

# Basic Principles and Calculations in Chemical Engineering Ninth Edition

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ISBN-10: 0-13-732717-X  
ISBN-13: 978-0-13-732717-1

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*First Printing: August 2022*

## Corrections for August 1, 2022

Pg	Error	Correction
	<b>Global:</b> Any reference to chemical engineering software available on a companion website is erroneous.	Specific corrections are listed below.
151	CE software on this book's Web site	Revise the sentence to: "You can look up the values in physical properties databases available on the Internet, in reference books, and in many other places."
489-490	Furthermore, we will often refer to the tables on the website for this book as the "steam tables." In this book, you will also find a foldout in the back pocket that contains abbreviated steam tables in both AE and SI units. From the website, you can obtain values of the properties of water in mixed units that are continuous over	Replace with: "The properties of water and steam from one source may not agree precisely with other sources because the values available from different sources are likely generated by using equations having different accuracy and precision."

	the permitted range of values, thus avoiding single or double interpolation in tables. The properties of water and steam from the website may not agree precisely with other sources because the values from the website are generated by simpler equations than those of the other sources.	
592	Note that we used the data from the steam tables in the CE program from the website that accompanies this book.	Replace with: "Data from steam tables are used in these calculations."
592	You can use the steam chart in the CE software that accompanies this book to get the necessary property values.	Replace with: "The necessary property values can be obtained from the steam tables."
593	We will use the steam table on the CE software on the website that accompanies this text.	Replace with: "The necessary property values can be obtained from the steam tables."
600	The recommended approach to determining enthalpies for solving problems in this text is to use the CE software that can be found on the website that accompanies this text. It can predict enthalpies for more than 700 compounds over a wide range of temperatures. Figure 8.14 shows the enthalpy page for the CE software. Note that you can select the compound or element from one of the three compound lists, select either a gas or liquid, provide the temperature and reference temperature, and click OK, and the result is shown immediately. Although the results from the CE software are not as accurate as those provided in industrial databases, they are more than sufficient for working the problems in this text and much more convenient than other sources for enthalpies.	Replace with: "A number of resources are available on the Internet for obtaining the values of enthalpy and other thermophysical properties. Many of them can be accessed without any charge, while a licensing fee is required to access the information contained in others. Some of these resources are listed on page 616. Figure 8.14 shows a listing of the thermophysical property data, which is available from the National Institute of Standards and Technology (NIST, <a href="https://webbook.nist.gov/chemistry/fluid/">https://webbook.nist.gov/chemistry/fluid/</a> ). You can specify the substance, choose the property units, the type of data, and the standard state conditions. Clicking the continue button will bring up a screen that allows you to input the pressure and temperature values, with the software returning the property values immediately."

601	Figure 8.14 and caption: Screenshot of the enthalpy page from the CE software	Replace with new image (see end of this errata sheet) and caption: "Screenshot of NIST webpage"
605	Appendix F on the accompanying website . . . enthalpy changes.	Delete in its entirety.
609	Some common values of $\Delta\hat{H}$ for phase changes are listed in Appendix E on the website that accompanies this book, and more than 700 are used by the CE physical property software on the website.	Replace with: "Values of $\Delta\hat{H}$ for phase change for many common compounds are available from several sources available on Internet, such as those listed on page 616."
610	The CE physical property software on the Web site that accompanies this book . . . (1 atm pressure).	Replace the sentence with: "The heat of vaporization at the normal boiling point (1 atm pressure) data for most substances are readily available from many resources, some of which are listed later on page 616."
612	But using the CE software on the website, . . . linear interpolation.	Delete in its entirety.
614	However, if you know the quality . . . the CE program on the website will return the properties of the mixture shown as parameters.	Delete in its entirety.
616	The CE program that accompanies this book is an example. The program . . . save time in your calculations, we recommend using this software.	Delete in its entirety.
616	<a href="http://www.lib.berkeley.edu/ENGI/physchemData.html">www.lib.berkeley.edu/ENGI/physchemData.html</a>	Replace with: <a href="http://guides.lib.berkeley.edu/physical-chemical-properties">guides.lib.berkeley.edu/physical-chemical-properties</a>
617	For example, you can introduce the value of $\hat{H}$ and $p$ into the dialog box in the steam tables in the CE software on the website that accompanies this book and recover the values of $T$ at the state that is specified by $\hat{H}$ and $p$ .	Replace with: "Some software programs will allow you to input the values of $\hat{H}$ and $p$ and recover the value of $T$ at the state that is specified by $\hat{H}$ and $p$ ."

