

# Preface

The prime objective of this book is to present fundamentals of chemical engineering in a simple and forthright manner and provide the broad background for applying these principles to industrial and theoretical problems. The importance of stoichiometry—material and energy balances—is widely known and accepted in the chemical industry in analyzing a particular process in whole or in part and also in evaluating the economics of the various processes. Basically, stoichiometry deals with the laws of conservation of mass and energy. With this, if the principles of unit operations and chemical reaction engineering are carefully bridged, the subject becomes extremely valuable to chemical engineers who apply these principles in solving process engineering problems. These have been our main considerations in selecting and preparing the material for this book.

Detailed discussions on material and energy balances of unsteady state operation will be of special interest as the topic is of significant industrial importance. In addition to these, extra care has been taken to include the most reliable thermodynamic and other useful data so that the book can serve as a standard text for students and as a reference book for practising engineers. The material has been so organized that the subject can easily be grasped by undergraduate students, nevertheless inclusion of many advanced problems makes the text quite appropriate for postgraduate students and process and design engineers.

Process engineering has been gaining greater importance in chemical industry. Optimization of the design, evaluation of alternatives, troubleshooting in the running plants, design of environmental friendly plants, and similar topics have become part of process calculations. These calculations lead to the development of process diagrams that convey a wealth of information to practicing/production engineers. Stoichiometric calculations assume a first step in these process calculations. With this chief objective in mind, the present edition has been thoroughly revised.

Emphasis on basic principles is continued with more clarity on non-ideal systems that have become now a part and parcel of the chemical industry. Many problems are drawn from industry that can be classified in this category. Recycling operations have also been considered important for a variety of reasons. New problems on recycling are added to cover few other industries such as gas processing, effluent treatment, etc. New problems on energy conservation involving stoichiometric calculations might be well appreciated by the practicing engineers. Excess enthalpies of inorganic and organic solutions change results in stoichiometric calculations significantly in many instances. This aspect is highlighted in this edition.

Thermodynamic data have been undergone thorough revision in light of updated data published by NIST, IUPAC, ACS, JSME and other institutes of repute in the last decade. The idea is to present the most authentic recent data which can be used by practicing engineers for their process designs. New concept of linear modeling in solving multivariable material balance problems is introduced which facilitates the use of mathematical software in solving such problems.

The book is organized in nine chapters. **Chapter 1** on Units is revised in light of the NIST Publication No. 330 (2008 edition) so that the current version of SI Units can be well understood. Conversion factors are corrected to reflect those mentioned in the NIST publication. **Chapter 2** is on Basic Chemical Calculations. Although major sections of previous edition are retained, more clarity on pure component pressure will be appreciated by the reader. **Chapter 3** on Material Balances without Chemical Reaction introduces the process flow sheet, material balances, graphical solution of problems and recycling and bypassing of operations. Introduction to linear modeling is intended to introduce generalized approach to the material balance problems. Material Balances Involving Chemical Reactions are explained in **Chapter 4**.

**Chapter 5** discusses Energy Balances with an emphasis on topics on thermochemistry, heat capacity, enthalpy and heat of mixing. **Chapter 6** on Stoichiometry and Unit Operations discusses distillation, absorption, stripping, extraction, leaching, crystallization, psychrometry, drying, adsorption and evaporation. **Chapter 7** on Combustion discusses different types of fuels and their combustion characteristics. **Chapter 8** is on Stoichiometry and Industrial Problems. Several new problems of industrial importance are included in this edition. Finally, **Chapter 9** on Stoichiometry and Digital Computation deals with the use of programming languages like FORTRAN, use of spreadsheet programs and specialized software (like Mathcad<sup>®</sup>) in solving industrial problems. Besides these, there are five **Appendices** which list important tables used in stoichiometric calculations.

The book is accompanied by an exhaustive website which can be accessed at <http://www.mhhe.com/bhatt/s5e>. It contains the following material:

**For Instructors**

- Solution Manual
- PowerPoint Slides

**For Students**

- Interactive Objective Type Questions (approx. 200)
- Sample chapter

The main advantages of the book that can be mentioned are a simple introduction of chemical engineering fundamentals, a careful and proper organization of the subject that allows the student a great deal of self-progress, and a treasure of examples and exercises of advanced levels enveloping a wide range of subjects for students of all levels and practising engineers.

The style of presentation in earlier editions is well appreciated by the faculty and students and hence pedagogy is unchanged. Simple presentation of principles, followed by problems in order of increasing difficulty is maintained. Use of Mathcad<sup>®</sup> is increasingly adopted in solving problems. Nearly 20% more solved and exercise problems are added to make the book richer and more diversified.

Chapters 6 and 8 have been loaded with many new problems making it a more industry oriented edition.

Continued patronage of faculty in Chemical Engineering, Industrial Chemistry, Process Engineering, Environmental Engineering, Biotechnology and others of various universities in India is acknowledged with gratitude. Their valuable suggestions and comments have been an inspiration for us to revise the edition with current syllabi of different universities.

We are grateful to Prof. (Dr.) M M Sharma, Padma Vibhushan and Former Director of Institute of Chemical Technology, Mumbai, for the continued encouragement. Also, we are thankful to the Director of Technical Education, Gujarat, and the Principal, L D College of Engineering for granting us the permission to publish this edition. We would also like to mention the names of all those reviewers whose inputs were useful while updating the book.

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We are also thankful to Ms Vibha Mahajan and other colleagues of Tata McGraw Hill, New Delhi, for their sincere efforts in bringing out this edition in a short period and in an attractive format.

We are sure our continued efforts in updating the edition will be appreciated by all our colleagues in academia and industry at large. We welcome suggestions from all for making a better and more useful publication.

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