CHG 3316 Corrections in the textbook

for Momentum

p. 12:

$$\Phi_{ij} = \frac{1}{\sqrt{8}}\left(1 + \frac{M_i}{M_j}\right)^{-1/2}\left[1 + \left(\frac{\mu_i}{\mu_j}\right)^{1/2}\left(\frac{M_j}{M_i}\right)^{1/4}\right]^2 \tag{1-20}$$

$$k_{\text{mix}} = \sum_{i=1}^{n} \frac{y_i k_i}{\sum_{j=1}^{n} y_j \Phi_{ij}} \tag{1-21}$$

p. 14:

$$\frac{KT}{\varepsilon} = \frac{313.46}{190} = 1.\cancel{1}65$$

p. 15

$$\mu = (0.855)(2044.1 \times 10^{-8} \text{ pascal-sec}) = 1747.7 \times 10^{-8} \text{ pascal-sec}$$

For case 2, let $CO_2 = 1$, $O_2 = 2$, and $N_2 = 3$. Then:

i	j	M_i/M_j	$\cancel{M_i/M_j}$ μ_i/μ_j	Φ_{ij}
1	1	1.00	1.00	1.00
	2	1.38	0.72	0.73

p. 20

1-4. Determine a value for the viscosity of ammonia at 150°C.

1-5. A young engineer finds a notation that the viscosity of nitrogen at 50°C and a "high pressure" is 1.89×10^{-5} pascal-seconds. What is the pressure?

p. 40

The momentum rate expressions would include both a convective (for example, $\rho v_x \frac{\partial v_x}{\partial x}$) and a molecular transport term (involving shear stress).

The force term would include both pressure and gravity forces. Once again using the approach (see Figure 2-17) for the equation of continuity, let $\Delta X \Delta Y \Delta Z$ zero. This gives the following for the x component of the motion equation:

$$\rho\left(\frac{\partial v_x}{\partial t} + v_x\frac{\partial v_x}{\partial x} + v_y\frac{\partial v_x}{\partial y} + v_z\frac{\partial v_x}{\partial z}\right) = -\frac{\partial p}{\partial x} - \left(\frac{\partial \tau_{xx}}{\partial x} + \frac{\partial \tau_{yx}}{\partial y} + \frac{\partial \tau_{zx}}{\partial z}\right) + \rho g_x \tag{2-22}$$

Next, define a term $\overline{P}$ such that

$$\overline{P} = P - \rho g_z z$$

For a z distance, $Z = L$, $(\partial p/\partial z - \rho Z g_z)$ can be rewritten $(\Delta P/L - \rho g_z)$, but

$$\frac{\Delta P}{L} - \rho g_z = \frac{P_L - P_0 - \rho g_z L}{L} = \frac{\overline{P}_L - \overline{P}_0}{L}$$

Hence,

$$-\frac{\overline{P}_0 - \overline{P}_L}{L} = \frac{\mu}{r}\frac{\partial}{\partial r}\frac{r\partial v_z}{dr}$$

Then,

$$-\frac{(\overline{P}_0 - P_L)r}{\mu}dr = d\frac{r\,dv_z}{dr}$$

Note that we have written the above as ordinary differentials because only r is involved.

Integrating and using the boundary conditions

$$r = 0,\ \frac{r\,dv_z}{dr} = 0$$

$$r = 0,\ \frac{r\,dv_z}{dr} = \frac{r\partial v_z}{\partial r}$$

gives

$$\frac{-(\overline{P}_0 - \overline{P}_L)r}{2\mu L} = \frac{dv_z}{dr}$$

Again integrating and using the boundary conditions

$$r = R, \qquad V_z = 0$$

$$r = r, \qquad V_z = V_z$$

gives

$$\frac{\overline{P} - \overline{P}_L}{4\mu L}[-r^2 + R^2] = V_z$$

or

$$V_z = \frac{(\overline{P}_0 - \overline{P}_L)}{4\mu L}\left[1 - \left(\frac{r}{R}\right)^2\right] R^2$$

Remembering that phenomenonologically at $r = 0$ the velocity is a maximum, we have

$$(V_z)_{\max} = \frac{\overline{P}_0 - \overline{P}_L}{4\mu L}$$

p. 413:

Table A-3-3 Intermolecular Force Parameters and Critical Properties (1. 9–14)

Substance	Molecular Wt. M	Lennard-Jones Parameters (9, 10) σ (A)	ϵ/K (°K)	Critical Constants (11–14) T_c (°K)	P_c (atm)	V_c (cm^3 g-mole^{-1})	μ_c (g cm^{-1} sec^{-1}) $\times \cancel{10}$ 10^6	k_c (cal s^{-1} cm^{-1} °K^{-1}) $\times \cancel{10}$ 10^6
Light Elements:								
H_2	2.016	2.915	38.0	33.3	12.80	65.0	34.7	—
He	4.003	2.576	10.2	5.26	2.26	57.8	25.4	—

corrections

p. 414:

Table A-3-3 (*continued*)

corrections

Substance	Molecular Wt. M	Lennard-Jones Parameters (9, 10) σ (A)	ϵ/K (°K)	Critical Constants (11–14) T_c (°K)	P_c (atm)	V_c (cm^3 g-mole^{-1})	μ_c (g cm^{-1} sec^{-1}) $\times \cancel{10}$ 10^6	k_c (cal s^{-1} cm^{-1} °K^{-1}) $\times \cancel{10}$ 10^6
C_3H_8	44.09	5.061	254	370.0	42.0	200	228	—
n-C_4H_{10}	58.12	—	—	425.2	37.5	255	239	—
i-C_4H_{10}	58.12	5.341	313	408.1	36.0	263	239	—
n-C_5H_{12}	72.15	5.769	345	469.8	33.3	311	238	—