Errata and Suggested Updates for

Combustion Thermodynamics and Dynamics
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1. p. 17: Eq. (1.65) requires that 2.9×10^7 be replaced by 2.9×10^{17}.

2. p. 22: Just before Eq. (1.103), replace $\overline{\rho}_{\text{O}} = 0.0004442414$ by $\overline{\rho}_{\text{O}} = 0.000442294$.

3. p. 22: In Eqs. (1.104, 1.105), replace 0.0004442414 by 0.000442294.

4. p. 24: In Eq. (1.112), a_{13} should include units of 1/s. So we should find

$$a_{13} = 1.85 \times 10^{11} \left(\frac{\text{mol}}{\text{cm}^3}\right)^{-1} \frac{1}{\text{s}} (\text{K})^{-0.5}$$

5. p. 35: In Eqs. (1.205), (1.206), the units for a_2 should include $1/\text{K}^{1.01}$.

$$\begin{aligned} a_2 &= \left(9.7 \times 10^{-15} \left(\frac{\text{molecule}}{\text{cm}^3}\right)^{-1} \frac{1}{\text{K}^{1.01}\ \text{s}}\right) \left(6.02 \times 10^{23}\ \frac{\text{molecule}}{\text{mol}}\right), \\ &= 5.8394 \times 10^9 \left(\frac{\text{mol}}{\text{cm}^3}\right)^{-1} \frac{1}{\text{K}^{1.01}\ \text{s}}, \end{aligned}$$

6. p. 60: Problem 1.3 should have "....to identify the local time scales..."

7. p. 60: Problem 1.4 should have "...energy conservation of Eq. (1.336)..."

8. p. 83: Problem 2.2 should mention the two gases are inert, so the wording should be "A volume with two chambers contains inert calorically perfect ideal gases."

9. p. 116: Eq. (3.317) should have units of kJ/kmol K. So we should find

$$\begin{aligned} &-2\left(5.9727 \times 10^5\ \frac{\text{kJ}}{\text{kmol}} - (6000\ \text{K})\left(216.926\ \frac{\text{kJ}}{\text{kmol K}}\right)\right) \\ &+\left(2.05848 \times 10^5\ \frac{\text{kJ}}{\text{kmol}} - (6000\ \text{K})\left(292.984\ \frac{\text{kJ}}{\text{kmol K}}\right)\right) \quad = \quad \left(8.314\ \frac{\text{kJ}}{\text{kmol K}}\right) \\ &\qquad\qquad \times \quad (6000\ \text{K}) \ln\left(\frac{y_{\text{N}}^2}{y_{\text{N}_2}} \frac{P}{P_o}\right). \end{aligned}$$

10. p. 129: just after Eq. (4.28), one should find $\chi_3 = CO_2$.

11. p. 163: in the first line at the top of the page, the subscript "N" should be italicized giving

    "Thus, for the mixture of ideal gases, $e(T, \overline{\rho}_1, \ldots, \overline{\rho}_N) = e_o$."

12. p. 178: Eq. (5.31) should have $\overline{c}_P$ and read

$$\frac{d\rho}{dt} = M \sum_{j=1}^{J} r_j \sum_{i=1}^{N} \nu_{ij} \left(\frac{\overline{h}_i}{\overline{c}_P T} - 1 \right),$$

13. p. 181: Eq. (5.61) should have "..... $+ \overline{R}T$....". It should read

$$\overline{g}_i = \overline{\mu}_i = \overline{h}_i^o - T \left(\overline{s}_i^o - \overline{R} \ln \left(\frac{P_i}{P_o} \right) \right) = (\overline{h}_i^o - T\overline{s}_i^o) + \overline{R}T \ln \left(\frac{P_i}{P_o} \right).$$

14. p. 182: Eq. (5.62) should have "..... $+ \overline{R}T$...." yielding the correct

$$\overline{\mu}_i = \overline{\mu}_i^o + \overline{R}T \ln \left(\frac{P_i}{P_o} \right).$$

