

# Exploration and Adjustment for the Training Objectives of Pharmaceutical Engineering in Higher Education of China

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**ABSTRACT**— *In China, there are nearly 300 universities and colleges establishing professional of pharmaceutical engineering at present. Meanwhile, China pharmaceutical industry is sustaining rapid growth in the past 10 years. Adhering to the concept of "Study in Practice", Chinese students are cultivated to meet the requirements from twenty-first century industrial production and development of modern pharmaceutical, and they are looked forward to become qualified pharmaceutical engineers, technical backbone or management professionals. It was introduced about some exploration and adjustment for the training objectives of pharmaceutical engineering in higher education of China in the paper.*

**Keywords**— pharmaceutical engineering, higher education, training objective, China

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## 1. INTRODUCTION

The development of the modern pharmaceutical industry began in nineteenth century. With the wide application of penicillin, aspirin, insulin, contraceptives and other drugs, the pharmaceutical industry has made great contribution to human health, also created a huge economic effect. It has become one of the pillar industries in the development of the global economy. In 2011, global sales of prescription and OTC drug sales reached \$745 billion, which were obviously more than \$707 billion in 2010 and \$688 billion in 2009. It is so exciting that 2015 global pharmaceutical sales are expected to exceed \$860 billion [1]. In the whole world, USA, Switzerland, Germany, UK, and France are the most developed countries in the pharmaceutical industry at present. The prospect for the development of the pharmaceutical industry is generally optimistic, which always shows relatively great demand for qualified personnel from the beginning of this century [2].

In China, there are nearly 300 universities and colleges establishing professional of pharmaceutical engineering at present. Undergraduate program in the major is highly integrated by the knowledge and theory systems of science, medicine and engineering as the foundation for industrial production [3]. The professional students need to learn and master theoretical courses (including mathematics, physics, chemistry, pharmacology, and pharmacy) and professional courses related with the production process of unit operation, pharmaceutical technology, pharmaceutical equipments and reaction engineering, workshop design), meanwhile they will accept the training for experimental skills together with scientific research [4], and understand related laws, policies and rules in this profession. The main goal is to teach the students about the basic knowledge and skills of chemical pharmaceutical, biopharmaceutical, Chinese medicinal pharmaceutical, pharmaceutical technology and engineering, at the same time to master the basic theory and methods of drug development technology together with engineering & equipment design, etc. Interdisciplinary study is the main feature of the major.

## 2. PROFESSIONAL BACKGROUND AND SOCIAL NEEDS

In the process of the development of current pharmaceutical industry, the shortage of senior technical talents in the field of pharmaceutical engineering is the main restrictive factor. For example, process analytical technology (PAT) has become the inexorable trend [5] of modern drug production, but many Chinese students do not study or even know it in the classroom. The technical level of pharmaceutical enterprises is still generally low in China, and related R & D ability is weak. The way and mode of business and management are relatively backward, and there exists serious brain drain problem [6]. The high-quality professional personnel are urgently needed to solve practical problems and have certain innovation

ability. Based on this background, the professional training is aimed to cultivate potential specialized persons who will become pharmaceutical engineers and management backbone personnel for the industrial production and development of modern medicine, and they can undertake social responsibility and have innovative consciousness together with practice ability of pharmaceutical engineering. The professional is not only responsible for the pharmaceutical industry to promote its health and sustainable development, but also widely provide service and support for health-care industry, chemical industry, energy and light industry, environmental protection and other industries. So it is closely related to modern civilization and basic necessities of human life [2,6].

Although in recent years the growth of world economy are slowing down, China pharmaceutical industry still could sustain rapid growth in the past decade, and the average annual growth rate has reached 20.8% (far higher than our GDP growth rate). It has become one of the key industries in the 12th five-year plan of China, and the annual growth rate is much higher than that of other industries. In 2014, terminal drug market in China reached \$215 billion (about 20% of that in world), and China has become the third largest pharmaceutical market of world [7]. With the improvement of domestic drug market and the level of production and management, China pharmaceutical industry are gradually mature year by year and has formed a complete industrial chain. At present, under the requirement and guidance of Good Manufacturing Practices (GMP, 2015 edition), China pharmaceutical industry is undergoing extensive upgradation and rebuilding. Although multinational pharmaceutical companies still have certain superiorities, the national pharmaceutical companies are rapidly growing and some representative enterprises have strong R & D capability. In the process of the rapid development of pharmaceutical industry, the severe shortage of senior technical talent is unavoidable fact. More and more professional talents are urgently needed to help China pharmaceutical industry to resolve the development problems and compete with international peers [6,7].

