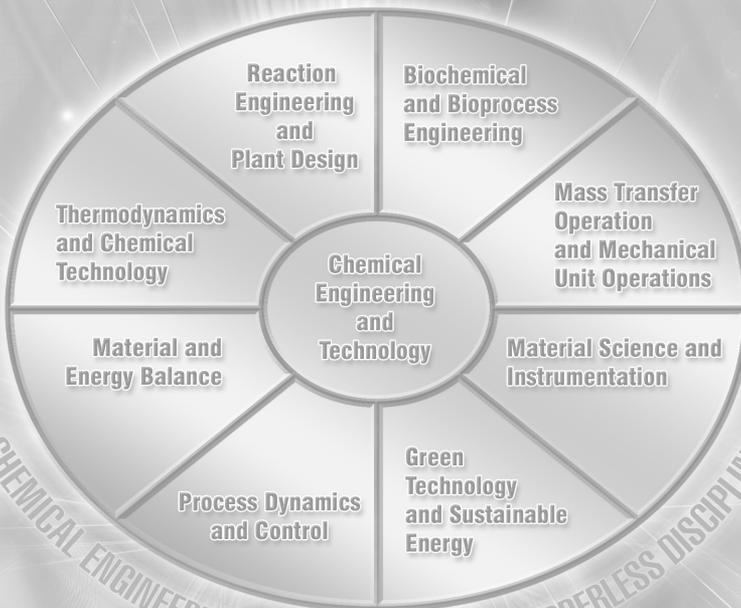


Teasers of Chemical Engineering and Technology



CHEMICAL ENGINEERING and TECHNOLOGY - A BORDERLESS DISCIPLINE

Teasers of Chemical Engineering and Technology

POGAKU RAVINDRA

PENERBIT UNIVERSITI MALAYSIA SABAH

Kota Kinabalu • Sabah • Malaysia

<http://www.ums.edu.my>

2015

A Member of the Malaysian Scholarly Publishing Council (MAPIM)

© Universiti Malaysia Sabah, 2015

All rights reserved. No part of this publication may be reproduced, distributed, stored in a database or retrieval system, or transmitted, in any form or by any means, electronics, mechanical, graphic, recording or otherwise, without the prior written permission of Penerbit Universiti Malaysia Sabah, except as permitted by Act 332, Malaysian Copyright Act of 1987. Permission of rights is subjected to royalty or honorarium payment.

Penerbit Universiti Malaysia Sabah makes no representation – express or implied, with regard to the accuracy of information contained in this book. Users of the information in this book need to verify it on their own before utilizing such information. Views expressed in this publication are those of the author(s) and do not necessarily reflect the opinion or policy of Universiti Malaysia Sabah. Penerbit Universiti Malaysia Sabah shall not be responsible or liable for any special, consequential, or exemplary problems or damages resulting in whole or part, from the reader's use of, or reliance upon, the contents of this book.

Perpustakaan Negara Malaysia

Cataloguing-in-Publication Data

Ravindra, Pogaku, 1958-

Teasers of Chemical Engineering and Technology / POGAKU RAVINDRA.

ISBN 978-967-0521-60-2

1. Chemical engineering. 2. Chemical technology.

I. Title.

660

Typeface for text:	Times New Roman
Text type and leading size:	11/13.2 points
Published by:	Penerbit Universiti Malaysia Sabah Tingkat Bawah, Perpustakaan Universiti Malaysia Sabah Jalan UMS 88400 Kota Kinabalu, Sabah
Printed by:	Percetakan CCS Sdn. Bhd. Jalan Tuaran, 88450 Inanam, Kota Kinabalu, Sabah, Malaysia

CONTENTS

Foreword	ix
Preface	x
Acknowledgements	xi
1 CHEMICAL TECHNOLOGY	1
1.1 Basic Principles	1
1.2 Material Technology	9
1.3 Chemical Industry	12
1.4 Petroleum Technology	26
1.5 Catalyst Technology	32
1.6 Environmental Technology	32
1.7 Food Technology	33
1.8 Instrumentation	33
Answers	35
2 THERMODYNAMICS	39
2.1 Basic Concepts	39
2.2 Substances Properties and Energy	45
2.3 Chemical and Phase Equilibrium	48
2.4 Gas Vapour Mixture and Air-conditioning	51
Answers	52
3 FLUID MECHANICS	55
3.1 Basic Principles and Properties	55
3.2 Fluid Dynamics	66
3.3 Pressure, Measurement and Instrumentation	70
3.4 Flow through Pipe	83
3.5 Viscous Flow	86
Answers	88
4 HEAT TRANSFER	91
4.1 Basic Concepts	91
4.2 Heat Conduction	101
4.3 Heat Convection	103
4.4 Heat Radiation	103
4.5 Boiling and Condensation	104
4.6 Heat Exchangers	109
Answers	112

