BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI

SECOND SEMESTER 2017-2018

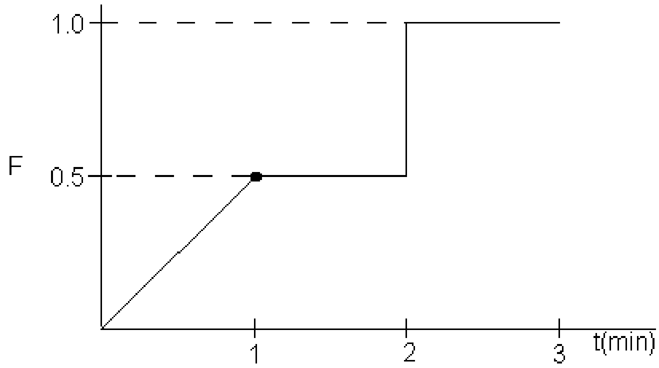
CHE G 641: Reaction Engineering

Mid Term Test — Date: 10.03. 2018

Duration: 11:00 AM - 12:30 PM — Maximum Marks: 40

PART- A — 5 X 2= 10 M

1. Is the assumption that there are no radial gradients a good one for most plug flow reactors? When is it not valid?
2. Consider a gas phase reaction $2A \rightarrow R + 2S$ with unknown kinetics. If a space velocity of 1 min^{-1} is needed for 90% conversion of A in a PFR find the corresponding space time and mean residence time or holding time of the fluid in the reactor.
3. The conversion decreases with increasing temperature for an exothermic reversible reaction. Explain from the principles of free energy and extent of reaction.
4. The F curves is shown below for a real reactor. What is the mean residence time?



5. At what conditions runaway reactions occur in CSTR?

PART- B

1. The following gas-phase reactions occur in a PFR:

   Reaction 1: $A \rightarrow B$, $-r_{1A} = k_{1A}C_A$

   Reaction 2: $2A \rightarrow C$, $-r_{2A} = k_{2A}C_A^2$

   Pure A is fed at a rate of 100 mol/s, a temperature of 150 °C, and a concentration of 0.1 mol/dm^3. Develop the model equations and show the algorithm (MATLAB) for solving temperature and molar flowrate profiles down the reactor.

   Additional information:

   ΔH_{Rx1A}= -20,000 J/mol of A reacted in reaction 1

   ΔH_{Rx2A}= -60,000 J/ mol of A reacted in reaction 2

   C_{PA}= C_{PB}= 90 J/mol. °C , C_{PC} = 180 J/mol °C

E_1/R = 4000 K, E_2/R= 9000 K

$k_{1A} = 10.0\ exp\left[\frac{E_1}{R}\left(\frac{1}{300} - \frac{1}{T}\right)\right]\ s^{-1}$ $\qquad$ $k_{2A} = 0.09\ exp\left[\frac{E_2}{R}\left(\frac{1}{300} - \frac{1}{T}\right)\right]\ \frac{dm^3}{mol.s}$

Ua= 4000 J/ m^3.s °C, $\qquad$ T_a= 100 °C $\qquad$ [12 M]

2. The reaction

$$A + B = c + D$$

Is carried out adiabatically in a series of tubular reactors with inter-stage cooling as shown in Fig. The feed is equimolar in A and B and enters each reactor at 27 °C. The heat removed between the reactors is −87.5 kcal/min.

(a) What is the outlet temperature of the first reactor?

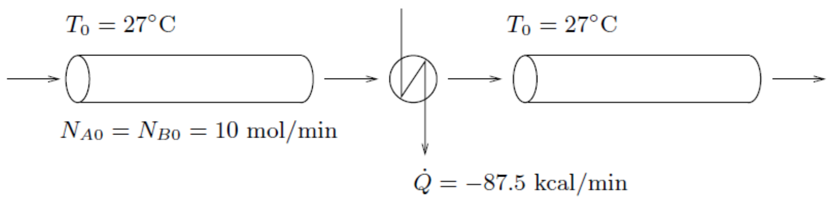
(b) What is the conversion of A at the outlet of the first reactor?

(c) Is the first reactor close to equilibrium at the exit? State any assumptions that you make while solving the problem.

DATA:

ΔH_R = -30 kcal/ mol $\qquad$ *Cp*= 25 cal/ mol. K $\qquad$ *K*= 5.0 x 10^5 at 50 °C

$N_{A0} = N_{B0}$ = 10 mol/ min $\qquad$ *Q*= -87.5 kcal/mol/ min $\qquad$ [12 M]



3. show that $\qquad$ [6 M]

$$1 < n \qquad X_{seg} > X_{mm}$$

$$0 < n < 1 \qquad X_{seg} < X_{mm}$$

$$n < 0 \qquad X_{seg} > X_{mm}$$

Where *n* is order of the reaction, *X* is the conversion.

ALL THE BEST