CONSTRUCTION AND EXPLORATION OF CHEMICAL ENGINEERING PRACTICE SYSTEM TEACHING BASED ON THE CONCEPT OF CDIO EDUCATION

LI Jianjun，SONG Jianzheng

(College of Environmental and Chemical Engineering, Yanshan University, Qinhuangdao 066004, China)

ABSTRACT:

The paper expounds the fusion of international CDIO engineering education mode, to train engineering technology talents possessing high quality of innovation ability and practice ability from the reality of our university. Through chemical practice base construction, practice content reform and engineering project design, the training of teachers engineering quality and the construction of results evaluation system, a multi-level practice teaching system was constructed including chemical training practice, chemical simulation, chemical perceptual practice, chemical production practice and graduation field work, for the sake of developing students ‘sense of engineering, innovation and unity.

KEYWORDS: CDIO, The practice teaching of chemical engineering, project design, practice content reform

With the rapid development in science & technology and social economy, there is higher requirement for engineering and technical personnel in the chemical industry. Chemical engineering as one of science and engineering, implementing CDIO mode is one of the major trend in the teaching reform of chemical specialty (Peihua Gu et al., 2008).Chemical engineering practical teaching plays an important role in specialized course system of chemical engineering, which is the important teaching contents and means to cultivate students’ CDIO engineering quality. Chemical engineering practical teaching contains chemical training practice, chemical simulation, chemical perceptual practice, chemical production practice, course design, chemical reaction engineering experiment, chemical engineering principle experiment, college student research project and graduation field work, etc. According to CDIO project ideas, we integrated all aspects of excellent teaching resources to construct a chemical engineering practice teaching platform. Chemical engineering practice teaching reform is not only important means to improve the quality of teaching, but important measures to improve students' employability, competitiveness and engineering competence.

1. CONSTRUCT MULTIPLE-LEVEL PRACTICE TEACHING SYSTEM

Based on the CDIO engineering education mode, we insist the main body of students and the leading role of the teacher in teaching arrangements. Design and comprehensive experiments are set up to provide more opportunities to students for active learning and hands-on practice, to help students develop personality and innovative ability (Haibo Jin et al., 2010).

Chemical practice teaching system of Yanshan University is based on provincial chemical experiment teaching demonstration center and the virtual simulation experiment teaching center. A five-level practice teaching system was constructed including courses teaching demonstrates, chemical simulation operation, comprehensive chemical practice, chemical design and research innovation, which is featured in its fundamental, comprehensiveness and research. Chemical practice teaching system has been used in teaching practice such as chemical training practice, chemical simulation, chemical perceptual practice, chemical production practice, course design, chemical reaction engineering experiment, chemical engineering principle experiment, college student research project and graduation field work. As shown in Figure 1 for chemical engineering practice teaching platform.

Through fundamental practical teaching such as chemical engineering principle experiment, courses teaching demonstration, chemical simulation operations and chemical perceptual practice, the students achieved the basic principles of chemical equipments and most basic chemical unit operations, cultivated the independence ability and autonomous learning. Through comprehensive practical teaching such as chemical comprehensive practice and course design, the students achieved not only comprehensive ability to apply knowledge to analyze and solve problems, but also the engineering concept. The research practical teaching, for instance, chemical project design, innovation and college research project, which cultivate students ' innovative spirit, maximize their ability and creativity.