622	Now, using the CE software on the website that accompanies this text, let's calculate the enthalpy changes for each component:	Replace with: "Now, let's calculate the enthalpy changes for each component on the basis of equation 8.14:"
625	Either integrate heat capacity equations (poor choice), or better, use the CE physical property software on the website, which gives $\Delta\hat{H}_i$ directly for the transition from 500°C to 300°C.	Replace with: "Either integrate the heat capacity equations, or if you have access to it, use a software that gives $\Delta\hat{H}_i$ directly for the transition from 500°C to 300°C."
642	The data come from steam tables in the CE software on the website that accompanies this book.	Replace with: "The source of the data are the steam tables, readily available on the Internet."
684	Appendix C contains standard heats of formation for a number of molecules. In the CE software on the Web site that accompanies this book, you will find heats of formation for more than 700 compounds, provided through the courtesy of Professor Yaws. <sup>3</sup>	Replace with: "Appendix C contains standard heats of formation for a number of molecules. Additionally, heats of formation for more than 700 compounds can be obtained using the correlations reported by Professor Yaws. <sup>3</sup> "
697	To avoid inconsistencies, the sensible heat data in the sixth column have been taken from the CE program from the Web site that accompanies this book instead of integrating heat capacity equations by hand.	Replace with: "The sensible heat data shown in tables below have been obtained through a computer program developed to perform calculations of equation 8.14."
698	The details of the heat of formation of compounds in solutions are presented in Chapter 12 on the Web site that accompanies this text.	Replace with: "The heats of formation of compounds in solution are available from sources such as <i>Perry's Chemical Engineers' Handbook</i> , <i>CRC Handbook of Chemistry and Physics</i> , and many others. For many compounds, the values are reported as function of solute concentration, allowing accounting of the heat of solution in calculations for increased accuracy."
704	We use the SI system for most of the solution for convenience, but the CE program on the Web site that accompanies this book makes use of the AE system just as easily.	Replace with: "We use the SI system for most of the solutions for convenience, but the calculations can be made just as easily using the AE system."

707	The Web site that accompanies this text gives different values.	Delete in its entirety.
709	Because you do not know the flame temperature (e.g., the solution) to a problem before you start, if you use tables such as Appendix C or the physical property software on the Web site that accompanies this text in calculating the "sensible heats" of the various streams entering and leaving the reactor, the solution will involve trial and error. To find the exit temperature for which $\Delta H = 0$ in the energy balance, the simplest approach is to use the CE software on the website that accompanies this text:	Replace with: "Because you do not know the flame temperature (e.g., the solution) to a problem before you start, the solution will involve trial and error. To find the exit temperature for which $\Delta H = 0$ in the energy balance:"
710	We use data from Appendix C and the CE software from the Website that accompanies this book.	Replace with: "We use data from Appendix C and other resources available on the Internet (for example, websites listed on page 616) and literature (correlations reported by Professor Yaws)."
711	Some enthalpies could not be calculated using the CE physical property software on the accompanying Web site as the states at some temperatures were out of range.	Delete in its entirety.
723	To make an energy balance, you have to get information about the heats of formation and the sensible heats. The data used below have been taken from the CE software on the Web site that accompanies this book.	Replace with: "To make an energy balance, you have to get information about the heats of formation and the sensible heats using the resources mentioned earlier."
761	On the website that accompanies this book, you will find an animated example of using the humidity chart to get data.	Delete in its entirety.

# Replacement Figure 8.14:

Thermophysical Properties of Fluid Systems

Accurate thermophysical properties are available for several fluids. These data include the following:

- Density
- $C_p$
- Enthalpy
- Internal energy
- Viscosity
- Joule-Thomson coefficient
- Specific volume
- $C_v$
- Entropy
- Speed of Sound
- Thermal conductivity
- Surface tension (saturation curve only)

Please follow the steps below to select the data required.

- Please select the species of interest:  
Water
- Please choose the units you wish to use:
  - Temperature:  Kelvin  Celsius  Fahrenheit  Rankine
  - Pressure:  MPa  bar  atm.  torr  psia
  - Density:  mol/l  mol/m<sup>3</sup>  g/ml  kg/m<sup>3</sup>  lb-mole/ft<sup>3</sup>  lbm/ft<sup>3</sup>
  - Energy:  kJ/mol  kJ/kg  kcal/mol  Btu/lb-mole  kcal/g  Btu/lbm
  - Velocity:  m/s  ft/s  mph
  - Viscosity:   $\mu$ Pa $\cdot$ s  Pa $\cdot$ s  cP  lbm/ft $\cdot$ s
  - Surface tension:  N/m  dyn/cm  lb/ft  lb/in

\*Surface tension values are only available along the saturation curve.
- Choose the desired type of data:  
Data type:
  - Isothermal properties
  - Isoberic properties
  - Isochoric properties
  - Saturation properties — temperature increments
  - Saturation properties — pressure increments
- Please select the desired standard state convention:  
Standard state convention:
  - Default for fluid
  - Normal B.P. convention
  - ASHRAE convention
  - IIR convention
- Press to Continue

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Updated 08-27-2025

**Corrections for August 2025:**

The following inside front cover content was inadvertently omitted from the electronic editions.

