Status and Prospects of Mineral Processing Postgraduate Education in China

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This paper documents the current situation of Mineral Processing Education in China with an emphasis on Postgraduate Education.

Overview

Rapid economic growth is driving a rapid increase in student numbers in Higher Education Institutions (HEI) China, as shown (Figures 1 and 2). Currently 40% of all Chinese 18 – 21 year olds enroll for University education. This translates to over 4 million students enrolling in undergraduate degrees, 600 thousand master's degree enrollments and approximately 20,000 PhD students.

Fig. 1: The percentage of all 18-21 year olds in China who enroll as undergraduate students

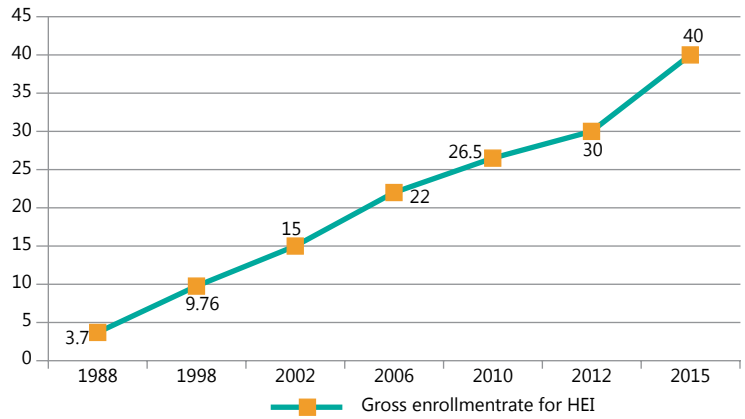
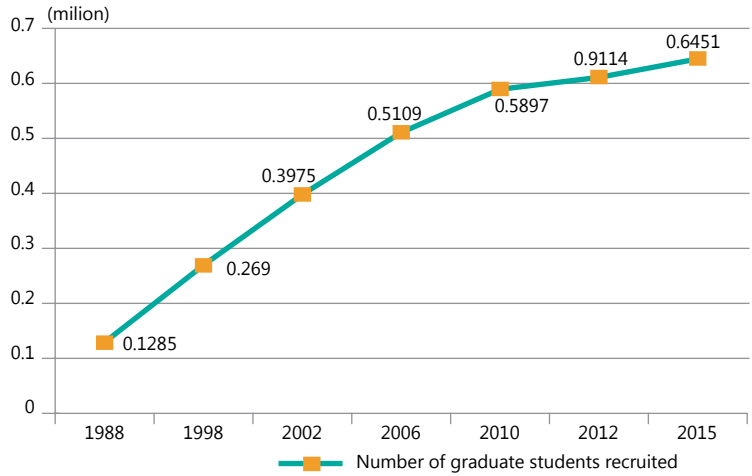


Fig. 2: The annual number of students recruited in postgraduate education



History

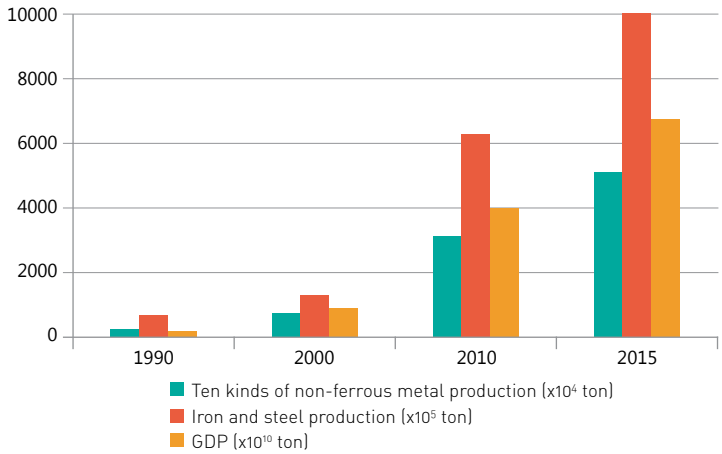
Mineral processing education in China began with Peiyang University, which started to offer Mineral processing education in the 1920s. Shenyang Institute of Technology (now called Northeastern University) introduced a program some years later, and has been offering undergraduate education in the field since 1949.

