Completely Mixed Flow Reactors

CENG 340–Introduction to Environmental Engineering

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Steps for Solving Mass Balance Problems in Completely Mixed Flow Reactors (CMFRs)

(Modified from *Environmental Engineering* by Mihelcic and Zimmerman)

The most difficult part of solving mass balance problems in CMFRs arise from uncertainty of the location of the control volume boundaries, and uncertainty of values of the individual terms in the mass balance equation (e.g., Q_{out}, $\dot{m}_{rxn}$). The following steps will hopefully help solve mass balance problems:

1. Draw a diagram, identify the control volume and all of the influent and effluent flows. All mass flows must cross the control volume and it should be reasonable to assume the control volume is well mixed. (Remember that the significance of "completely mixed" is that $C_{out} = C_{\text{in the reactor}}$.)

2. Write the mass balance equation in general form:

$$\frac{dm}{dt} = \dot{m}_{in} - \dot{m}_{out} + \dot{m}_{rxn}$$

3. Determine whether the problem is at steady state ($\frac{dm}{dt} = 0$) or nonsteady state ($\frac{dm}{dt} = V \times \frac{dC}{dt}$).

4. Determine whether the compound being balanced is conservative ($\dot{m}_{rxn} = 0$) or nonconservative. If the compound is nonconservative, then $\dot{m}_{rxn}$ must be determined based on reaction kinetics as follows:

$$\dot{m}_{rxn} = V \times (\frac{dC}{dt})_{\text{reaction only}}$$

5. Substitute known or required values for each of the terms in the mass balance equation.

6. Solve the problem. You'll need to solve differential equations for nonsteady-state problems and algebraic equations for steady-state problems.

Examples of Mass Balance Problems for CMFRs

Go through the examples in Section 4.1.3 of the textbook (pp.113–120). There are four examples and we've done (including today) two in class.