Version history for *A Heat Transfer Textbook*, 5th edition

This document lists corrections and changes made between the initial version of the 5th edition and the initial release of the 6th edition. An intermediate version, 5.10, was released as an ebook.

Significant errata appearing in the printed book (ISBN 978-048683735-2) and the ebook Version 5.00. Most errata were corrected in the ebook Version 5.10. The rest were corrected in Version 6.00 (specifically the ones on pgs. 180, 244, 256, 259, 265, and 472, the second one on pg. 264, the last two on pg. 418, and the ones on pgs. 641, 642, and 652).

Page 19, eqns. (15) and (16): change sign of lefthand side of both equations

Page 24, line 2b: delete "$c =$ "

Page 25, Fig. 1.12: "gas temperature" should be "initial temperature difference"

Page 39, Prob. 1.9: answer is "1125 J" (not 1123)

Page 43, Prob. 1.28: change "2,257,000" to "2,450,000"

Page 44, Prob. 1.33: answer is "-270 W/m^2" (not 270)

Page 49, line 3b: should read "heat conduction, or heat diffusion, equation…"

Page 68, 2nd equation: change sign of the righthand side to have $-kC_1/r_o$

Page 91, Prob. 2.23: change "firebrick" to "facing brick"; answer is 40°C (not 460)

Page 92, Prob. 2.32: answer is "7.21×10^6 kJ/h" (not 7.12×10^6)

Page 94, Prob. 2.42: Change "50" to "1.5" and change "99.66%" to "89%"

Page 96, Prob. 2.46(e): Change "reduce" to "increase"

Page 100, Fig. 3.1: "exhaust" should be "compressor air" and "kitchen" should be "refrigerator"

Page 100, line 9b: "3.7" should be "3.7b"

Page 112, line 7: Change "$T_{h_{\text{out}}}$" to "$T_{c_{\text{out}}}$"

Page 132, Prob. 3.18: answer is "76.85°C" (not 75.09)

Page 132, Prob. 3.20: answer is "135.7°C" (not 140.5)

Page 135–6, Prob. 3.41: The latent heat should be "23.1 kJ/kg" (not 850). This problem has been rewritten in Version 5.10.

Page 178, unnumbered equation: $x = dx$ should be $x + dx$

Page 180, second equation: $(0.04 - 0.15)^3$ should be $(0.04 - 0.015)^3$

Page 237, line 11b: "three" should be "four".

Page 244, lines 14b–12b: The interior and exterior shape factors are equal for regular polygons, not for arbitrary shapes.

Page 256, Problem 5.22: The answer for (c) is $S_c \simeq 0.588$; S_d is substantially greater than S_c, but difficult to compute accurately as a result of the exterior corners.

Page 259, Prob. 5.27: For (b), T_{sfc} should be "216°C" (not 200); for (c), T_{sfc} should be "259°C" (not 255)

Page 261, Prob. 5.42: melting temperature should be "60°C" (not 40)

Page 264, Prob. 5.52b: τ should be $\boldsymbol{T}$ in the equation.

Page 264, Prob. 5.53: "eqn. (5.13)" should be "eqn. (5.14)"

Page 265, Prob. 5.56b: "a wire" should be "a wire of radius δ"

Page 265, Prob. 5.61: solve this problem for a fixed position and take $r/r_o = 1$.

Page 307, eqn. (6.62): Change "0.565" to "0.564"

Page 311, eqn. (6.71): Change "0.453" to "0.4587"

Page 313, eqn (6.75): Sign of leftmost term should be "−"

Page 320, line 7b: "(6.88)" should be "(6.87)"

Page 328, line 16: "viscosity" should be "Prandtl number"

Page 329, line 1 and legend of figure: "4.1" should be "4.3"

Page 333, eqn. (6.124): The last term should be: "$\frac{1}{c}(0.0296\,\mathrm{Re}_u^{0.8}\mathrm{Pr}^{0.6} - 0.332\,\mathrm{Re}_l^{1/2}\mathrm{Pr}^{1/3})$"

Page 335, Example 6.9 solution: The previous correction should be carried into the example, leading to these changes: $\overline{\mathrm{Nu}}_L = 1{,}435$, $\overline{h} = 18.82$ W/m^{2}K, $Q = 752.8$ W.

