

JK Lakshmi Pat University Jaipur

INSTITUTE OF ENGINEERING AND TECHNOLOGY

End Term Examination, May, 2019
B. Tech. in Chemical Engineering, Semester Sixth

Roll No.....

Course Code : CHE608

Time: 3.0 hours

Max. Marks: 40

Course Name: Chemical Reaction Engineering-II

Instructions to students:

1. Do not write anything other than your roll number on question paper.
2. Assume suitable data wherever required and mention it clearly.
3. Writing appropriate units, nomenclature, and drawing neat sketches/schematics/ flow chart wherever, required are an integral part of the answer.

Q.1

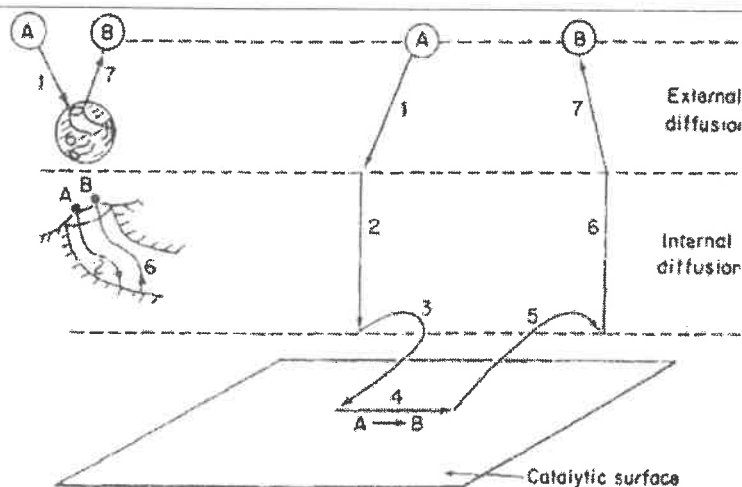
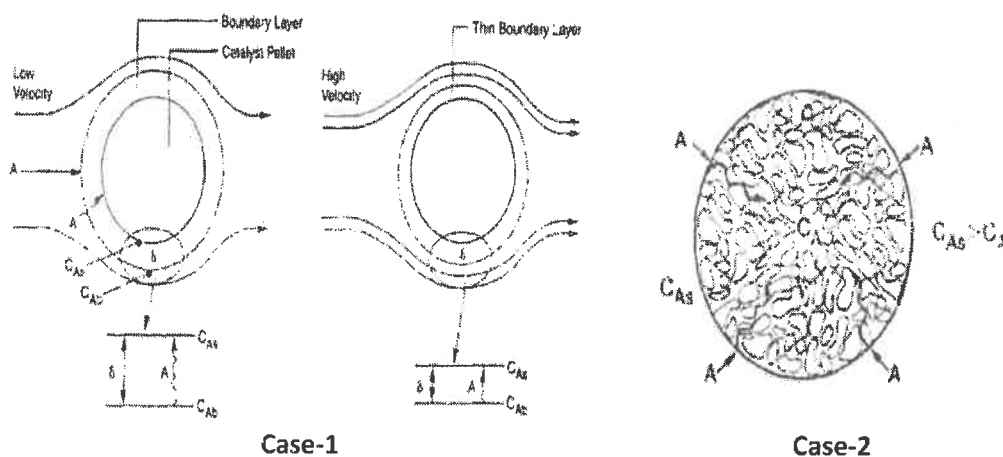


Figure-1

Evaluate and explain the steps in the above diagram.

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Q.2



Case-1

Case-2

Figure-2

Estimate the rate equation for the two different cases shown in the above figure. The effect of particle size and fluid velocity on overall rate for case-1 and effect of particle size rate constant for case-2 are describe graphically.

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Q.3

The first order reaction $A \rightarrow B$ was carried out over two different-sized pellets. The pellets were contained in a spinning basket reactor that was operates at sufficently high rotation speed that external mass transfer resistance was negligible. The results of two experimental runs made under identical conditions are as given in table.

Table-1

	Measured Rate ($\text{mol/g cat} \cdot \text{s}$) $\times 10^5$	Pellet Radius (m)
Run 1	3.0	0.01
Run 2	15.0	0.001

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- (a) Estimate the Thiele modulus and effectiveness factor for each pellet.
 (b) How small should the pellets be made to virtually eliminate all internal diffusion resistance?