15. p. 190: In Eq. (5.158), on the left side of the equation, the last entry should be $n_{\rm N}$. That is the N should be in italics. Thus we should find

$$\begin{pmatrix} n_1 \\ n_2 \\ \vdots \\ n_N \end{pmatrix} = \begin{pmatrix} n_{1o} \\ n_{2o} \\ \vdots \\ n_{No} \end{pmatrix} + \begin{pmatrix} \mathcal{D}_{11} \\ \mathcal{D}_{21} \\ \vdots \\ \mathcal{D}_{N\ 1} \end{pmatrix} \xi_1 + \begin{pmatrix} \mathcal{D}_{12} \\ \mathcal{D}_{22} \\ \vdots \\ \mathcal{D}_{N\ 2} \end{pmatrix} \xi_2 + \cdots + \begin{pmatrix} \mathcal{D}_{1\ N-L} \\ \mathcal{D}_{2\ N-L} \\ \vdots \\ \mathcal{D}_{N\ N-L} \end{pmatrix} \xi_{N-L}.$$

16. p. 190: In Eq. (5.160), on the left side of the equation, the last entry should be n_N. That is, the N should be in italics, yielding

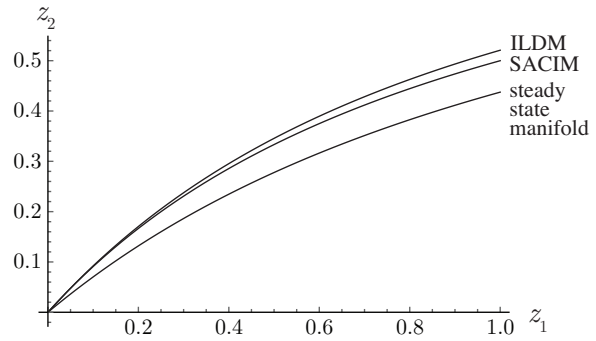
$$\begin{pmatrix} n_1 \\ n_2 \\ \vdots \\ n_N \end{pmatrix} = \begin{pmatrix} n_{1o} \\ n_{2o} \\ \vdots \\ n_{No} \end{pmatrix} + \begin{pmatrix} \mathcal{D}_{11} & \mathcal{D}_{12} & \ldots & \mathcal{D}_{1\ N-L} \\ \mathcal{D}_{21} & \mathcal{D}_{22} & \ldots & \mathcal{D}_{2\ N-L} \\ \vdots & \vdots & \vdots & \vdots \\ \mathcal{D}_{N1} & \mathcal{D}_{N2} & \ldots & \mathcal{D}_{N\ N-L} \end{pmatrix} \begin{pmatrix} \xi_1 \\ \xi_2 \\ \vdots \\ \xi_{N-L} \end{pmatrix}.$$

17. p. 192: The left side of Eq. (5.177) should be divided by $\overline{R}T$, yielding

$$\begin{aligned} \frac{1}{\overline{R}T} \left. \frac{\partial A}{\partial \xi_p} \right|_{\xi_j, T, V} &= \sum_{i=1}^{N} \mathcal{D}_{ip} \left(\overline{\mu}_{T,i}^o + \overline{R}T \ln \left(\frac{n_i}{n^o} \right) \right) = 0, \\ & \qquad\qquad p = 1, \ldots, N-L, \\ &= \sum_{i=1}^{N} \mathcal{D}_{ip} \left(\overline{\mu}_{T,i}^o + \overline{R}T \ln \left(\frac{n_i P}{n P_o} \right) \right) = 0, \\ &= \sum_{i=1}^{N} \mathcal{D}_{ip} \left(\overline{\mu}_{T,i}^o + \overline{R}T \ln \left(\frac{P_i}{P_o} \right) \right) = \sum_{i=1}^{N} \overline{\mu}_i \mathcal{D}_{ip} = 0. \end{aligned}$$

18. p. 195: The last sentence on the page should read, "And once it reaches...."

19. p. 255: In Fig. 6.6, the labels "SACIM" and "ILDM" should be reversed, yielding



20. p. 260: Eq. (6.65) should be $z_1 + z_2 + 2z_3 = 4/120 = 0.03333333$ mol/g for N conservation.

21. p. 260: Eq. (6.66) should be $z_1 + z_4 + 2z_5 = 4/120 = 0.03333333$ mol/g for O conservation.