Page 339, Prob. 6.18: "eqn. (6.115)" should be "eqn. (6.114)"

Page 399, Prob. 7.15: tube temperature should be "30 °C" (not 27)

Page 399, Prob. 7.16, last line: "0.5 mm" should be "0.4 mm"

Page 399, Prob. 7.17: The relative roughness should be "$\varepsilon/D = 0.002$" (not 0.0006) and the answer should be "$h = 394$ W/m^{2}K".

Page 405, Prob. 7.47, 2nd para., line 5: "20 cm" should be "20 mm".

Page 418, eqn. (8.13b): The subscript "D" should be "L" on both Nu and Ra.

Page 418, eqn. (8.13b): The exponent 1/6 should apply only to Ra, not to the entire expression in square brackets.

Page 418, last line: β should also be evaluated at T_f.

Page 456, Problem 8.13: Use $\varepsilon = 0.9$; the answer should be "4.59 W/m^{2}K" (not 1.9)

Page 459, Problem 8.37: Use $\varepsilon = 0.7$; the answer should be "25.8 W" (not 10.5)

Page 472, line 1: Change "like operate" to "like to operate"

Page 496, Fig. 9.12: In the ordinate label $\sqrt{g\cdots}$ should be $\sqrt[4]{g\cdots}$.

Page 526, Problem 9.17: Line 1, "…of position z…"; line 2, "Set $z = 0$ where…"

Page 528, Problem 9.34: The last term on the right-hand side should be $4q_wL/GDh_{fg}$.

Page 529, Problem 9.36: "Sect." should be "Table".

Page 580, eqn. (10.45): The right-hand side of the equation should be: $\cdots = \sum_{j=1}^{n}\left(A_i\delta_{ij} - A_iF_{i\text{–}j}\right)\sigma T_j^4$.

Page 590, line 12b: Change "hydrogen" to "oxygen".

Page 602, Problem 10.10: Answer should be "0.087" (not 0.145).

Page 638, last line: Change "Problem 10.53" to "Problem 11.53".

Page 641, Example 11.7, line 2: "species 1" should be "species 2".

Page 642, Example 11.8, line 5: "species 1" should be "species i".

Page 652, line 2: "density" should be "concentration".

Page 690, lines 2–3: A more accurate value of A is $A = 2.9 \times 10^9$ kmol/m^{2}s. With that value, the answer to (b) changes to 2.03 g/m^{2}s and the answer to (d) changes to 5.58 g/m^{2}s. Also, in part (b), "ethane" should be "methane".

Page 743, second entry for c: Replace "c" by "c_i"

Changes (other than errata) incorporated in Version 5.10

Chapter 1 :

Pages 4–7: A few small edits for clarity.

Page 10, Fig. 1.3: Figure has been revised and relabeled for clarity.

Page 11: Eliminate footnote with small text edits.

Page 11, Ex. 1.1: Change conductivity of lead from 35 to 34 W/m·K and adjust numbers

Page 13–14: Rewrite discussion of thermal conductivity values.

Page 14: Change thermal conductivity of copper to "398 W/m·K" and "230 Btu/h·ft^2·°F"

Page 16–17, Example 1.2: Extensively rewritten for better clarity.

Page 17: Rephrase eqns. (1.12) and (1.13) and some surrounding text, including footnote.

Page 19, second paragraph: Rewritten for greater clarity.

Page 23, Fig. 1.10: Expand caption for greater clarity.

Page 24, Fig. 1.11: Minor adjustment to labeling for clarity.