Central South Institute of Mining and Metallurgy (Central South University has been offering undergraduate education since 1952, masters level education since 1956 and PhD education since 1984.

The status of mineral processing in the national economy

The demand of metal and mineral resource is increasing year by year, with the rapid economic development, and mineral processing is essential to support last year more than 40 M tonnes of non-ferrous metals and more than 8000 M tonnes iron and steel.

Fig. 3: Metal production growth in China 1990 to present



The University sector is expanding rapidly in response. In 1990 only 23 universities had minerals education, but now there are many more. The number of universities teaching minerals processing are shown below.

Numbers of Chinese Minerals Processing University Programs		
39 Undergraduate degree programs	28 Master's degree programs	14 Doctoral programs

Central South University student numbers are about 140 per year undergraduates and about 50 per year of master's degree students.

Postgraduate Education of Mineral Processing

In China, Mineral Process education falls under the category of "Engineering", which also includes "Mining" and "Safety Technology":

- Philosophy
- Economics
- Law
- Education
- History

- Engineering
- Agriculture
- Science
- Medicine
- Management
- Art

The Mineral Processing discipline is divided into the following five areas, according to the kind of minerals being recovered. This is not necessarily the same as the way it is done in other countries.

Classification of Chinese Mineral Processing programs:

1. Non-ferrous Ore Processing
2. Coal Dressing
3. Ferrous Metallurgy
4. Mineral material
5. Secondary Resources, Recycling and Cleaner Production

Content of Chinese Mineral Processing Programs

Undergraduate programs

Students generally study for 4 years, with the first 2 years covering basic courses and the third and fourth years more specialised courses.

Table 1: Elementary course of undergraduate student of mineral processing (first 2 years of study)

English	Experimental Chemistry—Basis of Inorganic and Structural Chemistry
Engineering Drawing	Experimental Chemistry— Base And Synthesis of Organic Chemistry
Engineering Mechanics	Experimental Academic Chemistry—Synthesis of Inorganic Compound
Mathematics	Physical Chemical Experiment

Physics	Manufacture engineering training
Physical Chemistry	The Fundamental of Computer Programming C++）
Electrical Engineering	Experiments in Electrics and Electronics
Linear Algebra	Practice in Electrics and Electronics
Fundamentals of mechanical design Basic	Analytical Chemistry Experiment
Principles of chemical engineering	College physics experiment

Table 2: Major course of undergraduate student of mineral processing (third and fourth years of study)

Accessory Equipments on Dressing Plant	Experiments on Minerals Processing	Process Monitoring and Control in Minerals Processing
Project construction and Production management	Cognition Practice	Application of Computer in Minerals Processing
Comminution Engineering	Production Practice	Project construction and Production management
Physical Separation	Graduation Practice	Introduction to mineral processing
Flotation	Graduation Thesis (Design)	Reagents in Minerals Processing
Research Methodology on Minerals Processing	Technological Economy in Minerals Processing	Minerals Processing (Bilingual Teaching)
Comminution Engineering	Environment Engineering in Mining Industry	Chemical Separation in Mineral Processing
Engineering Design on Minerals Processing	Cleaner Production and Circular Economy	Process and Equipments of Renewable Resources

Postgraduate programs

Postgraduate programs generally have the following fundamentals courses of study, which include non-technical studies such as English and as well as technical courses:

- English
- Numerical Analysis
- Statistics
- Chemistry
- Fluid Mechanics

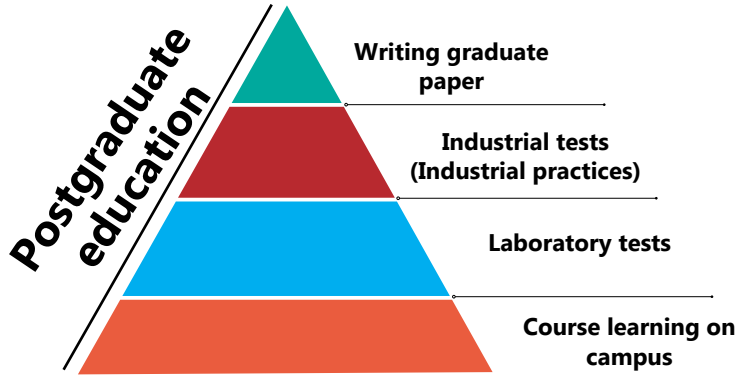
The specialist course in postgraduate programs depend on the commodity being studied. Examples of subjects studied in postgraduate programs are shown in Table 3.

