsorption data were obtained for Fe-Al2O3 catalyst. The results for a 50.4 g catalyst were:

Pressure, mm Hg 8 30 50 102 130 148 233 258 330 442 480

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Volume adsorbed 103 116 130 148 159 163 188 198 221 270 294

CC (at 0 C and 1 atm)

Estimate the surface area for this catalyst.

Density of N 2 at its normal boiling point is 0.808 g/cc and projected area of a molecule is 16.2x 10-16cm2/molecule

[1+3+2+5=11]