22. p. 277: Problem 6.2. Replace "Find the critical value of beta for which the CIM is neither attracting or repelling" with "Study the behavior as β is varied. Identify values of β that induce attraction and those that induce repulsion. Describe the behavior of the transition from attraction to repulsion."

23. p. 304: Eqs. (8.51), (8.52) need a $-\boldsymbol{\sigma}$. We should find

$$\begin{aligned} \mathbf{Z}(t) &= e^{-\boldsymbol{\sigma} t} \cdot \mathbf{Z}_o, \\ \mathbf{S}^{-1} \cdot (\mathbf{Y}(t) - \mathbf{Y}_{eq}) &= e^{-\boldsymbol{\sigma} t} \cdot \mathbf{S}^{-1} \cdot (\mathbf{Y}_o - \mathbf{Y}_{eq}), \\ \mathbf{Y}(t) &= \mathbf{Y}_{eq} + \mathbf{S} \cdot e^{-\boldsymbol{\sigma} t} \cdot \mathbf{S}^{-1} \cdot (\mathbf{Y}_o - \mathbf{Y}_{eq}). \end{aligned}$$

24. p. 305: In Eq. (8.54) the entry in the lower left corner of the matrix $\mathbf{A}$ should be -990000. This affects Eq. (8.56) as well. This correction renders $\mathbf{A}$ to be consistent with Eq. (8.59). Thus we should have Eq. (8.54) as

$$\mathbf{A} = \begin{pmatrix} 1000000\ \mathrm{s}^{-1} & -99000000\ \mathrm{s}^{-1} \\ -990000\ \mathrm{s}^{-1} & 99010000\ \mathrm{s}^{-1} \end{pmatrix}, \quad \mathbf{Y}_o = \begin{pmatrix} 10^{-2} \\ 10^{-1} \end{pmatrix}, \quad \mathbf{Y}_{eq} = \begin{pmatrix} 10^{-5} \\ 10^{-6} \end{pmatrix}.$$

We should have Eq. (8.56) as

$$\frac{dY_2}{dt} = (990000\ \mathrm{s}^{-1})(Y_1 - 10^{-5}) - (99010000\ \mathrm{s}^{-1})(Y_2 - 10^{-6}), \quad Y_2(0) = 10^{-1}.$$

25. p. 307: In Eq. (8.74) the entry in the lower left corner of the matrix A should be -990000. This affects Eq. (8.76) as well. Thus we should have Eq. (8.74) as

$$\mathbf{A} = \begin{pmatrix} 1000000\ \mathrm{s}^{-1} & -99000000\ \mathrm{s}^{-1} \\ -990000\ \mathrm{s}^{-1} & 99010000\ \mathrm{s}^{-1} \end{pmatrix}, \quad \mathbf{Y}_o = \begin{pmatrix} 10^{-2} \\ 10^{-1} \end{pmatrix}, \quad \mathbf{Y}_{eq} = \begin{pmatrix} 10^{-5} \\ 10^{-6} \end{pmatrix}.$$

Eq. (8.76) should be

$$\left(10^2\ \frac{\mathrm{cm}}{\mathrm{s}}\right)\frac{dY_2}{dx} = \left(10^1\ \frac{\mathrm{cm}^2}{\mathrm{s}}\right)\frac{d^2Y_2}{dx^2} + (990000\ \mathrm{s}^{-1})(Y_1 - 10^{-5}) \\ -(99010000\ \mathrm{s}^{-1})(Y_2 - 10^{-6}),$$

26. p. 308: In Eqs. (8.83, 8.84), terms just to the right of ℓ_1 and ℓ_2 should be enclosed by the absolute value symbol so as to render the result positive. Thus we should find

The relevant length scales are

$$\begin{aligned} \ell_1 &= \left| \frac{1}{\left(5 - 5\sqrt{400001}\right)\mathrm{cm}^{-1}} \right| = 3.2 \times 10^{-4}\ \mathrm{cm}, \\ \ell_2 &= \left| \frac{1}{\left(5 - 5\sqrt{41}\right)\mathrm{cm}^{-1}} \right| = 3.7 \times 10^{-2}\ \mathrm{cm}. \end{aligned}$$

27. p. 310: In Eq. (8.99) the entry in the lower left corner of the matrix A should be -990000. Thus we should find

$$\mathbf{A} = \begin{pmatrix} 1000000\ \mathrm{s}^{-1} & -99000000\ \mathrm{s}^{-1} \\ -990000\ \mathrm{s}^{-1} & 99010000\ \mathrm{s}^{-1} \end{pmatrix}.$$

28. p. 312: Problem 8.3 should refer to Section 8.2.2.

