

University of Kentucky
Chemical & Materials Engineering Department
CME 550: Chemical Reactor Design
Homework 8

Due at *beginning* of class on Monday November 14, 2005
Partial credit will be given in 1/2-point increments.

- 1) In most states, the legal intoxication limit is 1.0 g of ethanol per liter of body fluid. The ingestion of ethanol into the bloodstream and subsequent elimination can be modeled as a series reaction. The rate of absorption from the gastrointestinal tract into the bloodstream is a first-order reaction with a rate constant of 10 h^{-1} (based on the entire volume of body fluid). The rate at which ethanol is broken down in the bloodstream is limited by regeneration of a coenzyme, and therefore can be modeled as a zero-order reaction with a rate constant of $0.192 \text{ g}/(\text{h}\cdot\text{L of body fluid})$. How long would a person need to wait for their blood alcohol concentration to be below the legal limit if they drink two tall martinis (a) immediately after arriving at a party or (b) one immediately and the second after 1 hour has elapsed? For these calculations, assume that a tall martini contains 40 g of ethanol and that the volume of body fluid is 40 L. How would the answer differ if a 60-L person drinks two tall martinis right away? [2 pt] [Based on F.S. Fogler, *Elements of Chemical Reaction Engineering*, problem P6-7]
- 2) Levenspiel 8.8 [2 pt]
- 3) For the liquid-phase reaction of aniline with ethanol (see problem 8.8) conducted in H_2SO_4 solution, the rate coefficient for the first reaction, k_1 , is $0.25 \text{ L}/(\text{mol}\cdot\text{min})$. If $60 \text{ L}/\text{min}$ of feed containing $4 \text{ mol}/\text{L}$ aniline and $4 \text{ mol}/\text{L}$ ethanol is to be converted to the maximum concentration of monoethylaniline, calculate the reactor volume required. Numerical integration will be required. Either integrate of the set of ODEs to describe the concentrations of all species as a function of space-time, or integrate $1/(-r_A)$ vs. C_A . [2 pt]
- 4) Levenspiel 8.14 [2 pt]
- 5) Levenspiel 8.19 [1 pt]
- 6) Levenspiel 8.21 [1 pt]