CORRECTIONS TO MASS and HEAT TRANSFER—Analysis of Mass Contactors and Heat Exchangers

NOTE: Changes from previous Errata that were added on 7/22/11 are indicated by red text.

Page 10, Figure 1.3 new Figure

Page 30, Figure 2.3 is not drawn to scale; it should be a tall thin vessel. Please place a note on the caption that reads "Vessel is not drawn to scale"

Page 32, k_2 and K_B values should be switched k_2 =0.64 and K_B =0.48.

Page 50, integrals in the middle of the page, lower limit should be 8020 not 8017.6

Page 51, Problems 2.2 and 2.3, Add before Table P2.1 and P2.2, respectively "Determine the rate constants for this reaction."

Page 63, first line after Equation 3.2.10---Figure 1.3 should be Table 1.3

Page 64, Figure 3.2 $\beta = 4.68 \times 10^{-2}\ \text{min}^{-1}$

Page 68, 1st line after section 3.3.1 "Subsection 3.2.3" should be "Subsection 3.2.1"

Page 72, Figure 3.5, the inlet and outlet stream "2" should have the additional parameter $\hat{C}_{p2}$.

Page 83, equation before 3.4.4 is missing the flow rate q_l and should read:

$$\left(\rho_l \hat{C}_{pl} \frac{\pi}{4} D_{IN}^2 \Delta z T_l\right)\Big|_{t+\Delta t} = \left(\rho_l \hat{C}_{pl} \frac{\pi}{4} D_{IN}^2 \Delta z T_l\right)\Big|_{t} + q_l \rho_l \hat{C}_{pl} T_l \Delta t\,\Big|_{z}$$

$$- q_l \rho_l \hat{C}_{pl} T_l \Delta t\,\Big|_{z+\Delta z} - Ua \frac{\Delta z}{L}\left(T_l - T_2\right)\Delta t.$$

Page 83, the sentence above Equation 3.4.4 should read "If we divide by Δt, Δz, we obtain"

Page 89, Equation 3.4.12 should have a negative sign in the numerator of right-hand side

Page 101, Step 4: "To get an initial estimate of the area, we will consider two values of the heat transfer coefficient – 1.0 and 1.5 kW/m^{2}K." should be replaced with "To obtain an initial estimate of the area, the heat transfer coefficient will be assumed to be 1.5 kW/m^{2}K"

Step 5: "With an exit temperature of the utility stream, T_2 = 70°C, the heat exchanger areas must be 9 m^2 (U = 1.0 kW/m^{2}K) and 6 m^2 (U = 1.5 kW/m^{2}K)." should replace "With an exit temperature of the utility stream, T_2 = 70°C, the heat exchanger areas must be 6.0 m^2."

Page 101: second to last equation for v_1, D_i should be $D_{1,\,in}$, v_1 = 0.77 m/s

Page 101, 102: D_{1out} should read $D_{1,\,out}$ and D_{2in} should read $D_{2,\,in}$

Page 102, replace Table E3.2 information with below:

$D_{1,nom}$ (in)	v_1 (m/s)	$D_{2,nom}$ (in)	v_2 (m/s)	Re_1	Re_2
4	0.20	5	0.29	41511	5751
3	0.35	4	0.38	54474	7295
2.5	0.54	3.5	0.35	67689	8548
2	0.77	3	0.40	80854	10087
1.5	1.27	2.5	0.61	103804	12567
1	2.99	1.5	1.75	159319	18771
0.5	8.50	1	3.83	268690	29065

Page 102, Equation for $D_{2,in}$ should be

$$D_{2,in} = \ldots = \sqrt{\frac{4(0.000766)}{\pi 0.77} + 0.525^2} = 0.063m = 2.48in$$

values inserted into equation for v_2 should read:

$$v_2 = \ldots = \frac{4(0.000766)}{\pi(0.0779^2 - 0.0603^2)} = 0.40 \text{ m/s}$$

Page 102, Before the line "For a 2.5-in. nominal-diameter pipe…" should be a statement: "The Reynolds number calculation for the outer pipe (Re_2) can be found on page 330. For a 2.5 in nominal diameter pipe the velocity is 0.61 m/s."

Page 102, For paragraph starting, “When the outer diameter…can be found:” change to “…can be found for both 6 m^2 and 9 m^2” An additional equation should be added:

$$L = \frac{a}{\pi D_{i,in}} = \frac{9.0 m^2}{\pi 0.0525 m} = 54.6 m = 179\, ft.$$

Page 102, For the paragraph that starts “Piping comes in…” Replace “For this heat exchanger…” with “For the two cases under consideration, we will need 6 and 9 20-ft. pipe segments.”