According to the demand of the talents from Chinese pharmaceutical enterprises in product development, efficient production, process improvement and innovation and other aspects, it is needed to adjust the outdated professional training objectives according to the national standard of pharmaceutical engineering training specification (drafted by Ministry of Education of The People's Republic of China for pharmaceutical major) and pharmaceutical engineering personnel training requirements of Teaching Guidance Committee of Pharmaceutical Engineering Specialty (TGCPES). Meanwhile, the adjustment needs to consider the actual situation of various universities and colleges. New professional orientation and training objectives are required to serve the pharmaceutical industry of China, and students must have qualified international perspective and innovation ability. So the great effort is needed for every educational worker.

### **3. EMPLOYMENT FIELD AND SOCIAL COMPETITIVE ADVANTAGE**

#### **3.1. Employment field**

Graduates of this major mainly can work in pharmaceutical, fine chemical industry and related government departments, together with enterprises, institutions, research institutes and colleges. They will be able to engage in scientific research, engineering design, new drug development, production management, quality control, sales and marketing, *etc.* In addition the graduates can also be suitable for other kinds of enterprises and institutions related with pharmaceutical engineering.

#### **3.2. Social competitive advantage**

Adhering to the concept of “Conceive-Design-Implement-Operate (CDIO)” and “Study in Practice” [8], the major of pharmaceutical engineering insists the teaching content of engineering education for the lead, and is building the training system for application-oriented technical talents with modern pharmaceutical engineering and technology. A great platform of engineering practice is being established for engineering design, process training, production management, quality control, and product development and innovation ability for the full range of multi-caliber talents. In addition, it is highly emphasized about the studying ability, innovative ability, thinking ability and application ability (as SITA abilities) besides basic theory, basic knowledge and basic skills (so-called “three basic”) of the major. So the graduates can be well received by pharmaceutical production enterprises, drug research and development units, engineering design units, drug inspection and administration departments, drug circulation enterprises and related education units. The health care products, food, chemical industry and fine chemical enterprises also welcome this kind of high-caliber talents.

#### **4. TRAINING OBJECTIVES BETWEEN UNIVERSITY AND MAJOR**

Training objectives of the major need to accord with that of the university, and is also the concretization of the latter. Under the great background of higher education and pharmaceutical industry in China, every university has similar training objectives of the major; meanwhile they maintain their own features at different degree. For instance, Sichuan University is one of key universities of China under the direct supervision of Ministry of Education, which is located in West China. It has a comprehensive range of disciplines covering 11 categories, namely, science, engineering, medicine, economy, management, liberal arts, law, history, philosophy, agriculture and education. The university has strong strength in science and research, and has made remarkable achievements over the years. It has 9 national key laboratories and engineering centers, 9 key laboratories and 4 engineering research centers under the supervision of Ministry of Education, 9 national centers for talent training, scientific research and teaching, and 7 national experimental teaching demonstration centers. On the basis of the management system of department-focused, teacher-strengthened, students-centered, Sichuan University adopts the approach of student-centered, research-respected and excellent standards to realize the cultivating targets that every student should have deeply humanities, profound professional knowledge, strongly innovative deal, broad international horizon. In the process of achieving these goals, the university takes measures in the following aspects: (1) open mainly research-oriented lab to undergraduates for research training program and encourage students to take part in the teacher's research group; (2) adopt the modern teaching ways to promote teaching reform and research-study activities; (3) establish all kinds of cooperative relationships with famous universities aboard to improve their communicative ability and international competitiveness; (4) take a series of special steps and encouragement policies for talents selection. Supported by the great platform of talents-cultivating, the training objectives of the pharmaceutical major in Sichuan University is adjusted and determined as following:

