Governing equations: Simulation of LS packed bed reactor

➢ Energy conservation

Heat source term

$$\text{Solid}: \frac{\partial}{\partial t}(\rho_s h_s) = \frac{\partial}{\partial z}\left(\lambda_{axs}\frac{\partial T_s}{\partial z}\right) - \alpha_{sg}\sigma_{sg}(T_s - T_g) + \alpha_{sw}\sigma_{sw}(T_s - T_w) + N_{LS}\cdot R_{CO_2}\left(\Delta H - \int_{T_g}^{T_s} C_{pg}\,dT\right)$$

$$\text{Gas}: \frac{\partial}{\partial t}(\rho_g h_g) + \frac{\partial}{\partial z}(\rho_g u h_g) = \frac{\partial}{\partial z}\left(\lambda_{axg}\frac{\partial T_g}{\partial z}\right) + \alpha_{sg}\sigma_{sg}(T_s - T_g) + \alpha_{gw}\sigma_{gw}(T_g - T_w)$$

✓ Heat transfer[3] [4]

$$Nu_{sg} = 0.633\cdot Pr^{*1/3}\frac{d_p}{d_t}\cdot 0.761 Re_p^{0.658}$$

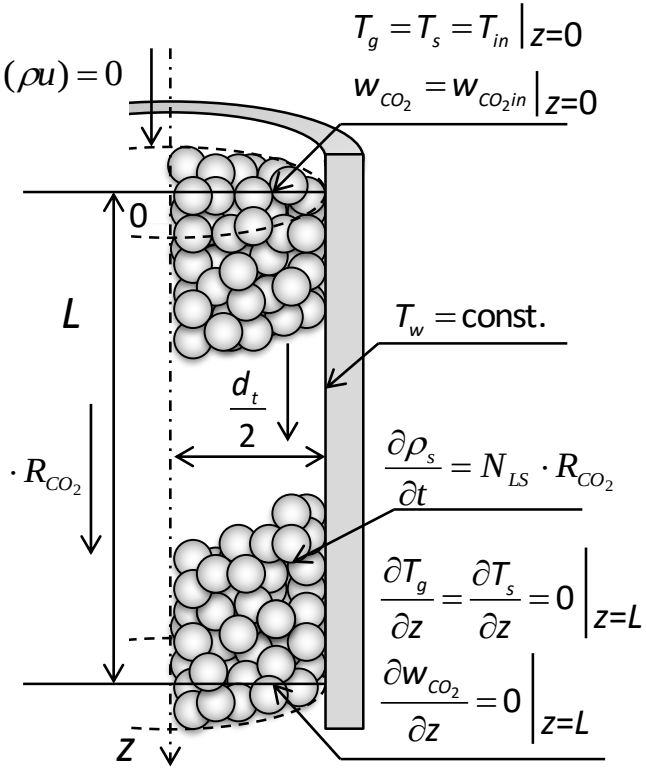
$$\alpha_{sw} = \frac{2.12\,\lambda_s}{d_p}, \quad Nu_{gw} = 0.6\,Pr^{1/3}Re^{1/2}$$

d_p : Particle diameter =5mm

d_t : Reactor diameter =23mm

$$\frac{\partial \rho}{\partial t} + \frac{\partial}{\partial z}(\rho u) = 0$$

$$\frac{\partial \rho_g}{\partial t} + \frac{\partial}{\partial z}(\rho u) = -N_{LS}\cdot R_{CO_2}$$



➢ CO_2 conservation

$$\frac{\partial}{\partial t}(\rho_g w_{CO_2}) + \frac{\partial}{\partial z}(\rho_g u w_{CO_2}) = \frac{\partial}{\partial z}\left(\rho_g D_{ax}\frac{\partial w_{CO_2}}{\partial z}\right) - N_{LS}\cdot R_{CO_2}$$

[3] 稲葉英男, 福田武幸, 日本機械学会論文集, 51-470, B(1985) [4] Anthony G. Dixon, AIChE Journal, 25[4](1979), pp. 663-676