Georg Schaub · Thomas Turek

Energy Flows, Material Cycles and Global Development

A Process Engineering Approach to the Earth System

Second Edition

Springer

Preface

Why a Second Edition?

Since the first publication of our book (or since the end of our data compilation 2009) there have been important new developments: (i) significant increases in anthropogenic energy and material flows due to economic growth in significant parts of the world, (ii) changes in energy policy in some countries, in particular in Germany (*Energiewende*), as a result of the accident in the nuclear power plant in Fukushima, with goals defined and measures initiated for a future energy supply without nuclear and fossil sources, (iii) cheap sources for natural gas like shale gas created temptations to forget about energy saving.

In addition to these points we thought of addressing some new aspects that today we consider important enough to include in a new edition. Examples are resources of materials related to new energy technology (like lithium), resources important for feeding the growing world population (like phosphorus), as limitations for anthropogenic activities on Earth, or potentials for renewable energy sources.

Acknowledgments

When preparing the manuscript of the second edition, we had support from various sides. Again, Stefan Pinnow did the skillful processing of the manuscript using LaTeX, Marion Benoit helped by typewriting, and Amy Koch helped improve the text and make it more understandable to the general reader. Jörn Brauns prepared the new figures. We thank them all.

Karlsruhe — Georg Schaub
Clausthal-Zellerfeld — Thomas Turek
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Why a Process Engineering Approach to the Earth System?

Engineers involved in the handling, processing, and utilizing of materials and energy are constantly faced with the environmental and economic effects of their activities. These include environmental changes on local, regional, and global scales, as well as the depletion of resources and the search for new raw materials and energy sources. This has been the experience of the authors during their professional activities as chemical engineers in industrial research and development, and in academic research and teaching in various areas of fuel chemistry and reaction engineering.

This book is based on a course that has been held for engineering students for more than 10 years. In writing this book, the authors were motivated by the following questions:

a) What are the factors determining macroscopic material and energy flows in the Earth's biogeosphere? What is the appropriate approach to understand potential perturbations of natural cycles, caused by human activities and to assess significant anthropogenic terms?
b) When using materials and energy, are human societies today and for the foreseeable future limited by the depletion of resources or more so by global environmental changes? As an example, discovery of large usable gas hydrate resources as a fossil energy source, would it be fortunate or more like a curse?
c) Given the considerable technology innovation and research activities ongoing worldwide: how to deal with the obvious lack of synthesis and integration approach?
d) As for the industrialized countries, to what extent can they serve as examples for less-developed countries? What are appropriate technology options for sustainable development?

Our book is intended to give a basic understanding and orientation and to stimulate discussion of these questions. It addresses students in (chemical and biotechnological) process engineering, also in other fields and anyone interested, with a basic knowledge in natural sciences. It is supposed to stimulate discussions about science, technology, and policy aspects of global development. The authors think that *development* gives a better match with the engineering way of thinking than *global change*, as it reflects *solving problems* in addition to *analyzing problems*.

Acknowledgments

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