Training students to adapt to the twenty-first century industrial production and development of modern pharmaceutical engineering and become qualified pharmaceutical engineers, technical backbone or management professionals. Graduates should systematically master the basic theory of modern pharmaceutical engineering, basic knowledge and basic skills together with related basic theory of modern science and technology, who can work in the fields of technology and process development, engineering design, production development and management, quality management and control, *etc.*

#### **5. TRAINING REQUIREMENTS**

Through repeated discussion and collecting extensive suggestions and comments from teachers, experts, employers, students and graduates, training objectives of the major have been adjusted and corresponding cultivation requirements are listed as follows:

(1) Profound cultural deposit and scientific literacy, together with good humanistic quality, social responsibility and legal concept. Teach them to meet the social requirements for inter-disciplinary pharmaceutical talents with good team spirit, communication and coordination ability and professional ethics; Train them to have strong mental endurance, treat difficulty and setback correctly in work and life, and show perseverance and indomitable spirit.

(2) Solid professional theory and basic knowledge of related science and industry, together with good learning, thinking and professional development ability. Train them to comprehensively understand the technological frontier and development trends of pharmaceutical industry.

(3) Good technology development and engineering management ability; Competent for the work in technology improvement and supervision, production management, quality management and control, technology and product development, process and engineering design, drug circulation and business operation, *etc.*

(4) Innovation consciousness, ability and international perspective; Being good at exploring the problems in pharmaceutical R & D and production practice, and learning to offer specific proposals and measures for these problems on the basis of the pharmaceutical professional knowledge; Good cross-cultural communication, cooperation and competition ability.

## **6. CULTIVATION OF INNOVATIVE CONSCIOUSNESS AND ABILITY**

Nowadays innovation is the core competitiveness of a country, so China universities are making great efforts to improve the innovative consciousness and ability of students in every major [9]. For instance, in the training of pharmaceutical engineering undergraduates in Sichuan University, in addition to classroom professional teaching and humanities edification, it is also emphasized and strengthened for their innovation consciousness and technological innovation ability through the following ways:

### (1) Plenty and various kinds of experimental training

Pharmaceutical engineering laboratory and experimental platform are well established and operated by experimental center in the school of chemical engineering. Based on all kinds of facilities and instruments, the students are trained with the experimental operation and simulation research systems. Solid models of equipments and workshop can be viewed even made by themselves. In the whole professional experiments, the percentage of design and integrated experiments is more than 50%; meanwhile there is enough space and funds for extracurricular innovative experiments and R & D training. Various small inventions are always welcomed by students and actively encouraged by their supervisors, and many of them are not limited to the field of pharmaceutical engineering. Some excellent students have become the patent owner, and it is very helpful for them to independently start their own business in future.

### (2) Characteristic competition platform

The academic competition helps to arouse and foster college students' interest and potential, competitive awareness, innovative spirit, practical skill, consciousness of teamwork, and broaden knowledge. Up to now, there many characteristic competitions which students can choose and participate in. They include "China Student Poster Competition in Pharmaceutical Engineering" (also as China regional seeding match for International Poster Competition in Pharmaceutical Engineering, the first prize winner in the first competition of 2010 was funded to participate in the ISPE global annual conference held in Dallas in November, 2011), "China Student design Competition in Pharmaceutical Engineering", "Drug Court Forum of Chinese Students", "Challenge Cup-extracurricular technology works competition" and so on, which are providing strong support for the development of higher education of Chinese pharmaceutical engineering.

### (4) Rich and colorful courses

In the classroom of Sichuan University, the seminar and design compulsory courses are always encouraged to open as more as possible. For example, the study of "drug research and development" and "chiral pharmaceutical technology" (each 2 credits) needs full discussion among students, who are divided in several small groups and asked to prepare their topic materials carefully before class. In the seminars and "International curriculum and practice" week, the experts from industrial circle can provide many rare opportunities of case analysis and discussion [10]. The teaching mode of "Flipped Classroom" is being well studied and applied by more and more Chinese teachers. Through the conversion of above teaching methods and training modes, it is expected to efficiently cultivate students' innovation consciousness and ability.

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