Page 24–25: Minor text edits.

Page 25, Fig. 1.12: Redraw and correct.

Page 26, lines 11–12, 14: Minor rephrasing for better clarity.

Page 26, line before Expt. 1.2: "opposed" changed to "oppose"

Page 29, Fig. 1.13: Figure has been completely redrawn for accuracy and clarity.

Page 29, lines 3–7: Rephrase for clarity and simplicity, also eliminating eqn. (1.27a)

Page 34: Minor rephrasing for clarity.

Page 39, Fig. 1.17: Redraw and relabel for conformance with SI units.

Page 41, Fig. 1.20: Redraw and relabel for conformance with SI units.

Page 42, Fig. 1.21: Redraw and relabel for conformance with SI units.

Page 42, Problem 1.24: Edit text.

Page 43, Fig. 1.22: Redraw and relabel for conformance with SI units.

Page 44, Problem 1.35: Change 134 mm to 112 mm, to avoid considering ullage in can.

Page 46, Problem 1.43: Edit text.

Chapter 2:

Pages 49–56, Sect. 2.1: Various text edits to improve clarity. Content same.

Pages 58–72, 76, 78–83, 85–86: Various minor text edits to improve clarity. The page breaks have shifted slightly on pp. 64–71, 75–77, 78–86.

Page 71, Fig. 2.14: Adjust line weights.

Page 86, Problem 2.1: Edit text.

Page 88, Problem 2.9: Edit text.

Page 89, Problem 2.14: Edit text.

Page 88, Fig. 2.22: Relabel for conformance with SI units.

Page 89, Fig. 2.23: Redraw and relabel for conformance with SI units.

Page 91, Problem 2.26: Edit text.

Page 93, Problem 2.34: Edit text.

Page 93, Problem 2.36: Edit text.

Page 94, Prob. 2.41: Change to "in a room at 25°C"

Page 96, Problem 2.43: Edit text.

Page 96, Problem 2.47: Added this new problem.

Page 97, Problem 2.48: Added this new problem.

Page 97, Problem 2.49 with Fig. 2.24: Added this new problem and new figure.

Chapter 3:

Pages 99–101, Sect. 3.1: Various text edits to improve clarity. Content same. Some figures now on different pages.

Page 101: Mention that fins serve to reduce gas-side thermal resistance

Pages 108–111, 114, 116–117, Sect. 3.2: Minor text edits to improve clarity, new description of sources for Fig. 3.14.

Page 115, Fig. 3.12: Change to SI units. Expand caption to better describe device.

Pages 118-119, Fig. 3.14: Redraw all frames from equations for better accuracy; edit captions.

Page 120, lines 11–13: Revised for better clarity.

Pages 121–123, 126–127, Sect. 3.3: Minor text edits to improve clarity. Describe *P*-NTU method.

Page 123, Fig. 3.16: Redraw figure.

Sect. 3.4: Minor text edits to improve clarity.

Fig. 3.17: Move from page 125 to page 124.

Page 125, Table 3.1: Added this new table of equations.

Page 130, Prob. 3.4: Change "0.81" to "0.80"

Page 135, Prob. 3.38: Edit problem statement slightly.

Page 135–6, Prob. 3.41: This problem has been rewritten.

Page 136, Prob. 3.43 : Edit problem statement; remove equation number [eqn. (3.26)]

Prob. 3.44: Added this new problem.

Pages 124–138: Page breaks have moved ahead by about 1 page relative to Version 5.0

Chapter 4:

Page 182, fin root temperature: Edited these paragraphs for clarity.

Chapter 5:

Page 253, Prob. 5.4, Fig. 5.28: Edit figure.

Page 259, Prob. 5.27: Add answer to part (c).

Chapter 6:

Pages 271–277, Sect. 6.1: Various text edits to improve clarity.

