Chemical Reactor Modelling and Analysis

APPENDIX C

The chemical reactor is one of the most important unit operations considered by chemical engineers; thus, proper modelling and analysis are essential. The engineer should be able to derive the basic balances for typical reactor designs and to anticipate the range of likely dynamic behavior. This appendix is provided to complement and extend the coverage in Chapters 3 through 5 by deriving the energy balance, demonstrating linear analysis, and addressing more complex dynamic behavior. Sections C.1 to C.3 apply standard modelling and analysis methods to this important chemical process and should be understood by all students. The material in Sections C.4 and C.5 presents more complex behavior that occurs in some chemical reactors and can be covered as enrichment material.

C.1 ■ ENERGY BALANCE

Material balances for reacting systems were derived in Chapter 3 and applied throughout the book. The energy balance for a continuous-flow chemical reactor is used, but not derived, in Section 3.5. The reactor energy balance is derived here, beginning with the general energy balance in equation (3.5), with the following assumptions:

1. The system volume is constant.
2. The heat capacity and density are constant.
3. $\Delta PE = \Delta KE = 0$.
4. The tank is well mixed.
5. One chemical reaction is occurring.