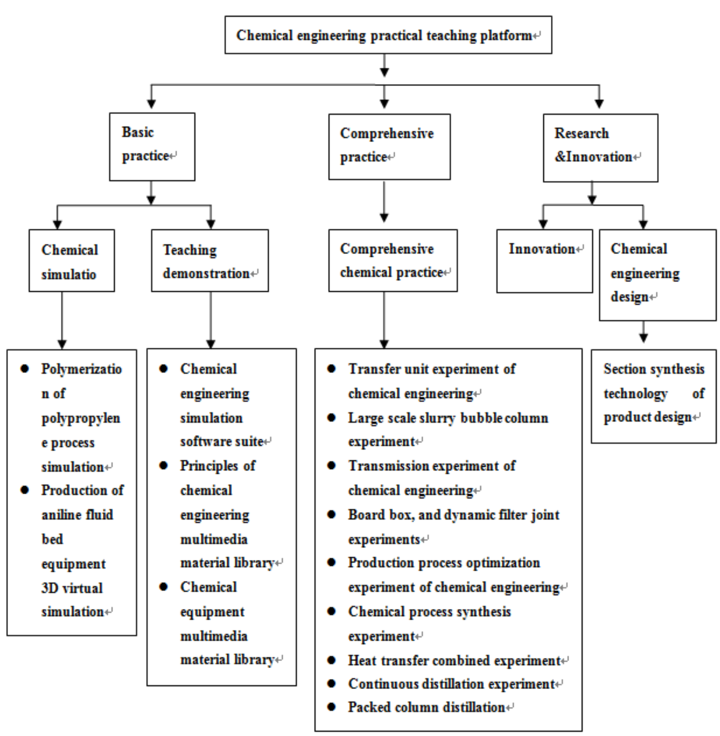

Figure 1. Diagram of the chemical engineering practice teaching platform

1.1 Courses teaching demonstration

The simulation software for chemical engineering principle experiment and chemical equipment multimedia material library are used in courses teaching demonstration. Through Intuitive simulation interface and showing actual teaching process, the students' attention is attracted, and interests are stimulated.

1.2 Chemical simulation

This class using simulation system, for example, "towers fine distillation experiment simulation system", "benzene Tower fine distillation experiment simulation system", "polypropylene aggregate section simulation software", and "3D virtual simulation software for phenyl amine fluidized bed device". With simulation of DCS style, students can simulate factory drive, parking, and normal run and various accident phenomenons processing in LAN, teachers can real-time provides or modify training content, organize exam and summary scores through interconnected teachers station. Chemical simulation can remedy the deficiency of students hands-on; truly reproduce process of chemical production in the chemical unit.

1.3 Comprehensive chemical practice

Multiple chemical equipment are supplied for comprehensive chemical practice, for example, chemical flows process synthesis experimental equipment, packed column distillation apparatus, chemical transfer unit experimental equipment, chemical transfer process apparatus, chemical production process optimization devices. These training projects help students to make connections between chemical process fundamentals and engineering practice, and engineering concept also established. for example, the “chemical production process optimization device", is used for production operation and the process parameter control of " polyvinyl acetate " through online simulation DCS control system, which help students to understand reactor, heat exchanger, fine distillation t tower, gas liquid separation device, aggregate reaction kettle and other chemical units.

1.4 Chemical engineering design

Chemical engineering design requires students to complete the teacher's specified tasks independently. For instance, based on teachers given design tasks of "polyvinyl acetate synthesis process of section design", students can free choose "reactor for vinyl acetate", "vinyl acetate distillation column" or "polymerizing-kettle" production units and then determine the design, At last, the design parameters can be optimized using polyvinyl acetate production process devices upon completion of the design task.

1.5 Innovations and research

This type of project is to encourage students to independent innovation, raise some challenging questions, participate in domestic and international innovation contest, apply for and complete the innovation project. For example, under the guidance of teachers, some student group have completed the "polyvinyl acetate production based on Aspen plus software process optimization" and "plug flow reactor and CSTR reactor system simulation development" projects.

2 REFORMS AND PRACTICE OF CHEMICAL ENGINEERING PRACTICE TEACHING SYSTEM

2.1 Reform of training content, to cultivate the ability for engineering analysis

2.1.1 Classroom teaching focus on student discussions, to cultivate students to integrate theory with practice

According to CDIO educational ideas, teaching process of curriculum should focuses on the design project and students have discussions based on project topics. After the discussions, basic viewpoint is formed with all panelists agreed, the group sends representatives to describe his works for the project, other students discuss the students' comments, and to analyze the advantages and disadvantages, make suggestions for improvement, and finally a summary is presented by teacher.

