Ch En 386

**Winter 2014 Homework**

**Homework #7 (20 points)**

**Due Friday, February 21**

Note: Anytime you solve a problem with Polymath or MathCad, you must print a copy of the report (Polymath) or the page with equations (MatchCad).

*Conditioning Problems (0.5 points each- you may not work with other students):*

1. State how CA0, CA (in the reactor), and CA (exiting the reactor) are related to moles, molar flow rate, volumetric flow rate, and/or reactor volume.
2. For an unsteady state CSTR, state whether you should use C, F, N, , or X to solve reactor problems. State why!
3. For an unsteady state CSTR, does dNA/dt = VRdCA/dt for all conditions? Explain.
4. If you have one reaction where A + 2B 🡪 2C, how is 1 related to XA for a batch reactor or a steady state flow reactor?

Magnitude and Reasonableness Problems *(0.5 points each)*

1. If you have a reversible reaction with A ↔ B and KC = 0.1, are you going to make much B if you start with only A in a flow reactor? Support your reasoning.
2. If A+B 🡪 C + D in an isothermal PBR, what value of W causes the pressure drop to decrease by ½ of the inlet pressure? What will happen as the pressure goes towards ambient pressure.

*Lesson 16: Solving with moles, flow rates, concentration and extent*

1. (3 points) Fogler P4-5b. Use N as the solving variable. In addition to answering the problem, show the moles and concentrations of each species with time. Solve with Polymath.
2. (3 points) Ammonia synthesis occurs by the non-elementary reaction N2 + 3H2 🡪 2NH3 in an isothermal PBR. Nitrogen enters at 2 mol/min and hydrogen enters at 6 mol/min. *v0* = 10 liters/min. The inlet pressure is 4 atm. There is a pressure drop with  = 0.03 kg-1. The rate law is:



where k = 7 mol kg-1 min-1 M-3 and KC = 2 M-1. How much catalyst do you need to convert 85% of nitrogen? Show plots of the flow rate of each species, the pressure, and the conversion along the length of the reactor. Solve using the variable F. You will need to solve using Polymath.

*Lesson 13: Unsteady flow reactors*

1. (4 points) A tank initially contains 400 liters of contaminated water containing 3M of contaminant A and no contaminant B.

v0=10 liters/s

CB = 3 M

v=10 liters/s

@ t=0

VR=400 liters

CA = 3 M

CB = 0

Beginning at t=0, water with contaminant B (at 3 M) flows into the tank at 10 liters/s and contents from the tank are removed at 10 liters/s. Contaminant A decays in the tank such that RA=-kCA. The value of k is 0.01 s-1. Contaminant B does not decay. The contents of the tank are perfectly mixed and you may assume constant density. Which contaminant has a higher concentration in the tank at 30 seconds? Solve by hand (this means use pencil and paper).

*Lesson 14: Reactors with mass transfer*

1. (3 points) Fogler P4-25 a, c. For part a, just show profiles of FA, FB, FC, and XA as a function of VR. For part c, answer this question by setting kCB= 0, kCC= 20 min-1, and showing XA as a function of VR. Use F as your solving variable and solve with Polymath. Clearly mark your plots. You may assume no pressure drop and that the gas surrounding the reactor is purged quickly such that that CAS and CBS surrounding the reactor is negligible.
2. (4 points) A drug (200 mg) is administered as a bolus injection into the blood (5 liters) at some initial time. The drug leaves the blood by entering a tissue region (8 liters) where the drug is used (see the figure below). In the tissue region, the drug is reversibly bound and metabolized at a first order rate of 0.01 min-1. There is no reaction of the drug in the blood. The transport coefficient (k’C) for the blood/tissue interface is 0.80 cm/min (i.e. it absorbs rapidly) and the transport area is 100 cm2. You may assume the tissue and blood regions are well-mixed and the kidney volume is negligible due to its small size. Solve using C as the solving variable. Use Polymath to solve.
   1. How long does it take for 90% of the drug to disappear from the blood?
   2. After 2 hours, how much drug (in mg) is in the tissue?