Page 103, Problem 3.5, “…contnuously heat a water-like process fluid…” Also at the end of the problem statement, add “…from 20 to 60°C. DOWTHERM properties are included in Problem 3.1.”

Page 105, problem 3.12, Remove the phrase “the volume of” from the seventh line

Page 106, problem 3.16, last line before part (a), the heats of combustion of ethanol, glucose and ammonia should read “684, 468, 348”. In 3rd line, “batch” should read “semi-batch”

Page 108, Problem 3.19, Part c should read, “Specify the outlet temperature of the utility stream for Figure P3.3” rather than the statement “Specify all temperatures…”

Page 108, Problem 3.20, “a. Compute…” and “b. Use…” should be a bulleted, rather than a lettered, list.

Page 119, line before equation 4.1.1, “Figure 1.5” should be “Figure 1.6”

Page 124, Equation 4.1.10, the left hand side should be $C^{II}_{A,\,eq}$

Page 126, equation 4.2.5 is two equations and should read:

$$\frac{d}{dt}\left(C_A^I V^I\right) = -a\mathbf{r}_A \qquad \frac{d}{dt}\left(C_A^{II} V^{II}\right) = a\mathbf{r}_A$$

Page 131, in the line between Equations 4.2.27 and 4.2.28 the equation should be 4.2.24 and not 4.2.17

Page 138, 3 lines below eqn (4.3.7), should read

$$C_{A,eq}^{I} = MC_{A,eq}^{II}$$

Page 142, Example 4.2, first line should read "A cylindrical vessel with a diameter of 1.4 m…"

Page 145, (4.3.20) should read

$$C_{A,eq}^{I} = MC_{A,eq}^{II}$$

$$C_{A,eq}^{II} = \left(\frac{C_{AF}^{I} + \lambda C_{AF}^{II}}{\lambda + M} \right).$$

Page 151, Ex 4.3, $C_{A1}{}^{II} = 6.7$ g/L (1 stage)

Page 152, 1st equation after figure E4.3, the last denominator should be squared- so it should read:

$$.... + \frac{\lambda^2}{(\lambda + \mathrm{M})^2} \mathrm{C}_{\mathrm{AF}}^{\mathrm{II}}$$

Page 156, Example 4.2 continued. "Because $V_I = \pi(6.0m)\left(\frac{1.4m}{2}\right)^2 = 9.24m^3$, we calculate $K_m a = 0.0065$ and

$$C_A^I = \frac{0.0065}{0.0122}\left(8.9x10^{-3}\right) kg/m^3$$

$$= 4.8x10^{-3}\, kg/m^3$$

….as $\chi = 0.6$,…"

Page 158, equation 4.4.2 and the equation in the text two lines below, $C_{A,\infty}^{I}$ and $C_{A,\infty}^{II}$ should be replaced by $C_{A,eq}^{I}$ and $C_{A,eq}^{II}$

Page 174, problem 7, the second equation should read:

$$\mathrm{V}^{\mathrm{I}} = \mathrm{V}^{\mathrm{II}} \frac{\mathrm{q}^{\mathrm{I}}}{\mathrm{q}^{\mathrm{II}}} = 56\,\mathrm{L}.$$

Page 176, Problem 4.5 the time, t, in the table should be (secs); Also, remove the text in part a, "The initial concentration of octanoic acid in the 250 mL charge is 2.75 x 10^{-4} g-mol/L."

Page 177, line 2 from the top of the page, should read "M^{-1}" not "M

Page 199, in the Solution to Example 5.1, first line, "…is sufficiently small such that…"

Page 207, end of the 1st paragraph, "z=0 (the bottom of the cylinder) toward the clear fluid at z=L."

Page 217, Figure 5.9 caption should read "Cross section of a heat exchanger tube."

Page 231, Section 5.8, Replace the first two sentances with the following: "Consider a wall (or insulated bar) that is initially at a temperature T_0, when the surface of the wall at y=0 is suddenly raised to temperature T_1."

Eliminated correction on page 232.

Page 233, equation (5.8.4) should read

$$y = \delta_T = \sqrt{4\alpha t}.$$

Page 235, middle of the page

$$Q_{total} = \frac{-0.66}{2\sqrt{\pi 0.47 x 10^{-6}}}(80-0)60^{\frac{1}{2}}\left(\pi 0.1^2\right) = -5.3kJ$$

Page 241, problem 5.5, line 5, the units of 1.5x10^{-3} cal/cm min K, should read cal/cm sec K.

Page 267, equation 6.3.2 "k_M" in the numerator should read "k_m".