For example, in the course of chemical reaction engineering, featured in two discussion sessions respectively, in the 4th chapter of "reaction" and the 6th chapter "gas-solid catalytic reaction engineering". The discussions are focus on ideal reactor calculation and fixed bed reactor design. Topics include following main content: (1) ideal reactor calculation (ideal reactor assumes, batch reactor calculation, plug flow reactor calculation and CSTR calculation) (2) fixed bed reactor design (fixed bed reactor model, Aspen Plus reactor calculation module, the solution algorithm of one-dimensional pseudo-homogenous model). Before discussions, students should be grouped analyzes the related literature review according to the selected topics. Each group of two or three students, making reporting seminar PPT (10 minutes). The on-site lottery determines which group and who to report in discussions, reporting must be completed on schedule. After the report is completed, there will be a five minute discussion, other groups of students communicate questions in the discussion time, and all students can participate, and finally reviews by the teacher.

After the seminar ended, students must submit seminar PPT. According to discussion, the students' comprehensive ability, creativity, engineering practice, unity cooperation was strengthened.

2.1.2 Using 3D virtual reality simulation to improve students ' learning interest

The teaching procedure of "learning by doing", make the students to form a positive interaction between learning and application of knowledge. According to different levels experiment courses, multi-media courseware, experimental basics video, 3D virtual reality simulations and other teaching tools are supplemented to improve students' interest in learning and teaching effectiveness.

Compared with multimedia demonstration teaching, 3D virtual reality simulation technology (Yingchun Xia et al.,2010) created a "self-learning" environment for learners, who can get the knowledge, skills, new learning methods through their interaction with information.

In the chemical reaction engineering teaching practice, we used the "3D virtual simulation software for phenyl amine fluidized bed device" simulation system. As Figure 2 showing the interface of 3D virtual simulation for phenyl amine fluidized bed device, in 3D virtual scene of phenyl amine production, it makes students understand the internal structure of the fluidized bed reactor, design and optimization, develop students' ability to analyze and solve various problems in manufacturing operations.

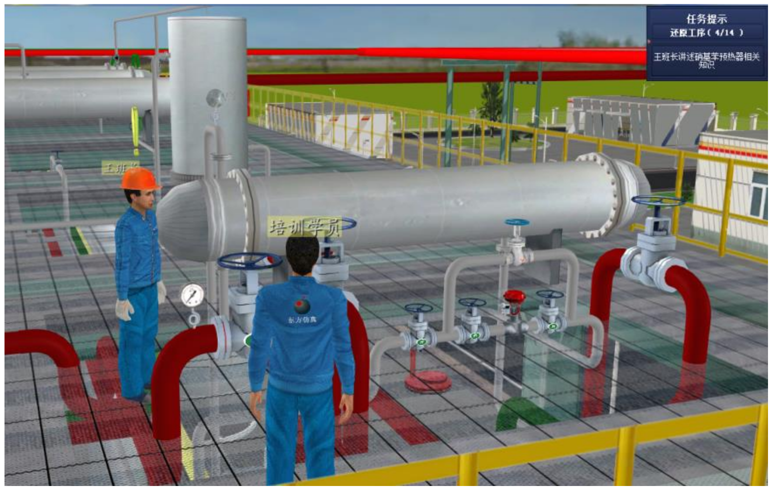

Figure 2. The interface of 3D virtual simulation for phenyl amine fluidized bed device

2.2 Using project-oriented teaching to cultivate student's engineering innovation ability and group cooperate

Based on "project-based education and learning”, project design and implementation is effective way to cultivate students' practical ability and engineering abilities and qualities. IN order to give full play to improve their initiative and creativity, to cultivate high-quality engineering and technical personnel, teaching practice must be advanced, representative, direction and must keep up with the latest developments in research, write textbooks that have professional featured and constantly updated content, thereby enhancing the students ' comprehensive quality and ability.

"Aspen Plus" process calculation software was introduced for project design in the course of teaching practice. Project design main content is reactor design, which requires students select topics from five different types of RStoic chemical measurement reactor, RYield received rate reactor, REquil balance reactor, RPlug Plug flow reactor and RBatch CSTR reactor. Students must complete the various steps: selection reactor, set material parameter, property methods selection, convergence process calculation, results output, project report. Each group of students must finish the design under the project progress, confirm to in a reply form for acceptance, required to submit project report and PPT after reply.

