Improve the Quality of Chemical Engineers' Education

Pin-Chan Du

Department of Chemical Engineering, Kao-Yuan Institute of Technology, Taiwan
Tel:(+886)-7-696-8121, Fax:(+886)-7-696-8128, pcdu@cc.kyit.edu.tw

Abstract: The traditional curriculum of chemical engineering dealt only with the engineering problems of the chemical and refining industries. The field has now moved toward new directions. Therefore, changing the chemical engineering education process is critical for the success, development, and growth of the field. To restructure the chemical engineering education, academic institutes need to recruit more engineers who have significant industrial experience. Furthermore, the traditional education process of an engineer has to be changed.

Keywords: chemical engineering, self-learning capability, independent research

1. Introduction

Due to the rapid growth and development of technology, information and scientific principles, a successful engineer must constantly expand his or her horizons beyond simple gathering of information and engineering principles [1]. However, the following reasons make it difficult to meet these new challenges. Firstly, the traditional set of core subjects for chemical engineering mainly consists of unit operation, thermodynamics, reaction chemical engineering, process control and design, and separation process. This was the suggested curriculum because chemical engineering has dealt only with the engineering problems of the chemical and refining industries. However, the field now has expanded into areas such as reducing traditional products, shifting to pharmaceutical industry, microelectronic industry, etc., applying intelligent control system to the existing process, and making vertical integration or downsizing, and etc. Thus, changing the chemical engineering education process is critical for the success, development, and growth of the field.

A second reason is that many instructors who lack industrial experience have been teaching chemical engineering in most education institutes. Therefore, the educators may have difficulty in realizing the needs of the industry and seeing future trends. This is the reason why they cannot give much emphasis with developing new technique and improved procedures. Therefore, to reengineer the current education process, the chemical engineering academic institutes must change their recruiting pattern.

Thirdly, the traditional school system of lectures-exams-homework-lab encourages the students to view the subject in an isolated, idealized, and exclusively technical way, therefore, cultivating a passive and individually-centered attitude [2]. As a result, the engineering graduates lack the ability and skills to actively seek solutions, pursue lifelong learning enrichment, and effectively inter-personal skills. To overcome these weaknesses, alternative techniques, that will enhance the quality of potential chemical engineers, must be added to the traditional pedagogy.

To enhance the quality of chemical engineer's education and create student's learning capability, this article recommends modifications to the current engineering curriculum and provide an alternative teaching approach.

2.Changes in curriculum

A chemical engineer is defined as an individual who handles the engineering of chemical reaction [3]. Therefore, as a chemical engineer, parts of his/her job are to improve the company's existing procedures, products and create advanced materials. The engineer's impact must not only be able to generate growth and expansion towards newer markets but be able to create more environmental-friendly products. For example, chemical engineers must try to make polymers that are truly disposable or recyclable [4]. Thus, it is important for him/her to constantly expand and look at new areas such as environmental science/engineering, biotechnology, microelectronics, technological alternatives, and etc. To broaden their background and cultivate their ability of self-learning the traditional curriculum of chemical engineering must be modified. The following table is the suggested 4-Year Undergraduate curriculum for Chemical Engineering:

Suggested 4-Year Undergraduate Curriculum of Chemical Engineering

	1st Year		2nd Year		3rd Year		4th Year	
	Course	Credit	Course	Credit	Course	Credit	Course	Credit
Required Courses	Chinese	6	Lab of Organic Chemistry	1	Lab of Biotechnology	1	Lab of Unit Operations	1
	English	6	Lab of Physical Chemistry	1	Lab of Instrument	1	Fine Products Lab	1
	Constitution	2	Lab of Instrument	1	Lab of Unit Operations	1	Lab of Simulated Process Control	3
	Chinese History	3	Organic Chemistry	3	Lab of Polymerization	1	Process Control	3
	Calculus	6	Material & Energy Balance	3	Chemical Engineering Thermodynamics	3	Special Topic on Fine Products	3
	Physics	6	Instrumental Analysis	3	Mathematics for engineers	3	Process Design	3
	General Chemistry	2	Physical Chemistry	6	Polymer Science	3	Unit Processes	3
	Lab of Chemistry	1	Mathematics for engineers	3	Unit Operations	3		
	Lab of Organic Chemistry	1	Unit Operations	3	Chemical Reaction Engineering	3		
	Intro. Of Chemical Engineering	2	Biochemistry	3	Physical Polymer Science	3		
	Application of Windows	2	Industrial Chemistry	3	Undergraduate Research	1		
	Industrial Safety	2						
	Introduction to AutoCAD	1						
	Organic Chemistry	3						
	Analytical Chemistry	2						
	Total	45		30		23		17
Electives			Industrial Instrumentation	2	Introduction to Material Science	3	Air Pollution Prevention	3
			Language C+	2	Special Topic	2	Introduction to Bioengineering	3
			Engineering Mechanics	2	Food Engineering	3	Special topic on Composite Material	3
			Study of Paper Search	2	Environmental Science	3	Electro chemical Engineering	3
			Quality Control	2	Inorganic Chemistry	3	Semiconductor Technology	3
					Introduction to Safety in Chemical Processes	3	Bio separation Technology	3
					Material Surface	3	Solid Waste Treatment	3
					Numerical Analysis	3	Ceramic Material	3
					Simulation of Chemical Processes	3	Energy Management	3
					Special Topic on Management	3		
					Surface Chemistry	3		
					Introduction to Biotechnology	3		
					Water Treatment	3		

* A total of 145 hours of credit is required for graduation.

3. Improved Instruction

If chemical engineering instructors lack industrial and fieldwork experience, they may not know how to develop new technique and processes to meet the needs of today's industry. On the contrary, an instructor with significant industrial experience will have no problem seeing the trends and demands of today's industries. Consequently, the instructor will have the ability to developing appropriate methods of design, equipment, processes and materials

instead of conducting researches not applicable to industry.

In most education institutes, however, it has been very obvious that new faculty members usually are hired directly from school. Thus, many instructors without industrial experience have taught chemical engineering. As a result, they do not have the opportunity and ability to develop the proper understanding and skills needed for today's students. Henceforth, in order to modify the chemical engineering education program, academic institutes must recruit engineers with considerable work experience.

4. Change in learning pedagogy

For years, the typical education routine of an engineer student was based on lecture-exam-homework-lab has to be modified, because it has became barriers to the individual's personal and interpersonal skill. As a result, this hinders the student's creativity and innovative skills. In recent years, much attention has been focused on the need to train innovative engineers for industry and society [5]. However, both self-learning capability and independent research capability are not of their concern. Since innovation and creativity involve the ability to put things (words, concepts, methods, and devices) together in novel way [6], the following techniques may be implemented to the traditional method to enhance the quality of will-be-chemical engineers:

Creating students' self-learning capability

The normal academic education can not provide effectively a person with the knowledge required for his/her whole life. In addition, it is not rare for an engineer to meet challenges that may not be related to his/her knowledge. Therefore, it is critical for an engineer to gain a self-learning skill before he/she enters the manpower market. To cultivate students in self-learning, instructors need to encourage them to create self-directed, self-thought, self-graded, and self-taught capabilities.

Encouraging students to conduct independent research

Independent research will enable students to analyze and solve problems independently. Encouraging students to initiate their own research topics, obtain the needed information by self-instruction, carry out research and write technical papers.

Assigning technology-related paper survey

Through a technology-related paper survey, students can learn how to summarize, write, and submit a technical report. This will benefit students in self-education and better performance later in his/her future career.

Providing a chance for students to teach and speak

Assign each student a topic to present in a class. The ability to properly organize and express one's thoughts and ideas through speech is a very important skill in today's market and industry.

5. References

[1] H. S, Fogler, "Element of Chemical Reaction Engineering," Prentice-Hall International, Inc., 1992.

[2] R. R. Rhinehart, "Improve the Quality of Chemical Engineering Education," Chem. Engng. Progress, pp.67-70, August 1991.

[3] L. D. Schmidt, "The Engineering of Chemical Reactions,' Oxford University Press, 1998.

[4] R. Shinnar, "The Future of Chemical Engineering," Chem. Engng. Progress, pp.80-85, September 1991.

[5] H. C. Van Ness, "Chemical Engineering Education: Will We Ever Get It Right?" Chem. Eng. Prog., pp.18, January 1989.

[6] R. M. Felder, "Creative in Engineering Education," Chem. Eng. Ed., 22, pp.120-124, 1988.