5	MASS TRANSFER AND SEPARATION PROCESS	115
5.1	Principles of Mass Transfer	115
5.2	Drying of Process Materials	122
5.3	Gas-Liquid Separation	123
5.4	Vapour-Liquid Separation	130
5.5	Liquid-Liquid Separation	141
	Answers	143
6	CHEMICAL REACTION ENGINEERING	145
6.1	General Chemical Reaction Principles	145
6.2	Homogeneous Reaction in Ideal Reactors	150
6.3	Catalyst and Flow Patterns	155
	Answers	155
7	MECHANICAL UNIT OPERATION	157
7.1	Units and Principles	157
7.2	Particle Tech	158
7.3	Separation Tech	162
7.4	Heating and Drying Tech	165
	Answers	166
8	PROCESS DYNAMICS AND CONTROL	169
8.1	Dynamic Behaviour of Processes	169
8.2	Feedback and Feed Forward Control	174
	Answers	176
	IMPORTANT INFORMATION FOR CHEMICAL ENGINEERS	177

Dedication

My graceful granddaughter
“AARADHYA” of SWETA ARJUN



FOREWORD

This book takes a fresh look at the objective view of chemical engineering courses. The book guides the users to enhance their knowledge and skills in the field of chemical engineering. Students will find the blend of academic and practical questions very helpful and teachers will welcome the novel way of testing the students by each teaser.



I understand that the special feature of the book is that the questions of all the exercises are based on real-life industrial situations in which I strongly believe the users would find it very handy in taking competitive exams, attending interviews and a ready-guide to practising professionals. This book covers most of the areas of chemical engineering, few subjects of food technology, biotechnology and other allied areas.

PROF. DATUK DR MOHD. HARUN ABDULLAH

Vice Chancellor
Universiti Malaysia Sabah
Kota Kinabalu, Sabah, Malaysia
December 2015

PREFACE

Let me express my gratitude to the readers of this book for their appreciation and overwhelming response. Their encouragement and support compelled me to publish second edition of the Teasers of Chemical Engineering book. This book has been written in view of the dire necessity of students and practising professionals of chemical engineering. The questions are innovative in their own way. The users would find it very handy in taking competitive exams, attending interviews and a ready-guide to practising professionals. This book covers most of the areas of chemical engineering, and other allied areas. Most normal textbooks used by chemical engineering, food engineering and biochemical engineering students are lack in adequate multiple-choice questions. For a better understanding of the subject, analytical ability and reasoning are key factors. Hence, this teasers of chemical engineering book would be beneficial to readers.

I hope that the structure and content will help students to master this challenging material for both their exams and their subsequent chemical engineering profession practice. This book could, therefore, be the first of its kind to bear a title like Teasers of Chemical Engineering and also to give a fully comprehensive treatment of this topic under different brain-teasing exercises. One of the special features of the book is that the questions of all the exercises are based on real-life industrial situations.

All experienced teachers turn to student-generated explanations for the best insight into what really needs to be taught. The students over the years have provided me with such teaching insights through the years.

There might be some inevitable errors which, despite all efforts may have escaped attention. I shall be obliged to those who point out such errors and suggest measures for the improvement of this book. I once again solicit suggestions and criticisms from our eminent readers which are the exclusive means of inspiration to me.

POGAKU RAVINDRA

Faculty of engineering
Universiti Malaysia Sabah
Kota Kinabalu, Sabah, Malaysia
December 2015

ACKNOWLEDGEMENTS

I express my gratitude to Prof. Datuk Dr Mohd. Harun Abdullah the Vice Chancellor of Universiti Malaysia Sabah for inspiring me to write the book. I place on record Prof. Ir Dr Rosalam Sarbatly, the Dean of Faculty of Engineering for his kind encouragement and unstinted support. Thanks are due to my distinguished colleagues of chemical engineering programme for their support.

I profusely thank students who served as guinea pigs during the formative stages of the book's development. My special thanks are due to Ms Helen Chuo for her help, who uncomplainingly typed the contents of the book. Thanks are due to my wife Rama Devi, children Divya, Sweta and Raghavendra Abhishek for extending support and cooperation for letting me to spend extra hours. Finally, I am thankful to Assoc. Prof. Dr Asmady Idris the Director of Penerbit UMS, not forgetting Ms Lindsay Lorraine Majawat, Mr Nataniel Ebin and Mr Azlan Yakob for their effort in bringing out the book with a nice get up.