# Conversion Factors

**Instructions:** Locate the given units on the row on the left-hand side of the table. Next, locate the desired units at the top of the column of the table. The conversion factor from the given units to the desired units is listed at the intersection of the row and the column. For example, to convert miles to feet, multiply by 5280.

## Length Equivalents

	meter	kilometer	inch	foot	mile
meter	1	$10^{-3}$	39.37	3.2808	$6.214 \times 10^{-4}$
kilometer	1000	1	$3.937 \times 10^4$	3280.8	0.6214
inch	0.02540	$2.540 \times 10^{-5}$	1	0.08333	$1.5783 \times 10^{-5}$
foot	0.3048	$3.048 \times 10^{-4}$	12	1	$1.894 \times 10^{-4}$
mile	1609.3	1.61	$6.336 \times 10^4$	5280	1

## Mass Equivalents

	grams	kilograms	metric ton	pounds	ton
grams	1	$10^{-3}$	$10^{-6}$	$2.2046 \times 10^{-3}$	$1.102 \times 10^{-6}$
kilograms	1000	1	$10^{-3}$	2.2046	$1.102 \times 10^{-3}$
metric ton	$10^6$	1000	1	2204.6	1.1023
pounds	453.6	0.4536	$4.536 \times 10^{-4}$	1	$5 \times 10^{-4}$
ton	$9.072 \times 10^5$	907.2	0.9072	2000	1

## Volume Equivalents

	liters	$m^3$	$in^3$	US gallon	$ft^3$
liters	1	$10^{-3}$	61.023	0.2642	0.03531
$m^3$	1000	1	$61.023 \times 10^3$	264.2	35.31
$in^3$	$1.639 \times 10^{-2}$	$1.639 \times 10^{-5}$	1	$4.329 \times 10^{-3}$	$5.787 \times 10^{-4}$
US gallon	3.785	$3.785 \times 10^{-3}$	231	1	0.1337
$ft^3$	28.32	0.02832	$1.728 \times 10^3$	7.481	1

The following back cover content was inadvertently omitted from the electronic editions.

### Atomic Mass of Common Elements

Name	Symbol	Atomic Mass	Name	Symbol	Atomic Mass
Aluminum	Al	26.98	Lead	Pb	207.2
Antimony	Sb	121.8	Lithium	Li	6.941
Argon	Ar	39.95	Magnesium	Mg	24.31
Arsenic	As	74.92	Manganese	Mn	54.94
Barium	Ba	137.3	Mercury	Hg	200.6
Beryllium	Be	9.012	Molybdenum	Mo	95.94
Bismuth	Bi	209.0	Neon	Ne	20.18
Boron	B	10.81	Nickel	Ni	58.69
Bromine	Br	79.90	Nitrogen	N	14.01
Cadium	Cd	112.4	Oxygen	O	16.00
Calcium	Ca	40.08	Phosphorus	P	30.97
Carbon	C	12.01	Potassium	K	39.10
Cesium	Cs	132.9	Selenium	Se	78.96
Chlorine	Cl	35.45	Silicon	Si	28.09
Chromium	Cr	52.00	Silver	Ag	107.9
Cobalt	Co	58.93	Sodium	Na	22.99
Copper	Cu	63.55	Sulfur	S	32.07
Fluorine	F	19.00	Tin	Sn	118.7
Gallium	Ga	69.72	Titanium	Ti	47.87
Germanium	Ge	72.64	Tungsten	W	183.8
Gold	Au	197.0	Uranium	U	238.0
Iodine	I	126.9	Xenon	Xe	131.3
Iron	Fe	55.85	Zinc	Zn	65.41

### Ideal Gas Constants (R)

8.315 kPa m <sup>3</sup> kg mol <sup>-1</sup> K <sup>-1</sup>
62.365 mm Hg L gmol <sup>-1</sup> K <sup>-1</sup>
0.08206 atm L gmol <sup>-1</sup> K <sup>-1</sup>
82.06 atm cm <sup>3</sup> gmol <sup>-1</sup> K <sup>-1</sup>
0.7303 atm ft <sup>3</sup> lb-mol <sup>-1</sup> °R <sup>-1</sup>
10.73 psia ft <sup>3</sup> lb-mol <sup>-1</sup> °R <sup>-1</sup>

This errata sheet is intended to provide updated technical information. Spelling and grammar misprints are updated during the reprint process, but are not listed on this errata sheet.