

Homework 14  
due December 9, 2008

1. Felder and Rousseau, problem 9.11 (energy balance with reaction)
2. One way to synthesize ethanol ( $\text{CH}_3\text{CH}_2\text{OH}$ ) industrially is by reacting  $\text{H}_2\text{O}$  with ethylene ( $\text{CH}_2\text{CH}_2$ ). Water adds across the double bond, and assume (for this problem) that ethanol is the only product.  
10 mol/s of  $\text{CH}_2\text{CH}_2$  (v) enters a reactor, along with 5 mol% excess liquid water. Both streams are at  $90^\circ\text{C}$ . A 70 mol% conversion of ethylene is achieved, and the product and unreacted feed all exit together as a vapor mixture at  $150^\circ\text{C}$ .
  - (a) Calculate the mole fraction of ethylene in the product stream.  
In solving the problem, remember to write the chemical reaction and to draw and label a flowsheet. Remember that a strategy from early in the course is to list the equations that you will solve, indicating which unknown will be found from each.
  - (b) Calculate the rate that heat must be added or removed (and specify which one!) to maintain the inlet and exit temperatures. Use the heat of formation method (i.e. a different method than you used in the previous problem).

If you find yourself without enough information, make and justify a reasonable approximation. Please answer all (requested) parts of a question! (This is good practice for an exam setting.)

Additional project questions will be distributed in a separate handout. Do meet with your team members!