Reactor Material and Energy Balance Summary

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I. Batch Reactor

I.A. Material Balance

$$\frac{dC_A}{dt} = \nu_A r$$

I.B. Adiabatic Energy Balance

$$\frac{dT}{dt} = \frac{-\Delta H_R r}{C_T C_{p,mix}}$$

I.C. Energy Balance for Jacketed Systems

$$\frac{dT}{dt} = \frac{-V_r \Delta H_R r + A_S U\left(T_j - T\right)}{C_T C_{p,mix} V_r}$$

$$\frac{\partial T_j}{\partial t} = \frac{F_j}{V_j}\left(T_{j,in} - T_j\right) - \frac{A_S U\left(T_j - T\right)}{C_j C_{p,j} V_j}$$

II. CSTR

II.A. Material Balance

$$\frac{dC_A}{dt} = \frac{F_{in}}{V} C_{A.in} - \frac{F_{out}}{V} C_A + \nu_A r$$

II.B. Adiabatic Energy Balance

$$\frac{dT}{dt} = \frac{\frac{F_{in}}{V} C_{T,in} C_{p,mix,in}\left(T_{in} - T\right) - \Delta H_R r}{C_T C_{p,mix}}$$

II.C. Energy Balance for Jacketed Systems

$$\frac{dT}{dt} = \frac{F_{in} C_{T,in} C_{p,mix,in}\left(T_{in} - T\right) - V_r \Delta H_R r + A_S U\left(T_j - T\right)}{C_T C_{p,mix} V_r}$$

$$\frac{\partial T_j}{\partial t} = \frac{F_j}{V_j}\left(T_{j,in} - T_j\right) - \frac{A_S U\left(T_j - T\right)}{C_j C_{p,j} V_j}$$

III. Steady State PFR

III.A. Material Balance

$$\frac{dC_A}{dz} = \nu_A \frac{r}{v_z}$$

III.B. Adiabatic Energy Balance

$$\frac{\partial T}{\partial z} = \frac{-\Delta H_R \frac{r}{v_z}}{C_T C_{p,mix}}$$

II.C. Energy Balance for Jacketed Systems

$$\frac{\partial T}{\partial z} = \frac{-\Delta H_R r + \frac{A_S}{V_r} U\left(T_j - T\right)}{v_{z,r} C_T C_{p,mix}}$$

$$\frac{\partial T_j}{\partial z} = -\frac{A_S U\left(T_j - T\right)}{v_{z,j} C_j C_{p,j} V_j}$$