A First Course on Kinetics and Reaction Engineering

Unit 12. Performing Kinetics Experiments

Definitions

bulk fluid - liquid or gas sufficiently far from the external surface of a solid to be outside the hydrodynamic boundary layer

boundary layer - region between the bulk fluid and the surface of a solid where convective flow is affected by drag between the fluid and solid surface

external transport limitations - changes of the apparent reaction rate due to the presence of concentration or temperature gradients between the bulk fluid and the external surface of a solid catalyst particle

internal transport limitations - changes of the apparent reaction rate due to the presence of concentration or temperature gradients within the pores of a solid catalyst particle

Nomenclature

ΔH	heat of reaction
λ	thermal conductivity
φ_s	experimental modulus used in testing for the absence of intraparticle gradients
C	concentration
D_{eff}	effective diffusivity
E	activation energy
R	Ideal gas constant
T	temperature, a subscripted w denotes the wall temperature
h	heat transfer coefficient
k_c	mass transfer coefficient
k_0	pre-exponential factor
r	rate of reaction with respect to a reactant
r	radius, a subscripted p denotes a catalyst particle radius, a subscripted r denotes the reactor tube radius

Equations

$$r = k_0 \exp\left(\frac{-E}{RT}\right) C \tag{12.1}$$

$$\frac{\left(-\Delta H\right)\left(-r\right) r_p}{hT} < 0.15 \frac{RT}{E} \tag{12.2}$$

$$\frac{(-r)r_p}{Ck_c} < \frac{0.15}{n} \tag{12.3}$$

$$\frac{|\Delta H|(-r)r_r^2}{\lambda T_w} < 0.4\frac{RT_w}{E} \tag{12.4}$$

$$\phi_s = \frac{r_p^2(-r)}{D_{eff}C} \tag{12.5}$$

$$\frac{r_p^2(-r)\Delta H}{\lambda T} < 0.75\frac{RT}{E} \tag{12.6}$$