

GREEN CHEMISTRY AND ENGINEERING



GREEN CHEMISTRY AND ENGINEERING

A Pathway to Sustainability

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Cover design: John Wiley & Sons, Inc.
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Published simultaneously in Canada

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Library of Congress Cataloging-in-Publication Data:

Marteel-Parrish, Anne E.

Green chemistry and engineering : a pathway to sustainability / Anne E. Marteel-Parrish,
Department of Chemistry, Washington College; Martin A. Abraham, College of Science, Technology,
Engineering, and Mathematics, Youngstown State University.

pages cm

Includes bibliographical references and index.

ISBN 978-0-470-41326-5 (hardback)

1. Environmental chemistry--Industrial applications. I. Martin A. Abraham. II. Title.
TP155.2.E58A27 2014
660.6'3--dc23

2013011104

Printed in the United States of America

10 9 8 7 6 5 4 3 2 1

I dedicate this book to Damon Parrish, Ph.D., my endlessly supportive and patient husband, and to Martin and Marie, my two children and best accomplishments in life. Without them I would not be the person I am today.

*I thank Sara Martin, Washington College Chemistry major 2014, and Damon Parrish for their assistance with the figures.
Anne E. Marteel-Parrish, Chestertown, MD, January 2013*

*I dedicate this book to my parents, Sam and Barbara Abraham, who have always been supportive of my goals and aspirations. They have encouraged me to dream big and reassured me that I could achieve anything that I wanted. I further dedicate this book to my family, my wife Nancy, and my children Elizabeth and Josh, who have put up with my long hours in the lab and the office. Without their support, none of this would have been possible.
Martin A. Abraham, Youngstown, OH, January 2013*

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PREFACE

When green chemistry was first described in 1998 through the publication of *Green Chemistry: Theory and Practice* by Paul Anastas and John Warner, nobody could have predicted the role that it would play today in the world's politics, economics, and education.

The success of green chemistry has been driven by academia, industry, and governmental agencies. It is a central theme within the American Chemical Society and the American Institute of Chemical Engineers, the professional societies for chemists and chemical engineers, and leading organizations that will determine the future of our professions.

The importance of education in driving the future of our profession cannot be understated. The future generations of scientists and engineers, our students of today, who learn chemistry from a green chemistry point of view, will be able to make connections between real-world issues and the challenges that chemistry presents to the environment, and to understand environmentally preferable solutions that overcome these challenges.

This book provides the springboard for students to be exposed to green chemistry and green engineering, the understanding of which will lead to greater sustainability. As Paul Anastas mentioned: "Green chemistry is one of the most fundamental and powerful tools to use on the path to sustainability. In fact, without green chemistry and green engineering, I don't know of a path to sustainability."

This book is aimed at students who want to learn about chemistry and engineering from an environmentally friendly point of view. This book can be used in the first undergraduate course in general chemistry and would be appropriate for a two-semester sequence to allow a more complete understanding of the role of chemistry in society. Portions of this text would be suitable as the basis for a one-semester introductory course on the principles of science and engineering for nontechnical majors, as well.

This book gives students a new outlook on chemistry and engineering in general. While covering the essential concepts offered in a typical introductory course for science and engineering majors, it also incorporates the more fascinating applications derived from green chemistry. This book spans the breadth of general, organic, inorganic, analytical, and biochemistry with applications to environmental and materials science. A novel component is the integration of introductory engineering concepts, allowing the reader to move from the fundamental science included in a typical course into the application

areas. As much as the excitement of green chemistry and green engineering occurs at the interface between science and engineering, it is that interface at which we aimed our attention.

This book is divided in three main areas: the first three chapters introduce the birth of green chemistry (Chapter 1), fundamental principles of green chemistry and green engineering (Chapter 2), and the role of chemistry as an underlying force in ecosystem interactions (Chapter 3). After having been provided the foundation of green chemistry and engineering, readers will realize how applications of green chemistry and engineering are relevant while acquiring knowledge about matter, the atomic structure, different types of compounds, and an introduction to chemical reactions (Chapter 4). Readers will also discover the different types of reactions and the quantitative aspect of chemistry in reactions and processes (Chapter 5), while learning about the role of kinetics and catalysis in chemical processes (Chapter 6) and the role of thermodynamics and equilibrium in multiphase systems and processes (Chapter 7). The last four chapters look into novel applications of green chemistry and engineering through the use of renewable materials (Chapter 8) and through the current and future state of energy production and consumption (Chapter 9), while unveiling the relationship between green chemistry and economics (Chapter 10). The importance of toxicology to green chemistry, and the identification of hazards and risks from chemicals to ecological, wildlife, and human health targets conclude this book (Chapter 11).

We hope that this book will enlighten students' perception about chemistry and engineering and will demonstrate the benefits of pursuing a career in the chemical sciences, while contributing to their knowledge of sustainability for our planet and its well-being for our future generations.

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