
Orientation to Chemical Engineering

**Sümer M. PEKER
F. Zehra ÖZÇELİK
Gülin ERSÖZ
Ayşe MORAL**

Ege University, Chemical Engineering Department
İzmir, Turkey



AKADEMİSYEN
KITABEVI

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Writers

Sümer M. PEKER

F. Zehra ÖZÇELİK

Gülin ERSÖZ

Ayşe MORAL

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siparis@akademisyen.com

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Introduction

This book addresses the chemical engineering students who are to begin their education towards a life-long career. Seldom do the students realize that what they are about to begin, is not only an education in a branch of engineering, but acquisition of a frame of mind, an outlook into life that will set their future life style. Indeed the way the subject matter is treated and the approach to problems and case studies will in time be a part of the students' personality. As an example, three close friends with similar attitudes may choose to study law, medicine and engineering. Their friendship may last life-long, but in a few years after graduation from the university and starting their career, they will realize that their approach to problems and frames of mind has changed. Approach to problems at work, transforms to an approach toward handling daily situations in life as time goes by.

Our deep belief in this concept is indicated with the name of the book, *Orientation to Chemical Engineering*, instead of being *Introduction to Chemical Engineering*. Much can be said about the approach and frame of mind of a chemical engineer: practicality, order-of-magnitude approach, analytical mind and ability to synthesize knowledge in different areas of science in the solution of a practical problem are some of the aspects.

Another motivation for writing this book came from the observation that most of the student failure has originated not from inability to understand the subject matter itself but something deeper that the student would fall into, such as the misuse of units or the inability to evaluate a plot, whatever the subject of the course was. These capabilities that were regarded as basic, was not taught in any one course, but simply assumed to be known. In the beginning of the 1980's the academic members of the Chemical Engineering Department of Ege University were in agreement that something was missing in the curriculum that caused the students do the same mistakes over and over again in every course that they had taken. Evidently, a course was required where basic concepts common to all engineering courses would be taught.

Nearly forty years have elapsed since this course was first included into the curriculum. Since the course was not offered in any other university in those years, we had to proceed by trial and error. Various methods of conducting the course were tried: Academic members of the Department lectured each week on their field of specialization; chemical engineers from the industry were invited for the lectures; problem-solving strategies were discussed with the students; but none of the methods was accepted to be helpful by the students. The contents of this book evolved with time with the suggestions of the students and feedback from the graduates. Individual lectures, not related with each other were found not to be very helpful because they did not give a coherent perspective of the profession. The graduates proposed that the engineering students should have a viewpoint of possible working areas, and job functions as early in the educational life as possible. They thought the students could

then make intelligent choices for their elective courses and term projects that would orient them to their future career in the field of his/her choice.

Four years of education is a long period for students who have just started their university experience. They tend to envision short-term goals only, so being successful in the courses they take is their sole aim. This book is intended for showing the forest to the students to prevent them from entangling in short term despairs among trees: the skills they have to acquire throughout the education; how these skills are encouraged in the course of learning; the layout of the courses and the logic behind their succession in the curriculum; possibilities and the opportunities offered for their orientation toward a specific career.

The intention of the first four chapters of this book is to introduce the profession; guide the students to use their time spent in university education efficiently toward their career goal, making use of all the opportunities and facilities offered to them; suggest possible organizations where they can work and their prospective job functions; introduce the state of the chemical industry in the present and the future trends.

Chapter 1 introduces the concepts and skills of “model” chemical engineers the students should aspire. In a way, it sets the goal for the personality traits to be developed through their education. The various job functions outlined and underlying knowledge level required is hoped to motivate the students for considering a minor or a double major in a related field of interest or at least attending workshops and short courses.

Chapter 2 is not concerned with the content of the courses that will not mean much for a beginner. Instead, what the students will gain from the content and the way the evaluations are made on the subject matter they have learned would be more informative. Cognitive and behavioral skills the engineering student is expected to acquire and how these skills are encouraged in the course of their education together with the opportunities offered by their universities is given in this chapter.