29. p. 389: The last equation of Eq. (12.130) should have instead $\rho_1 u_1 \lambda_1$. Thus, we should find

$$U \begin{pmatrix} \rho_2 - \rho_1 \\ \rho_2 u_2 - \rho_1 u_1 \\ \rho_2 \left(e_2 + \frac{1}{2}u_2^2\right) - \rho_1 \left(e_1 + \frac{1}{2}u_1^2\right) \\ \rho_2 \lambda_2 - \rho_1 \lambda_1 \end{pmatrix} \\ = \begin{pmatrix} \rho_2 u_2 - \rho_1 u_1 \\ \rho_2 u_2^2 + P_2 - \rho_1 u_1^2 - P_1 \\ \rho_2 u_2 \left(e_2 + \frac{1}{2}u_2^2 + \frac{P_2}{\rho_2}\right) - \rho_1 u_1 \left(e_1 + \frac{1}{2}u_1^2 + \frac{P_1}{\rho_1}\right) \\ \rho_2 u_2 \lambda_2 - \rho_1 u_1 \lambda_1 \end{pmatrix}.$$

30. p. 400: There is a sign error Eq. (12.223) in the term involving q. This propagates to Eqs. (12.236, 12.237). Thus, for Eq. (12.223), we should find

$$\left(\frac{v}{v_o}\right) = \frac{\left(1+\frac{D^2}{P_o v_o}\right)\left(1+\hat{\mu}^2\right)}{2\frac{D^2}{P_o v_o}} \pm \frac{\sqrt{\left(1+\frac{D^2}{P_o v_o}\right)^2 (1+\hat{\mu}^2)^2 - 4\frac{D^2}{P_o v_o}\left(1+\left(1+\frac{D^2}{P_o v_o}\right)\hat{\mu}^2 + 2\hat{\mu}^2\frac{\lambda q}{P_o v_o}\right)}}{2\frac{D^2}{P_o v_o}}.$$

For Eq. (12.236), we should find

$$\left(\frac{v}{v_o}\right) = \frac{\left(1+\frac{D^2}{P_o v_o}\right)\left(1+\hat{\mu}^2\right)}{2\frac{D^2}{P_o v_o}} \pm \frac{\sqrt{\left(1+\frac{D^2}{P_o v_o}\right)^2 (1+\hat{\mu}^2)^2 - 4\frac{D^2}{P_o v_o}\left(1+\left(1+\frac{D^2}{P_o v_o}\right)\hat{\mu}^2 + 2\hat{\mu}^2\frac{q}{P_o v_o}\right)}}{2\frac{D^2}{P_o v_o}}.$$

31. p. 402: In Eq. (12.238) one of the terms inside the parenthesis that is inside the radical needs changed: $2\hat{\mu}^2$ should be $2\hat{\mu}^2\frac{q}{P_0 v_0}$. We should find

$$\frac{D_{CJ}^2}{P_o v_o} = \frac{1 + 4\hat{\mu}^2\frac{q}{P_o v_o} - \hat{\mu}^4 \pm 2\sqrt{\frac{2q}{P_o v_o}\hat{\mu}^2(1+2\hat{\mu}^2\frac{q}{P_0 v_0} - \hat{\mu}^4)}}{(\hat{\mu}^2-1)^2}.$$

32. p. 407: Fig. 12.6. The lower right $T(\hat{x})$ should be $T(-\hat{x})$.

33. p. 453: In the author index, one simply reads "Chen, 173" and should be "Chen, J.-Y., 173".

34. p. 435: It should be emphasized that our calculations are for $P = 1$ atm and not Lehr's $P = 0.421$ atm.

35. p. 453: Add "Date, A. W., 173" to the author index