CHG 3316

Corrections in Chapter 10

page 230:

$$\mathbf{N}_{Ay} = \mathbf{U}_y C_A + J_{Ay} \tag{10-5}$$

$$\mathbf{N}_{Ay} - C_A(\mathbf{N}_{Ay}\overline{V}_A + \mathbf{N}_{By}\overline{V}_B) = J_{Ay} = -D_{AB}\frac{\partial C_A}{\partial y} \tag{10-6}$$

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rectangular coordinates)

not subscript (?)

$$\frac{\partial c_A}{\partial t} + \left(\frac{\partial N_{Ax}}{\partial x} + \frac{\partial N_{Ay}}{\partial y} + \frac{\partial N_{Az}}{\partial z}\right) = R_A \tag{10-7}$$

page 232:

$+$ missing in soft copy

$$\frac{\partial c_A}{\partial t} + \left(v_x\frac{\partial c_A}{\partial x} + v_y\frac{\partial c_A}{\partial y} + v_z\frac{\partial c_A}{\partial z}\right) = D_{AB}\left(\frac{\partial^2 c_A}{\partial x^2} + \frac{\partial^2 c_A}{\partial y^2} + \frac{\partial^2 c_A}{\partial z^2}\right) + R_A \tag{10-10}$$

subscript

$$\frac{\partial c_A}{\partial t} + \left(v_r\frac{\partial c_A}{\partial r} + v_\theta\frac{1}{r}\frac{\partial c_A}{\partial \theta} + v_z\frac{\partial c_A}{\partial z}\right)$$

$$= D_{AB}\left(\frac{1}{r}\frac{\partial}{\partial r}\left(r\frac{\partial c_A}{\partial r}\right) + \frac{1}{r^2}\frac{\partial^2 c_A}{\partial \theta^2} + \frac{\partial^2 c_A}{\partial z^2}\right) + R_A \tag{10-11}$$

subscript

$$\frac{\partial c_A}{\partial t} + \left(v_r\frac{\partial c_A}{\partial r} + v_\theta\frac{1}{r}\frac{\partial c_A}{\partial \theta} + v_\phi\frac{1}{r\sin\theta}\frac{\partial c_A}{\partial \phi}\right)$$

add

$$= D_{AB}\left[\frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial c_A}{\partial r}\right) + \frac{1}{r^2\sin\theta}\frac{\partial}{\partial \theta}\left(\sin\theta\frac{\partial c_A}{\partial \theta}\right) + \frac{1}{r^2\sin^2\theta}\frac{\partial^2 c_A}{\partial \phi^2}\right] + R_A \tag{10-12}$$

STEADY-STATE MOLECULAR DIFFUSION IN BINARY SYSTEMS

In steady-state cases the $\partial c_A/\partial t$ term is zero. A typical form (in this case for rectangular coordinates) is

$$\left(\frac{\partial N_{Ax}}{\partial x} + \frac{\partial N_{Ay}}{\partial y} + \frac{\partial N_{Az}}{\partial z}\right) = R_A \tag{10-13}$$

Likewise, if density and diffusivity are constant, we have

$$\left(v_x\frac{\partial c_A}{\partial x} + v_y\frac{\partial c_A}{\partial y} + v_x\frac{\partial c_A}{\partial z}\right) = D_{AB}\left(\frac{\partial^2 c_A}{\partial x^2} + \frac{\partial^2 c_A}{\partial y^2} + \frac{\partial^2 c_A}{\partial z^2}\right) + R_A \tag{10-14}$$

subscript

page 233:

$$D_{AB} = 1.8583 \times \cancel{10^{-}}\,10^{-7} \sqrt{\frac{T^3(1/M_A + 1/M_B)}{P\sigma_{AB}^2\Omega_{D_{AB}}}} \qquad \text{(10-17)}$$

same as Eq.(1-16)

for D_{AB} in m^2/s

subscript

Note that the temperature, pressure σ_{AB} and $\Omega_{D_{AB}}$ will be the same for both D_{AB} and D_{BA}. Furthermore, the remaining term $(1/M_A + 1/M_B)^{1/2}$ is the same for both D_{AB} and D_{BA}. Hence, $D_{AB} = D_{BA}$ in a binary gas system.

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Also, the Gurney–Lurie charts of Chapter 5 (Figures 5-3 through 5-5) can be used for mass transfer by substituting analogous quantities. These substitutions would be C_{A1}, C_A and C_{A0} for T_1, T, and T_0; D_{AB} for $(k/\rho C_p)$ and $D_{AB}/k_c x_1$ for k/hx_1 (where k_c is a mass transfer coefficient).

not "r"

page 236:

but for an ideal gas

$$\frac{n_{\text{Total}}}{V} = \cancel{\frac{RT}{P}} = \frac{P}{RT}$$

$$C_A = \frac{y_A P}{RT}$$

Using the boundary conditions

$$y = y_1, \quad Y_A = Y_{A1}$$
$$y = y_2, \quad Y_A = Y_{A2}$$

yields