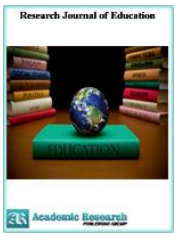

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Chemical Engineering Curriculum System Research and Building in the Training of Engineering Idea and Ability

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Abstract: The importance of education quality can never be over emphasized. The objective of this research is to introduce how to set up scientific and reasonable curriculum system in the training of chemical engineering ideas and abilities of students who majored in chemistry and other related specialties. According to the many years practice, the system is built and optimized, and it includes the following courses in the order of "Elementary Chemical Industry", "Chemical Engineering Experiment", "Chemical Industry Charting", "Industry Chemistry" or "Chemical Technology", "Chemical Process Simulation Experiment", "Chemical Process and Plant Design", "Chemical Practice". Teaching practices have testified that students cultivated by this curriculum system presented well comprehensive quality of innovative talents, and the employment capability is obviously enhanced.

Keywords: Chemistry specialty; Chemical engineering ideas and abilities; Chemical engineering curriculum system; Comprehensive quality.

1. Introduction

In order to improve students professional skill, chemical engineering ideas and abilities, science universities normally set up fundamental courses such as "Elementary Chemical Industry", "Chemical Engineering Experiment" for students specialized in chemistry or other related majors, which plays bridge role between theory to practice and fundament to profession. These courses are often offered following prerequisite courses of "Advanced Mathematics", "College Physics" and "Physical Chemistry". Since Ministry of Education of the People's Republic promulgated the order of "sound grounding, wide scope, wide adaptation" in 2012, its teaching class hour is constantly shorten due to expansion of public course and superaddition of selective course. Although the accessional professional course such as "Industry Chemistry", "Chemical Technology", "Chemical Process Simulation Experiment" can make up for the deficiency at some extant, the organization of those courses lacks systematicness and scientificity. Therefore, it's of great importance to organize and implement scientific and systematic chemical engineering curriculum system in order to train students' chemical engineering ideas and abilities in the limited teaching hour.

2. Research Objectives

The purpose of this paper was to introduce the experience in organization and implementation of chemical engineering curriculum system, ensure the training of students' chemical engineering ideas and abilities, and enhance their employment capability.

3. Methods: Building of Chemical Engineering Curriculum System Framework

For students, who majored in chemistry and aimed to engage in chemical industry, should study the following courses in the order of "Elementary Chemical Industry", "Chemical Engineering Experiment", "Chemical Industry

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Charting", "Industry Chemistry" or "Chemical Technology", "Chemical Process Simulation Experiment", "Chemical Process and Plant Design", "Chemical Practice". Course framework was built and showed as Figure 1.

4. Implementing Embodiment

4.1. Implementing Embodiment of "Elementary Chemical Industry" and "Chemical Engineering Experiment" (Peking University, 2004; Wang, 1992; Wuhan University *et al.*, 2005; Wuhan University, 2009)

"Elementary Chemical Industry" and "Chemical Engineering Experiment" are set as required courses with teaching period of 60 and 36 respectively. Curriculum objectives are help students master the principles of chemical engineering unit operations, realize unit operation equipment, and then enhance these cognitions through "Chemical Engineering Experiment". They are offered following prerequisite course of "Advanced Mathematics", "College Physics" and "Physical Chemistry". The basic teaching contents include: fluid flow and transportation, heat transfer process, mass transfer process **(**distillation, absorption**),** type of industry reactor and its calculation. At the same time, experiments corresponding to basic unit operations are required, such as detection of hydraulic resistance, characteristic curves of centrifugal pump, heat transfer coefficient between wall heat exchanger, separation capability by distillation, mass transfer coefficient by absorption, reactor model verification.

4.2. Implementing Embodiment of "Chemical Industry Charting" (Wuhan University, 1990; Yang and Wang, 2002)

Engineering drawing is an important means for engineers to express and exchange their design ideas and contents. Therefore, "Chemical Industry Charting" is normally set as a required course with teaching period of 40. Curriculum objective is to train students' capability of reading and making simple engineering drawing. The basic teaching contents include: basic regulations of engineering drawing (size and layout of drawing sheets, drawing scale, font and size, drawing lines, dimensioning), ruler gauge plotting (normal drawing implements and their usage, geometric construction, plotting step), projection basis (projection of point-line-surface-body and assembly), normal expressing methods of chemical equipment (view, sectional view, cutaway view), parts drawing (contents of parts drawing, common parts drawings), assembly drawings, chemical process flow diagrams, equipment layout diagrams, piping layout diagrams.