The project implementation makes students ' proficiency in reactor design at the same time deepened the understanding of the basic knowledge, and the students master the basics of chemical process design skills. The project implementation provided a basis for subsequent courses and graduation. For instance, in the graduation project topic "polyvinyl acetate synthesis section design", student determine the design scheme in accordance with given task based on" gas-solid catalytic reactor ", "vinyl acetate distillation column" and" polymerization kettle" production units, and then, using" polyvinyl acetate production process optimization devices ", the calculation results are verified and the design parameters can be optimized through the experiment. At the same time, we encourage students to independent innovation, participating in innovation competition, applications for innovative projects. For example, under the guidance of teachers, some student group have completed the "polyvinyl acetate production based on Aspen plus software process optimization" and "plug flow reactor and CSTR reactor system simulation development" projects.

2.3 Use of chemical engineering practice teaching platform and cultivating students ' ability of engineering practice

CDIO means to conceive-design-implement-operate (Jianzhong Cha et al., 2008), this theory applies to chemical processes practice, that is a chemical product or process design, analysis, synthesis, evaluation, and implementation. Chemical practice base was established in 2009 with multiple sets of chemical laboratory equipment: chemical process synthesis experimental equipment, packed column distillation equipment, large scale slurry bubble column apparatus, frame joint experiments and dynamic filtering devices, chemical transfer unit experiment platform, chemical delivery apparatus, chemical production process optimization experiment device. For instance, using "chemical production process optimization experimental devices", we select polyvinyl acetate product development projects with practical background, under the guidance of school teachers and Enterprise experienced engineering and technical personnel, instruct students to complete design case.

2.4 The reform of evaluation system

As CDIO educational ideas, a complete practice evaluation system was established. For example, in teaching practice of chemical reaction engineering, the comprehensive assessment includes seven sections: attendance, assignments, seminars, virtual simulation, project design, experiment and examination. Specific requirements and scoring methods are as follows: (1) attendance grades accounted for 5%, require students to participate in all nodes and sign in. (2) assignments 5%, require students to accomplished independently and submitted before courses. (3) discussions 10%, with two seminars, require students grouped to access the information, summary, write reports, report in PPT. (4) simulation 10%,with two simulations, students are required to be familiar with production technology, to complete the online test simulation. (5) 10% projects designed, require students grouped complete the selection and reactor calculation, writing research reports and report in PPT, reply in the form of assessment. (6) Experimental grades 10%, students are required to prepare, full participation, independent completion and submission of test reports. (7) Examination 50%.

2.5 Strengthen the cooperation between colleges and enterprises, highlighting teacher engineering quality

Our university established a long-term cooperative relationship with Sino-Arab fertilizer Co., LTD. and Huaying phosphate Co., LTD. Teachers, company engineers and technicians, students formed teams to complete projects and ensure implement of practice teaching. Development departments are invited to establish research and development division, and we are exploring a new idea in specialized laboratory construction under university-enterprise cooperation mode.

3. CONCLUSION

Practice shows that CDIO formed distinct features and advantages. Students generally reflect the teaching effect of the course has improved a lot in the past, which promote the improvement of the teaching quality of chemical engineering.

REFERENCES

Haibo Jin, Yongji song, (2010). Construction and practice of the practical teaching of chemical engineering and technology specialty. Theoretical study, 2010, (6),199-201

Jianzhong Cha. (2008).Engineering education reform strategy "CDIO" and industry-university cooperation and internationalization. University teaching in China, 2008, (5), 16-18.

Peihua Gu, & Minfen Shen, (2008). From CDIO to EIP-CDIO-Shantou University engineering education and talent training model. Advanced engineering education and research, 2008, (1), 12-20

Yingchun Xia&Wu Chongguang (2010).Modern chemical simulation training factory. Journal of system simulation, 2010, (22), 370-375

Jianjun LI is an associate Professor in College of Environmental and Chemical Engineering of Yanshan University, Qinhuangdao, P.R.China.
Jianzheng SONG is a Senior experimentalist in College of Environmental and Chemical Engineering of Yanshan University, Qinhuangdao, P.R.China.

Corresponding author
Jianjun LI
Yanshan University
438 Hebei Avenue
Qinhuangdao,Hebei,P.R.China 066004
1-378-593-2713
jianjunli@ysu.edu.cn