Pages 277, Fig. 6.5: Expand caption to explain δ_t'

Pages 275, Fig. 6.4: Revised to better indicate the potential range of boundary layer transition.

Pages 279–283, 287–293, Sect 6.2: Various text edits to improve clarity. Adjust property values in examples.

Pages 293–298, Sect. 6.3: Minor edits for clarity and to improve description of physical property variations.

Pages 298–302, Sect. 6.4: Rework dimensional analysis. Other minor edits for clarity.

Pages 302–312, Sect. 6.5: Various edits for clarity. Adjust property data in both examples. Some larger changes are as follow.

Page 305, Fig. 6.14: Completely redrawn. Wider range of Pr, plot exact result. Discussion of figure rewritten.

Page 306, eqns. (6.58) and (6.59): Better describe the accuracy and Pr ranges of these two fits to Pohlhausen's closed-form solution of the governing equations.

Page 310, Ma and Ec discussion: These passages revised to better explain property variations and the role of each parameter.

Page 311, eqn. (6.71): Change numerical coefficient to more accurately fit the exact solution for uniform heat flux. State accuracy.

Pages 313–315, Sect. 6.6: This section was completely rewritten. The limitations of the Reynolds-Colburn analogy are clarified, and the text no longer presents a "derivation." Equation numbering shifts. Examples 6.7 and 6.8 have both been dropped.

Pages 314–323, Sect. 6.7: Various minor edits for clarity. Equation number shifts slightly.

Page 323, eqns. (6.100) and (6.101): These two equations have been moved to a footnote.

Pages 323–335, Sect. 6.8: This section has been substantially reorganized and divided into Sect. 6.8 on the turbulent b.l. and Sect. 6.9 on the transitional b.l. Equations (6.112)–(6.124) have changed significantly, with some equations eliminated, some edited, and almost all renumbered.

Page 327, Fig. 6.19: This figure has been replaced by a new figure that shows only fully turbulent data, with accompanying text that describes the statistical accuracy of eqn. (6.111).

Pages 326–328: Equations (6.112) and (6.113) have been eliminated (the latter now appears in Prob. 6.46), and eqn. (6.114) is presented by itself. The reason for this is that eqn. (6.112) is not accurate over a wide range of Re.

Figures 6.20, 6.21, and 6.22: These figures have been replaced by new figures and text. The previous Fig. 6.20 has been redrawn and is now Fig. 6.22.

Page 331, Average Nusselt number: The discussion of a direct laminar-to-turbulent transition has been dropped entirely because recent research shows that it is an oversimplification. The remainder of the section has been revised to focus on the physically correct 3 piece model (laminar/transition/turbulent b.l.), eqn. (6.124). The example that follows has been rewritten, with two follow-on examples.

Page 338, Prob. 6.12: This problem has been rewritten.

Page 338, Prob. 6.17: This problem has been rewritten.

Page 344, Prob. 6.46: This problem has been rewritten.

Probs. 6.47, 6.48, 6.50: These problems are now 6.50, 6.47, and 6.49, respectively.

Page 344–5, Prob. 6.49: This problem has been rewritten because the previous data are now plotted in the new Fig. 6.20.

Chapter 7:

Page 371, line 3b: Edited to mention Fig. 8.6.

Page 406–7, Prob. 7.51: This new problem has been added.

Chapter 8:

Page 415, top: Edit discussion of β.

Several problems have been edited to better account for thermal radiation in gases.

Page 454, Prob. 8.5: This problem has been edited.

Page 454, Prob. 8.6: This problem has been edited.

Page 456, Prob. 8.13: This problem has been revised.

Page 456, Prob. 8.15: This problem has been fully rewritten.

Page 457, Prob. 8.17: This problem has been edited.

Page 457, Prob. 8.20: This problem has been edited.

Page 457, Prob. 8.22: This problem has been edited.

Page 458, Prob. 8.24: This problem has been edited.

Page 458, Prob. 8.30: This problem has been revised.

