Chapter 1
Flowing Reactors

Plug Flow Reactors
PFRs
1. Plug Flow Reactors

While plug-flow reactors appear to be simpler than CSTRs, mathematically they are more complex. The general balance equation does not reduce down to a simple algebraic relationship as is the case with CSTRs, but it involves the evaluation of an integral. To see why, we need to examine a PFR.

\[
\frac{dF_i}{dV} = r_i \quad (1)
\]

Assumptions

- Within a volume element, \( dV \), there are no spatial variations in the rate, temperature, pressure, etc.
- Mixing is perfect within a volume element.
- Concentration varies with axial position along the reactor.

This results in a differential equation for the reactor

\[
V = \int_{F_{A0}}^{F_{Af}} \frac{dF_A}{-r_A} \quad (2)
\]
1.0.1. **Packed Bed Reactors**

Packed bed reactors (PBR) are simply PFRs packed with catalyst particles. In this case the weight of catalyst rather than the volume is the important variable. The equation becomes

\[
\frac{dF_i}{dW} = r'_i \tag{3}
\]

Where the prime on the expression for the rate signifies that the rate is measured with respect to catalyst weight. Solving equation (3) for the weight yields

\[
W = \int_{F_{A0}}^{F_{Af}} \frac{dF_A}{-r'_A} \tag{4}
\]

Equations 1 and 3 can be solved by integration or with an ODE solver. The integral method works well for isothermal reactors, but when the temperature is allowed to change it is necessary to use numerical techniques.