4.3. Implementing Embodiment of "Industry Chemistry" or "Chemical Technology" (Cui, 1989; Gong, 2013)

"Industry Chemistry" or "Chemical Technology" is a comprehensive and designing course following "Elementary Chemical Industry". Based on manufacturing technique purpose, it describes the utilization of chemical engineering unit operations and equipment, production method, technical principle, typical technological process, process condition, energy-saving and cost-reducing, "three wastes" treatment. It's set as selective course with a teaching period of 34. Students can get knowledge of basic components of chemical process, principle, process condition and optimization, equipment structure and material, treatment of three wastes, green production and energy saving. "Sulfuric Acid Industry" and "Synthetic Ammonia Industry" can be used to introduce the typical components of chemical process (material preparation, material purification, chemical reaction, separation and refining of product, "three wastes" treatment), and show concepts of material balance, heat balance and energy conservation. They can also view the development of modern chemical industry through the study of fine chemicals industry, petrochemicals industry, coal chemicals industry and so on.

4.4. Implementing Embodiment of "Chemical Process Simulation Experiment"

Study of "Chemical Process Simulation Experiment" course needs knowledge of basic chemical engineering theory, experimental technique and realization for chemical industry production. It's also set as a selective course with a teaching period of 34 following "Elementary Chemical Industry", "Chemical Engineering Experiment", "Chemical Industry Charting" and "Industry Chemistry". This curriculum can provide experimental projects of unit operation and production process in the way of scene simulation and computer simulation, and enable students to understand characteristics and rules of chemical production, acquaintance controlling mode of technological parameter, train professional technique of analyzing and solving real problem, and even successfully finish thesis or design, or engage in work of chemical production in the future. The provided projects about unit operation include: centrifugal pump, shell-and-tube heat exchanger, rectifying tower, absorbing tower, batch stirring tank reactor. Projects about chemical process are: general chemical factory 3D simulation experiment (training contents include: safety education, emergency treatment, plant layout, component of production process), 3D simulation production practice experiment of methanol synthesis (training contents include: component of production process, technological parameter setting and optimizing, typical equipment, emergency operation).

4.5. Implementing Embodiment of "Chemical Process and Plant Design" (Lou *et al.*, 2002; Sun, 2012)

Study of "Chemical Process and Plant Design" is based on basic chemical engineering theory, experimental technique and realization for chemical industry production. It's set as a selective course with a teaching period of 34

following "Elementary Chemical Industry", "Chemical Industry Charting", "Industry Chemistry" and even "Chemical Process Simulation Experiment". Purpose of the teaching is enable students to understand the design importance, basic principles, contents, and master the design methods about chemical engineering unit operation and equipment, technological process. It asks students to achieve the ability of engineering preliminary design. The teaching contents include: basic contents and program of chemical process and plant design, process design, material balance and heat balance, equipment technique design, equipment drawing, equipment layout, piping layout, utility design, safety and protection, design estimation, technical and economic evaluation.

4.6. Implementing Embodiment of "Chemical Practice"

"Chemical Practice" course is essential for students who long for engaging in chemical engineering or other related works in the future. It can be set as a selective course with a teaching period of 24 following "Industry Chemistry", "Chemical Process Simulation Experiment". It's a final comprehensive practical teaching and aims to strengthen understanding for professional knowledge, further train the capabilities to analyze and solve real project problems with the learned, and finish the transition from student role to operating post. Production of Chlor-alkali & Polyvinyl Chloride is traditional process (Zhang and Wei, 2013), it includes many typical chemical engineering unit operations, equipment and processes such as transportation of NaOH solution (corresponding to fluid flow and transportation), production of liquid choline (corresponding to heat transmission), preparation of hydrochloric acid (corresponding to absorption), refining of crude chloroethylene (corresponding to rectification), synthesis of HCl and polyvinyl chloride (corresponding to chemical reaction process) (Zhou and Ding, 2016). It can be used as a practice project.

5. Results and Discussion

In this research, a scientific curriculum system has been built in the training of students' chemical engineering ideas and abilities. This system not only includes engineering basic courses such as "Elementary Chemical Industry", "Chemical Engineering Experiment" and "Chemical Industry Charting" as compulsive basic courses, but also includes courses of general education such as "Chemical Technology" and "Chemical Process Simulation Experiment". Especially, the "Chemical Process and Plant Design" and "Chemical Practice" are supplemented as strengthened training and practice. It has been testified that the students trained by this systematic chemical engineering curriculums show comprehensive quality of open idea, perfect engineering ideas and intergrated design skills. This can not only improve their employment ability, but also can actively impel the combination of production, teaching and research.

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Figure-1. Framework of chemical engineering curriculum system