Page 459, Prob. 8.37: This problem has been edited.

Page 459, Prob. 8.38: This problem has been edited.

Pages 458–460: Page breaks have shifted slightly.

Page 464, Prob. 8.59: Added this new problem.

Chapter 10:

Page 592, Fig. 10.26: Update percentages and reference for this figure.

Page 593, last paragraph: Incorporate recent developments in radiative materials.

Page 596, last paragraph: Add reference for atmospheric aerosols.

Page 609, Problem 10.55: Added this new problem.

Chapter 11:

Page 666, paragraph 4: Edit text.

Appendix A:

Pages 707–713: Updated property data sources and edited text.

Tables A.3, A.4, A.5, A.6: Updated properties of Ammonia, Carbon Dioxide, Methanol, Nitrogen, and Oxygen.

Table A.3: Updated properties of CFC-12, D_2O, Lead, and NaK.

Table A.4: Minor adjustments to some triple point and critical point temperatures.

Table A.6: Updated properties of Air and Hydrogen

Other edits:

Various tables in Chpts. 2, 5, 6, 9, 11, and App. A: Miscellaneous adjustments to layout.

CHANGES (OTHER THAN ERRATA) INCORPORATED *after* VERSION 5.1.

Chapter 1 :

Page 21, Table 1.1: Change first number to "4.2" from "4.3".

Page 46: Update solar temperature and solar diameter in Problems 1.43 and 1.44.

Chapter 2 :

Page 63, *passim*: Change notation for electric current density to $\vec{i}$ from $\vec{J}$.

Chapter 3 :

Page 139: Delete reference [3.9], which was the same as [3.7] in Version 5.10.

Section 3.4: This section has been rewritten to better describe the design process.

Chapter 4 :

Page 184: Add Fig. 4.14, for Problem 4.7.

Page 190: Edit Problem 4.42.

Page 190: Edit Problem 4.43.

Page 191: Edit Problem 4.44.

Page 191: Edit Problem 4.45.

Chapter 5 :

Pages 199–200: Edit text surrounding Example 5.1.

Page 217: Add additional data to Table 5.2 for low values of Biot number.

Page 245: Drop citation of 1925 Rüdenberg paper, which is not very comprehensive.

Page 259: Edit Problem 5.27.

Page 265: Edit Problem 5.58.

Page 266: Edit Problem 5.63.

Page 266: Add Problem 5.65.

Page 266: Add Problem 5.66 and Fig. 5.31.

Chapter 6 :

Page 340: Replace Problem 6.26

Page 342: Edit Problem 6.38. Raise wind chill temperature to 24°F.

Page 342: Edit Problem 6.39.

Page 346: Add Problem 6.51.

Chapter 7 :

Page 356: Edit footnote.

Problems, *passim*: Text edited.

Chapter 8 :

Page 417: Add footnote on Boussinesq.

Page 419, Example 8.1: Evaluate β at the film temperature, not T_∞. Change numbers accordingly.

Page 425, Example 8.3: Evaluate β at the film temperature, not T_∞. Change numbers accordingly.

Page 429, Example 8.4: Evaluate β at the film temperature, not T_∞. Change numbers accordingly.

Page 437, Example 8.5: Evaluate β at the film temperature, not T_∞. Change numbers accordingly.

Page 454: Minor edits.

Page 460, Problem 8.42: Lower melting point, raise transfer factor.

Page 461, Problem 8.49: Raise water pressure to 70 bar.

Page 462, Problem 8.51: Add hint.

Chapter 9 :

Page 495: Mention experiments of She and Dhir (2021).

Page 496: Edit text related to C. F. Bonilla.

Chapter 10 :

Pages 543, 550, 591, 609: Update solar temperature to 5772 K from older value of 5777 K.

Page 544: Edit passage on diffuse and directional emission and reflection, and associated index entries.