Chapter 3 introduces the institutions involved in the applications of chemical engineering. The classification of the institutions into groups according to their functions is not standard, but arbitrarily made in this book to enable the students to associate these organizations with the job functions and responsibilities of chemical engineers. Although the book is written in English for students in universities where education is conducted in English, the Turkish students are addressed, who will constitute most of the readers. Hence, reference is made to the chemical engineering practices and institutions prevalent in Turkey throughout the book.

Chapter 4 gives an overview of the chemical industry, prospective developments and emerging fields. Classification of chemical productions in Sections 4.2.2 - 4.2.5 is made according to the underpinning unit operations and chemical conversions. Innovation and efficiency in production are the two keys that open up market shares in the international scale. An overview of the types of chemical productions with respect to efficiency in terms of process design or product design is outlined in this chapter.

The attention of the student is drawn to innovative product design that will dominate competitive productions in the future.

Engineering and chemical engineering courses, starting from fundamental concepts of physical chemistry and progressing up to the design stage constitute the core of chemical engineering curriculum. Chapters 5 and 6 analyze and demonstrate these concepts on sample cases.

Chapter 5 analyzes production processes referred to in the overview of chemical industries in Chapter 4 using a top-to-bottom approach. A process presented as an alternative technology for production of vinyl acetate monomer is used to illustrate the components of a process flow sheet, such as main and side streams, recycle, reflux, vent and by-pass, together with the unit operations used in the productions. The emphasis here is on the logic and the reasons for employing these equipment in the given order and process flow sheet sequence.

Later on in the analysis of unit operations, the students' attention is drawn to the fact that all transfer and separation processes are based on *differences* in one of the physical properties: Given the physical properties of the components in a system, the students should be able to decide on the separation method to be used. They should be able to analyze a given process qualitatively using these different separations/operations as a Lego block.

Chapter 6 complements Chapter 5 in context. Scale-up is an important process in chemical engineering: the performance of processes developed in model scale is observed in pilot-scale equipment before being constructed in real (plant) size. The students should be aware of the fact that all-laboratory set-ups are actually laboratory or pilot scale representations of plant-scale equipment. The other concepts of significance introduced in this chapter are assumptions and the reasons for making them; the difference between a variable and a parameter and how qualitative observations are quantified within the framework of the model study.

The next four chapters are developed basing on the difficulties the students face during their education. This part reviews the basic knowledge on units and dimensions (Chapter 7), graphical means of expression of results (Chapter 8), basic statistics required for the evaluation of laboratory data (Chapter 9), and how to communicate information (Chapter 10). The contents are underpinning to all the fundamental courses of chemical engineering, as well as laboratory work.

Chapter 7 gives basic knowledge on three elemental topics: significant figures in writing numbers; unit conversions, consistency and mathematical operations with units; dimensionless numbers. These topics are fundamental in all engineering applications and mistakes cannot be tolerated.

Chapter 8 on graphics is included in this book to stimulate awareness of the operations that can readily be done by computers, as well as introducing different types of graphs and nomograms.

Chapter 9 on statistics is by no means comprehensive. Only the applications that the students will use in laboratory work, in writing reports and in term projects are included in this chapter.

Chapter 10 on communications is included into the book to help the students in writing reports. The information given in the chapter will also be helpful to the students in preparing their presentations and writing application letters.

Chapter 11 outlines the various aspects of ethical conduct throughout their education and professional life.

It is impossible to cover all of the contents of the book within a two credit-hour course. The intention of the book is to supply background information to enable the students to acquire a vision of the education that will be offered to them during the four years in the university, the professional life awaiting them after graduation and what they can do to attain the career in their ideals. The instructor may choose to concentrate on one part only, or a selection from the chapters can be made.

We hope that the contents of the book will be useful in informing the students of the basic concepts required in their university education and contribute to their understanding of chemical engineering as a profession.

Prof. Dr. Sümer M. Peker

Doç. Dr. F. Zehra Özçelik

Doç. Dr. Gülin Ersöz

Chem. Eng. MS, Ayşe Moral

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