Page 270, Example 6.4, "In Section 3.5 we considered…"

Page 270, Solution, 2nd line, should read "…Reynolds number is 80,848." The following equations then become:

$$Nu_1(80°C) = 0.0265(80{,}848)^{0.8}(2.4)^{0.3} = 290,$$

$$\therefore h_1 = 290\ x\ 0.6/5.25\ x\ 10^{-2} = 3322.$$

Page 271, top of page "The Reynolds number for this flow is 10,088." The following equations then become:

$$Nu_2(80°C) = 0.0243(10,088)^{0.8}(6.0)^{0.4} = 79,$$

$$\therefore h_2 = 79\ x\ 0.6/1.8\ x\ 10^{-2} = 2647.$$

$$U_{out} = \frac{1}{\frac{1}{2647} + \frac{0.0603 \ln\left(6.03/5.25\right)}{2\ x\ 16} + \frac{6.03}{3322\ x\ 5.25}} =$$

$$= \frac{1}{3.8x10^{-3} + 2.6x10^{-4} + 3.5x10^{-4}} = 1016\ \text{W/m}^2K$$

Page 271, last paragraph of example 6.4 should read "Thus, we find the estimated heat transfer coefficient is slightly higher than the lowest value of U = 1.0 kW/m^{2}K we selected and considerably lower than the value we assumed of 1.5 kW/m^{2}K."

Page 281, the superscript on y_{02} should be I not II; the superscript C^{II} in the following equation should be I not II (~mid-page)

Page 281, last equation on the page, , should read " = 1.8x10^{-5} m/s"

Page 283, the values for the viscosity are at 25, and 50 °C, so it should read:

$$\mu = 0.54x10^{-3}\ \text{Pa s}\ (50\ ^{o}\text{C})$$

Page 288, problem 6.3a should read "…for the heat transfer coefficient of the radioactive fluid pumped through the tube side with the same flow rate as the simulant?"

Page 292, problem 6.15, line 2, "Figure 6.15" should read "Figure 6.14".

Page, 308, Equation (7.2.3) should read:

$$We_I = \frac{\rho^I N^2 L_p^3}{\sigma}$$

Page 311, the equation for q^{II}_{AVG} should have a p_s in the numerator on the right hand side.

$$q_{AVG}^{II} = q_{OR}^{II} p_s \frac{\left(\ln p_o / p_s\right)}{p_o - p_s}$$

Page 316, the ΔP in equation 7.3.1 should be replaced with ε as should the ΔP in the line above the equation.

Page 328-334 – see attached corrected .pdf

p. 334, Figure 8.2, Change 56 tubes to 84 tubes

Page 342, in equation for k_m, should read as follows:

$$k_m = 2\sqrt{\frac{1.8x10^{-9} x0.01}{\pi x0.0125}} = 4.3x10^{-5} m/s$$

Page 343, equation for C_A^{II} should read:

$$C_A^{II} = \frac{q^I}{q^{II}}\left(C_{AF}^I - C_A^I\right)$$

equation for a_v has missing units, should be: $a_V = 110\ m^2/m^3$

Page 343, last equation three equations should read:

$$= -1.16 mg/L = -1.16x10^3 mg/m^3$$

$$a = \left(-400 mg/\min\right)\left(\frac{1}{60}\frac{\min}{s}\right)\left(\frac{1}{-1.16x10^3 mg/m^3}\right)\left(\frac{1}{4.3x10^{-5} m/s}\right)$$

$$= 134 m^2$$

Page 344, Tower packing volume $= a/a_v$

$= 134/110 \approx 1.2\ m^3$

Tower packing height $= (1.2x4)/(\pi(0.6)^2)$

≈ 4.3 m

Page 347, The same typo identified on Page 32 needs to be corrected in the last line of the paragraph under Equation 8.3.2. The h^{-1} in both k_1 and k_2 should be replaced with h

Page 349, the equation for the power at the top of the page should have the term 1000 kg/m^3 not kg/m^2. Fourth line from the bottom of the page should read

$3.47\ m^3/s \times 10^{-4}$

Page 350, Right before equation (8.3.7), replace the rate equation with $r_A^I = -k_4 C_A C_B$ and replace equation (8.3.7) with $\frac{dC_O^I}{dt} = -k_m a_V \left(C_O^I - C_{O,eq}^I\right) - k_4 C_A C_B$
In following line, k_4 should replace k_3

Page 351, Third line, the rate equation should read: $r_A^I = -k_5 k_1 C_A C_B / \left(K_B + C_B\right)$. The use of $k_5 k_1$ assumes…."
Replace equation (8.3.8) with $\frac{dC_O^I}{dt} = -k_m a_V \left(C_O^I - C_{O,eq}^I\right) - \frac{k_5 k_1 C_A C_B}{K_B + C_B}$
Also, in the line above Figure 8.11, $k_5 = 0.41$ (no units)

New Figure 5.9

New Figure 6.13

New Figure 8.11