Open-Ended Problems

Open-Ended Problems

A Future Chemical Engineering Education Approach

J. Patrick Abulencia and Louis Theodore

WILEY

Co-published by John Wiley & Sons, Inc. Hoboken, New Jersey, and Scrivener Publishing LLC, Salem, Massachusetts.
Published simultaneously in Canada.

Cover design by Russell Richardson

Library of Congress Cataloging-in-Publication Data:

ISBN 978-1-118-94604-6

Printed in the United States of America

10 9 8 7 6 5 4 3 2 1

To

Nicole, who signed up for a lifetime of addressing open-ended problems with me

(J.P.A.)

To

My two long-standing Manhattan College colleagues

Dr. John Jeris

Dr. Wally Matystik

(L.T.)

Contents

Preface

Chemical engineering is one of the fundamental disciplines of engineering, and contains many practical concepts that have been utilized in the past in countless real-world industrial applications. However, the profession is changing. Therefore, the authors considered writing a text that highlighted open-ended material since chemical engineers in the future will have to be innovative and creative in order to succeed in their careers. One approach to developing the chemical engineer's ability to solve unique problems is by employing open-ended problems. Although the term "open-ended problem" has come to mean different things to different people, it describes an approach to the solution of a problem and/or situation where there is usually not a unique solution. The authors of this text have applied this approach by including numerous open-ended problems in several of their courses. Although the literature is inundated with texts emphasizing theory and theoretical derivations, the goal of this book is to present the subject of open-ended problems from a pragmatic point-of-view in order to better prepare chemical engineers for the future.

This book is the result of much effort from the authors, and has gone through classroom testing. It was difficult to decide what material to include and what to omit, and every attempt was made to offer sufficient chemical engineering course material at a level that could enable chemical engineers to better cope with original and unique problems that will be encountered later in practice. It should be noted that the authors cannot claim sole authorship to all of the essay material in this text. Although much of the material has been derived from sources that both of the authors have been directly involved, every effort has been made to acknowledge material drawn from other sources.

The book opens with an Introduction (Part I) to the general subject of open-ended problems. This is followed by 22 chapters (Part II), each of which addresses a traditional chemical engineering (or chemical

engineering related) topic. Each of these chapters contain a brief overview of the subject matter of concern, e.g., thermodynamics, which is followed by three open-ended problems that have been solved by the authors, employing one of the many potential possible approaches to the solution. This is then followed by approximately 30-40 open-ended problems with *no* solutions. A reference section complements the chapter's contents. Part III is concerned with term projects. Twelve chapter topics, including a total of 42 projects, are provided.

It is hoped that the book will describe the principles and applications of open-ended chemical engineering problems in a thorough and clear manner for academic, industrial, and government personnel. Upon completion of the text, the reader should have acquired not only a working knowledge of the principles of chemical engineering, but also (and more importantly) experience in solving open-ended problems. The authors strongly believe that, while understanding the traditional basic concepts is of paramount importance, this knowledge may be rendered virtually useless to future engineers if he/she cannot apply these concepts to unique real-world situations.

Last, but not least, the authors 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 chemical engineering. If you have come this far and read through the Preface, you have more than just a passing interest in this subject. The authors strongly suggest that you take advantage of the material available in this book and believe that it will be a worthwhile experience.

January 2015
J. Patrick Abulencia
Bronx, NY

Louis Theodore
East Williston, NY

Acknowledgements

The authors were assisted during the preparation of this book by several individuals that we wish to acknowledge. Rita D'Aquino served as our executive editor, and spent many days proofing the manuscript and preparing the index. Colleen Kavanagh and Xi Chu are two Manhattan College students who assisted with preparing the manuscript and figures. The authors are sincerely grateful for all of your contributions.