Mass Transfer Operations for the Practicing Engineer

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Louis Theodore
Francesco Ricci

A JOHN WILEY & SONS, INC., PUBLICATION

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Published by John Wiley & Sons, Inc., Hoboken, New Jersey
Published simultaneously in Canada

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Library of Congress Cataloging-in-Publication Data:

Theodore, Louis.
Mass transfer operations for the practicing engineer / Louis Theodore, Francesco Ricci.
p. cm.
Includes Index.
ISBN 978-0-470-57758-5 (hardback)
1. Engineering mathematics. 2. Mass transfer. I. Ricci, Francesco. II. Title.
TA331.T476 2010
530.4′7501512—dc22 2010013924

Printed in the United States of America

10 9 8 7 6 5 4 3 2 1

To Ann Cadigan and Meg Norris:
for putting up with me (LT)

and

To my mother Laura, my father Joseph,
and my brother Joseph Jr:
for reasons which need not be spoken (FR)

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Preface

Mass transfer is one of the basic tenets of chemical engineering, and contains many practical concepts that are utilized in countless industrial applications. Therefore, the authors considered writing a practical text. The text would hopefully serve as a training tool for those individuals in academia and industry involved with mass transfer operations. Although the literature is inundated with texts emphasizing theory and theoretical derivations, the goal of this text is to present the subject from a strictly pragmatic point-of-view.

The book is divided into three parts: Introduction, Applications, and Other Topics. The first part provides a series of chapters concerned with principles that are required when solving most engineering problems, including those in mass transfer operations. The second part deals exclusively with specific mass transfer operations e.g., distillation, absorption and stripping, adsorption, and so on. The last part provides an overview of ABET (Accreditation Board for Engineering and Technology) related topics as they apply to mass transfer operations plus novel mass transfer processes. An Appendix is also included. An outline of the topics covered can be found in the Table of Contents.

The authors cannot claim sole authorship to all of the essay material and illustrative examples in this text. The present book has evolved from a host of sources, including: notes, homework problems and exam problems prepared by several faculty for a required one-semester, three-credit, "Principles III: Mass Transfer" undergraduate course offered at Manhattan College; L. Theodore and J. Barden, "Mass Transfer", A Theodore Tutorial, East Williston, NY, 1994; J. Reynolds, J. Jeris, and L. Theodore, "*Handbook of Chemical and Environmental Engineering Calculations*," John Wiley & Sons, Hoboken, NJ, 2004, and J. Santoleri, J. Reynolds, and L. Theodore, "*Introduction to Hazardous Waste Management*," 2nd edition, John Wiley & Sons, Hoboken, NJ, 2000. Although the bulk of the problems are original and/or taken from sources that the authors have been directly involved with, every effort has been made to acknowledge material drawn from other sources.

It is hoped that we have placed in the hands of academic, industrial, and government personnel, a book that covers the principles and applications of mass transfer in a thorough and clear manner. Upon completion of the text, the reader should have acquired not only a working knowledge of the principles of mass transfer operations, but also experience in their application; and, the reader should find himself/herself approaching advanced texts, engineering literature and industrial applications (even unique ones) with more confidence. We strongly believe that, while understanding the basic concepts is of paramount importance, this knowledge may

be rendered virtually useless to an engineer if he/she cannot apply these concepts to real-world situations. This is the essence of engineering.

Last, but not least, we believe that this modest work will help the majority of individuals working and/or studying in the field of engineering to obtain a more complete understanding of mass transfer operations. If you have come this far and read through most of the Preface, you have more than just a passing interest in this subject. We strongly suggest that you try this text; we think you will like it.

Our sincere thanks are extended to Dr. Paul Marnell at Manhattan College for his invaluable help in contributing to Chapter 9 on Distillation and Chapter 14 on Crystallization. Thanks are also due to Anne Mohan for her assistance in preparing the first draft of Chapter 13 (Humidification and Drying) and to Brian Bermingham and Min Feng Zheng for their assistance during the preparation of Chapter 12 (Liquid–Liquid and Solid–Liquid Extraction). Finally, Shannon O'Brien, Kathryn Scherpf and Kimberly Valentine did an exceptional job in reviewing the manuscript and page proofs.

FRANCESCO RICCI
LOUIS THEODORE

April 2010

NOTE: An additional resource is available for this text. An accompanying website contains over 200 additional problems and 15 hours of exams; solutions for the problems and exams are available at www.wiley.com for those who adopt the book for training and/or academic purposes.