Page 580: Correct and rearrange eqn. (10.45).

Pages 583–590: Various text edits.

Page 590: Update solar irradiation to 1361 W/m^{2}K, from older value. Add Ref. [10.20].

Page 597: Update Fig. 10.27 to include Earth's global surface temperature change for 2019–2023.

Pages 598–600: Edit text on solar power utilization.

Page 604: Rewrite Problem 10.21, and move it to be Problem 10.56 on page 610.

Page 604: Add new Problem 10.21.

Page 605: Edit Problem 10.22.

Page 608: Edit Problem 10.49 to use more recent astronomical data.

Page 608: Edit Problem 10.50.

Chapter 11 : *This chapter has been heavily revised and rearranged, to the point that an itemized list of changes is not meaningful.*

Every section, other than section 11.1, has undergone substantial changes. Section 11.2 has been edited, with new figures; and Example 11.2 has been rewritten to reflect current understanding of carbon gasification. The notation for mole flux has been changed from $\vec{J}^*$ to $\vec{J}$, which better reflects the current practice in the research literature. Section 11.3 has been clarified, also with new figures, and the limitations of the binary Fick's law are stated. Section 11.4 has revised coverage of interfacial boundary conditions and solubility relations, with a new example and more discussion.

Section 11.5 now includes the Stefan problem and the mass transfer driving force, with an overall aim of illustrating how mass convection becomes inseparable from mass diffusion when mixtures are not dilute. In this section, the material on the Stefan tube, formerly in Section 11.7, is fully revised with new examples and figures. Section 11.6 has been shortened to focus only on the analogy between heat and mass transfer. Section 11.7 now addresses simultaneous heat and mass transfer at low rates in dilute mixtures; this section includes several new examples and new figures. The reader seeking only a brief introduction to mass transfer can stop here.

Section 11.8 deals specifically with the Couette flow model for high rate mass transfer in a binary mixture, with new figures and a new example. Section 11.9, on high rate heat and mass transfer, contains additional examples of technically important processes, with new figures, but does not continue with elementary models (as most of such problems require more advanced tools). Section 11.10, on physical properties, has been edited and updated, including more accurate values of the collision integrals in Table 11.4, as well as new discussion of concentrated liquids and several new figures.

A new section 11.11 has been added, introducing the essential elements of transport in non-ideal mixtures and in multicomponent mixtures; this section includes a brief development of the Maxwell-Stefan equations. This new section is intended as a jumping-off point for students who aim to work with more complex mass transfer problems, such as are often encountered in chemical separation processes. The end-of-chapter problems have been reordered to following the current organization of the text (which is considerably different than in the 1987 edition of this book), and of course the problems reflect various changes in the material covered. Many of the problems rewritten or edited, and most have had better solutions written for the solutions manual. Some of the problems are intended to provide a deeper exposure to concepts introduced only briefly in the text.

Finally, the reference list has changed significantly, now running to nearly 80 sources with doi links to most of the journal literature. These references range from primary sources of the 19^{th} century to research published during the last decade. The aim in selecting these sources has been to provide direct access to data sets and to seminal developments in the field, as well as to point out several other textbooks that can guide students through more advanced or ancillary material.

Mass transfer is a vast subject, arguably larger, more complex, and less well understood than heat transfer.

—JHL V, 15 January 2024.

Appendix A :

Pages 720 and 727, Tables A.3 and A.5: Note that ammonia is R717 and that carbon dioxide is R744.

Page 726, Table A.4: Update critical point temperature for water.

Page 729, Table A.5: Add correlation for saturation pressure of water, with citation.

Page 733, Table A.6: Mantissa of hydrogen properties adjusted to match the other tables.

Appendix B :

Page 740: Add new S.I. prefixes (2022) to Table B.1.

Page 743: Edit Ref. [B.1].

Appendix C :

passim: Minor edits. Avogadro number value, remove number density, B_m equation number.