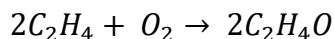


ECHE 260: Intro to Chemical Systems

Homework #7 (50 points)

Quantitative Questions (45 points)

1. (25 points) Ethylene oxide is an important chemical precursor to many consumer goods such as soaps, detergents, synthetic fabrics and antifreeze. Ethylene oxide is formed by the catalytic oxidation of ethylene in a continuous, steady state reactor according to the following equation:



There is a single feed to the reactor which contains a gas mixture. In this feed, ethylene and oxygen exist in stoichiometric proportions and there is an equimolar amount of nitrogen (an inert gas) and ethylene. The inlet stream is 600K at 1atm. The outlet stream is 1000K and 1 atm. The fractional conversion of ethylene is 0.30. How much heat is transferred to or from the reactor during the reaction? (This may be a useful resource: <https://webbook.nist.gov/cgi/cbook.cgi?ID=C75218&Mask=1>)

- Draw and fully label a process flow diagram. Assign variables to all relevant unknowns.
 - Perform a DOF analysis on the reactor to determine whether or not the material balance is solvable (DO NOT solve it).
 - Write the first law of thermodynamics for the reactor, cancel terms & justify why. The final form of this energy balance should include species flowrates from the PFD and specific molar enthalpies.
 - USING THE HEAT OF REACTION METHOD, draw the theoretical path for each species and clearly identify the reference states you would use for the calculations.
 - USING THE HEAT OF REACTION METHOD and based on your theoretical paths, write the equations for the molar enthalpies using $\Delta H'$ s from part d.
 - USING THE HEAT OF REACTION METHOD, write the relevant equations for the theoretical path for all species and the heat of reaction. Look up any constants, clearly identify sources of tabulated data.
 - Explain how you would solve the problem. DO NOT SOLVE.
2. (12 points) Resolve problem 1 part d), part e), part f), and part g) but this time use the HEAT OF FORMATION method.

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3. **(3 points)** Qualitatively describe how your solutions were different for each method (*hint*: think about reference states, the time it took you to write the expressions, complexity of your equations, access to tabulated data).

Reflection (5 points)

4. We are now finished learning new technical content for the course (yay!).
 - a. Is there anything that you still find confusing about ENERGY balances? (including reactions, phase change, etc.)
 - b. Is there anything that you still find confusing about MATERIAL balances (including reactions, phase change, etc.)