Q.4

Species A, which is present in dilute concentrations, is diffusing at steady state from the bulk fluid through a stagnant film of B of thickness δ to the external surface of the catalyst. The concentration of A at the external boundary is C_{Ab} and at the external catalyst surface is C_{As} , with $C_{Ab} > C_{As}$. Because the thickness of the hypothetical stagnant film nest to the surface is small with respect to the diameter of the particle i.e., $\delta \ll d_p$, we can neglect curvature and represent the diffusion in rectilinear coordinates as shown in figure below. Determine the concentration profile and the flux of A to the surface using (a) shell balance and (b) the general balance equations. Additional information are as D_{AB} : $0.01 \text{ cm}^2/\text{s}$, C_{T0} : 0.1 kmol/m^3 , y_{Ab} : 0.9 and y_{As} : 0.2 .

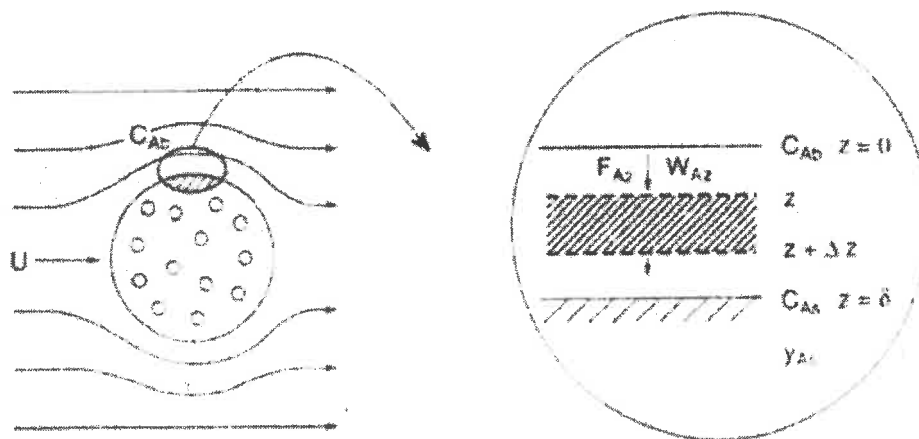


Figure-3

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Q.5

Our examination of diffusion and reaction in catalyst pellets shown that in many cases the reactant concentration near the center of the particle was virtually zero. If the condition were to occur in a hydrogel, the cells at the center would die. Consequently, the gel thickness needs to be designed at allow rapid transport of oxygen. Let's consider the simple gel geometry shown in figure

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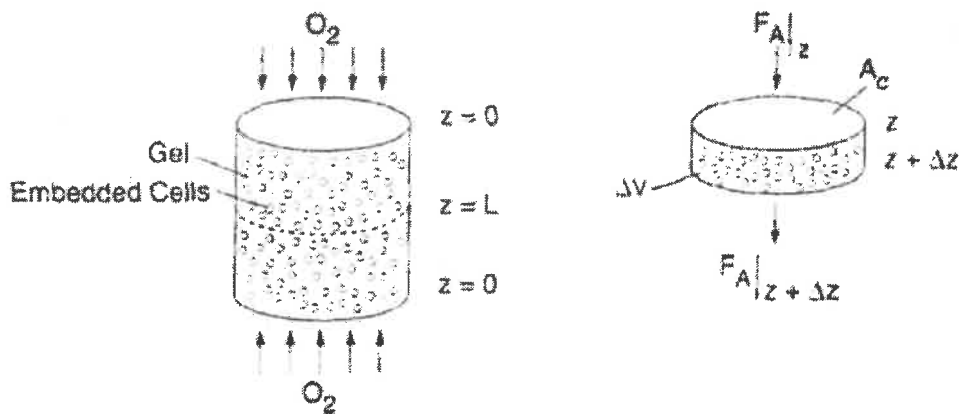


Figure-4: Schematic of cartilage cell system

Estimate the gel thickness at which the maximum oxygen consumption rate is $10^{-13} \text{ mol/cell hr}$. The cell density in the gel is $10^{10} \text{ cells/dm}^3$, and the bulk concentration of oxygen ($z=0$) is $2 \times 10^{-4} \text{ mol/dm}^3$, and the diffusivity is $10^{-5} \text{ cm}^2/\text{s}$.

*****BEST OF LUCK*****

