CE 329 Fall 2015

Class 24 Worksheet

Suppose a stirred tank is operating at steady state as shown on the left (there's no reaction), when the inlet composition is suddenly changed

The inlet concentration of red coloring changes from 1 to 0 mol L-1

The temperature of the inlet flow stream changes from 50 ºC to 25 ºC

Assuming the transient will continue until a new steady state is reached, describe how the concentration of red coloring and the temperature will vary at the points labeled A, B and C if the fluid is a constant density liquid

Write a mole balance equation for the red coloring; expand all summations and continuous products and eliminate all zero-valued and negligible terms

What initial condition is needed to solve this equation?

Repeat the first two parts above for the case where the fluid is an ideal gas

Example 22.1 described a steady state CSTR where the rate of liquid-phase reaction (1) is adequately described by the rate expression given in equation (2). Reactant A is fed to a steady state CSTR at a rate of 0.01 lbmol min^{-1}, and reactant B is fed at a rate of 0.25 lbmol min^{-1}. This corresponds to an inlet volumetric flow rate of 0.08 ft^3 min^{-1}. The CSTR has a fluid volume of 18 ft^3, and it operates adiabatically. The heat of reaction may be taken to be constant and equal to -1.7 x 10^4 BTU $lbmol^{-1}$. The heat capacities of A, B and Z are equal to 1000, 180 and 1200 BTU $lbmol^{-1}$ $°R^{-1}$, respectively, and they may be considered to be independent of temperature. If this reactor was operating at 650 °R and the volumetric flow rate was suddenly doubled, how would the conversion change?

$$A + B \rightleftarrows Z \tag{1}$$

$$r_1 = \left(1.2 \times 10^{14}\ \text{ft}^3\ \text{lbmol}^{-1}\ \text{min}^{-1}\right)\exp\left\{\frac{-23000\ °\text{R}}{T}\right\}C_A C_B \times\left[1-\frac{C_Z}{\left(6.5 \times 10^{-13}\ \text{ft}^3\ \text{lbmol}^{-1}\right)\exp\left\{\frac{20000\ °\text{R}}{T}\right\}C_A C_B}\right] \tag{2}$$