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Book Review

GREEN CHEMISTRY AND ENGINEERING
A Pathway to Sustainability

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In the last decades, humanity faced huge challenges in the sustainability of our lifestyles and systems. Global environmental issues including energy sources, water access and use, land use and ecological damage require urgent and relevant answers. In this context, green chemistry and green engineering are instruments used increasingly more by scientists and engineers to make decisions having positive impact on the environment.

Green chemistry, also called sustainable chemistry addresses the design of chemical processes and products aiming to reduce or eliminate the use or generation of hazardous substances. Green chemistry is also recognized as sustainable chemistry and it applies to organic chemistry, inorganic chemistry, biochemistry, analytical chemistry, physical chemistry and chemical engineering as well.

Green chemistry refers to the life cycle of a product, including its design, manufacture, use, and disposal. In addition, green engineering can be defined as environmentally conscious manners, values, and principles, combined with science and technology, all directed toward improving environmental quality.

Green engineering encompasses all of the engineering disciplines, and is compatible with sound engineering design principles. Green engineering deals with the design of materials, processes, systems, and devices with the objective of minimizing environmental impact, including energy utilization and waste production. The term refers to the entire life cycle of a product or process, from extraction of raw materials to final disposal of materials that cannot be reused or recycled at the end of the useful life of a product.

It is very important to shift our society in a really sustainable direction. First of all, it is particularly important to teach the new generation of chemists and chemical engineers in order to understand and to practice green chemistry. Many universities have courses and degrees on green chemistry. In this context, the book *Green Chemistry and Engineering. A Pathway to Sustainability* is addressed to academic staff, scientists, students and various stackeholders who want to learn about chemistry and engineering from an environmentally friendly point of view.

The book is structured in three main sections: the first three chapters deal with the foundation of green chemistry and engineering. The next three chapters deal with the matter as the heart of green chemistry. Different types of reactions, quantitative aspects of chemistry in reactions and processes, the role of kinetics and catalysis and the role of thermodynamics and equilibrium in multiphase systems are presented.

The last part of the book includes the last four chapters and presents the applications of green chemistry and engineering through the use of renewable materials, the current and future state of energy production and consumption, the relationships between green chemistry and economics and with the importance of toxicology to green chemistry.

The first chapter, *Understanding the issues*, underlines the importance of chemistry on the development of human society. A brief history of

chemistry and the green chemistry concept are presented.

Principles of green chemistry and green engineering are discussed in Chapter 2. The definitions of green chemistry and green engineering and their principles are given and explained. The strong connection between green chemistry and engineering and sustainability is also discussed.

Chapter 3 deals with the chemistry as an underlying force in ecosystem interactions. The importance of chemistry is emphasized within the following topics: nature and the environment, energy and its production from chemical sources, waste and pollution prevention, ecotoxicology, and green living.

Chapter 4 entitled *Matter: the heart of green chemistry* discusses matter and its properties, the three states of matter, their application in green chemistry and green engineering, and how the understanding of the intrinsic nature of materials can lead to an improved design and a reduction in the environmental impact of the products.

Chapter 5 briefly discusses the chemical reactions. Definition of chemical reactions as well as balancing of chemical equations is presented. The most common patterns of chemical reactions are summarized in this chapter, together with clarifying examples. The efficiency of a chemical reaction is explained and some examples of calculation are included.

Chapter 6 introduces the reader in the fields of kinetics, catalysis and reaction engineering. The definition of reaction rate and the kinetics of parallel and consecutive reaction are presented. The basics of chemical equilibrium and the factors affecting the reaction rate are also discussed. Catalysis and catalysts represent an important subchapter of chapter 6. Other issues refer to kinetics of catalytic reactions, types of catalysis and their impact on green chemistry. Due to the fact that chemical reactions are conducted in reactors, elements of reaction engineering are included.

The design equations of main types of reactors (batch, stirred, plug flow) are explained. In a logical sequence, Chapter 7 deals with thermodynamics, separations, and equilibrium. The chapter starts with the presentation of the two laws of thermodynamics. Valuable examples illustrating the energy effects of processes for ideal gases are included. Real gases – as opposed to an ideal gas – exhibit properties that cannot be explained entirely using the ideal gas law. In this respect, Chapter 7 deals with the behavior of real gases: compressibility effects; variable specific heat capacity; non-equilibrium thermodynamic effects; issues with molecular dissociation and elementary reactions with variable composition.

Some considerations regarding the importance of phase equilibrium in chemical engineering are made. Examples illustrating how to determine composition of vapor phase, solubility of a gas in a liquid and solubility of a solid in a liquid are included.

An introduction in renewable materials is the issue of Chapter 8. This chapter explores the sources of renewable feedstock, mainly carbohydrates, lignin, lipids and proteins, followed by the production of chemicals based on this kind of resources. Finally, some current applications of renewable materials are presented.

Chapter 9 deals with the current and future state of energy production and consumption. The chapter includes challenging issues like: current state of energy consumption, enthalpy of chemical reactions; non-conventional energy resources; renewable sources of energy in the 21st century; the future of energy sources.

A particular chapter (Chapter 10) refers to the economics of green and sustainable chemistry. This chapter helps the reader to understand the roles that green chemistry and green engineering play in the concept of sustainability. In fact, the Chapter 10 introduces the concepts, economic benefits, and needed thinking in order to increase the viability and introduction of technologies that employ green chemistry and green engineering. Among the most important issue there are: chemical manufacturing and economic theory; economic impact of green chemistry; business strategies regarding application of green chemistry; incorporation of green chemistry in process design and sustainability; case studies demonstrating the economic benefits of green chemistry.

Chapter 11 deals with the connection between green chemistry and toxicology. A environmental chemist must know the basics of toxicology, how the adverse effects of chemicals affect the living organisms. In this respect, the chapter presents the fundamental principles of toxicology, chemically induced toxicity, computational toxicity and green chemistry; applications of toxicology into green chemistry initiatives.

By gathering the most important information both from fundamental sciences, research and industry, the work of Marteel-Parrish and Abraham becomes an important tool for environmental engineers and researchers and also for specialists working in chemical industry. The book can be a guide for policy makers, companies staff, authorities or other decisional factors, all involved in environmental protection and not only.

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