A First Course on Kinetics and Reaction Engineering

Unit 36. Segregated Flow Models

Definitions

micro-mixing - mixing that occurs within a single fluid element
macro-mixing - mixing that occurs between fluid elements

Nomenclature

$\lambda$ age (or residence time) of a fluid element leaving a reactor
$C_i$ concentration of species $i$, an overbar indicates the average over all fluid elements
$F(\lambda)$ age function equal to the fraction of the fluid leaving a reactor with an age less than $\lambda$
$\dot{V}$ volumetric flow rate
$n_i$ moles of species $i$, an overbar indicates the average over all fluid elements
$t$ residence time, an overbar indicates the average over all fluid elements, a prime indicates its use as a dummy variable for integration

Equations

\[ dF(\lambda) = \frac{dF}{d\lambda} \, d\lambda \]  \hspace{1cm} (36.1)

\[ \bar{n}_i = \int_{F=0}^{F=1} \dot{V} C_i(t') dF(t') = \dot{V} \int_{F=0}^{F=1} C_i(t') dF(t') \]  \hspace{1cm} (36.2)

\[ \bar{n}_i = \dot{V} \int_{t'=0}^{t'=\infty} C_i(t') \frac{dF(\lambda)}{d\lambda} \bigg|_{\lambda=t'} \, dt' \]  \hspace{1cm} (36.3)

\[ \bar{C}_i = \frac{\bar{n}_i}{\dot{V}} = \int_{t'=0}^{t'=\infty} C_i(t') \frac{dF(\lambda)}{d\lambda} \bigg|_{\lambda=t'} \, dt' \]  \hspace{1cm} (36.4)

\[ \bar{\lambda} = \int_{t'=0}^{t'=\infty} t' \frac{dF(\lambda)}{d\lambda} \bigg|_{\lambda=t'} \, dt' \]  \hspace{1cm} (36.5)

\[ \bar{f}_i = \int_{t'=0}^{t'=\infty} f_i(t') \frac{dF(\lambda)}{d\lambda} \bigg|_{\lambda=t'} \, dt' \]  \hspace{1cm} (36.6)

\[ \int_{F=0}^{F=1} dF(t') = 1 \]  \hspace{1cm} (36.7)
\[ \int_{t'=0}^{t'=\infty} \frac{dF(\lambda)}{d\lambda} \mid_{\lambda=t'} \, dt' = 1 \quad (36.8) \]