Table 3: Postgraduate programs: example of major specialist courses in Postgraduate Mineral Processing Programs in China

China Southern University (CSU) **course of non-ferrous ore processing**	Flotation solution chemistry Flotation reagent molecular design Theoretical electrochemistry Measuring and testing technique of Mineral Processing Mining economics Mineral crystallochemistry Interaction between particles and fine particle flotation
Major courses in Coal Dressing	Technology of producing cleaned coal Theory of two-phase flow Process simulation and optimization Powder engineering Colloid and interface chemistry Mining engineering numerical calculation

Major courses in Ferrous Metallurgy	Metallurgical kinetics Metallurgical thermodynamics Metallurgical reaction engineering Metallurgical melt Direct reduction and smelting reduction Iron and steel metallurgy process mineralography New technology of iron ore comprehensive development
Resources and Environmental Science	Inorganic materials structure-activity theory Solid material chemistry Material modification Structural chemistry Structural chemistry of porous materials Materials synthesis and preparation Ceramic matrix composite
Secondary Resources Recycling and Cleaner Production: Environmental Science	Environmental impact assessment Industrial water treatment Renewable resources sorting and utilization Solid waste pollution control and resource recovery Separation science and engineering Physical separation

Fig. 4: Broad postgraduate educational outcomes



Central Southern University

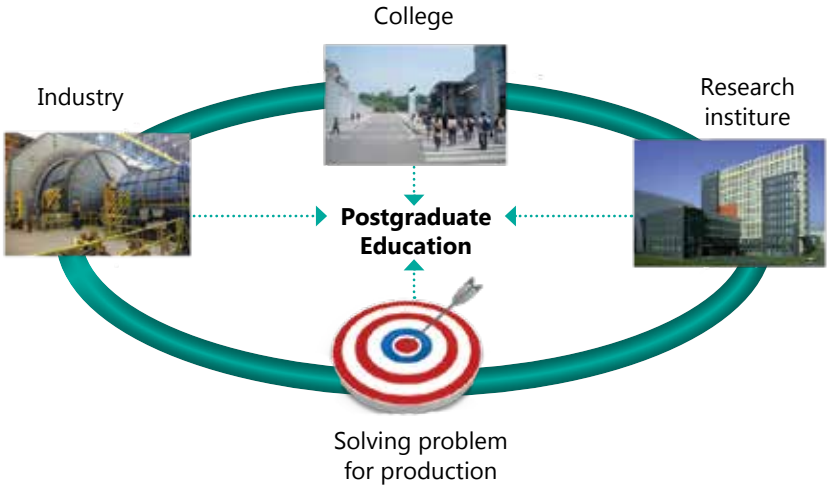
Post graduate study programs combine theoretical knowledge with practical work in laboratory, pilot plant and industrial situations. It is not uncommon for students to spend 3 – 6 months or longer in industry dealing with real industrial problems.

Postgraduate students develop much more than just technical skills. They often take advantage of additional learning opportunities and spend longer than the minimum time; with masters students taking up to 3 years and PhD students taking up to 4 to complete their degrees. They are closely associated with research institutes and other high level researchers, and international seminars and conferences are held regularly.

In 2016 there were about 500 master and 100 PhD graduates. The Choices of these graduates after graduation were:

- Further education both in China and Overseas (~20%)
- Universities and Colleges, Research and Engineering institutes (~40%)
- Related industry, i.e. Ming and Processing plant operations, equipment/ manufactures (~20%)
- Others (~20%)

Fig. 5: The postgraduate learning environment



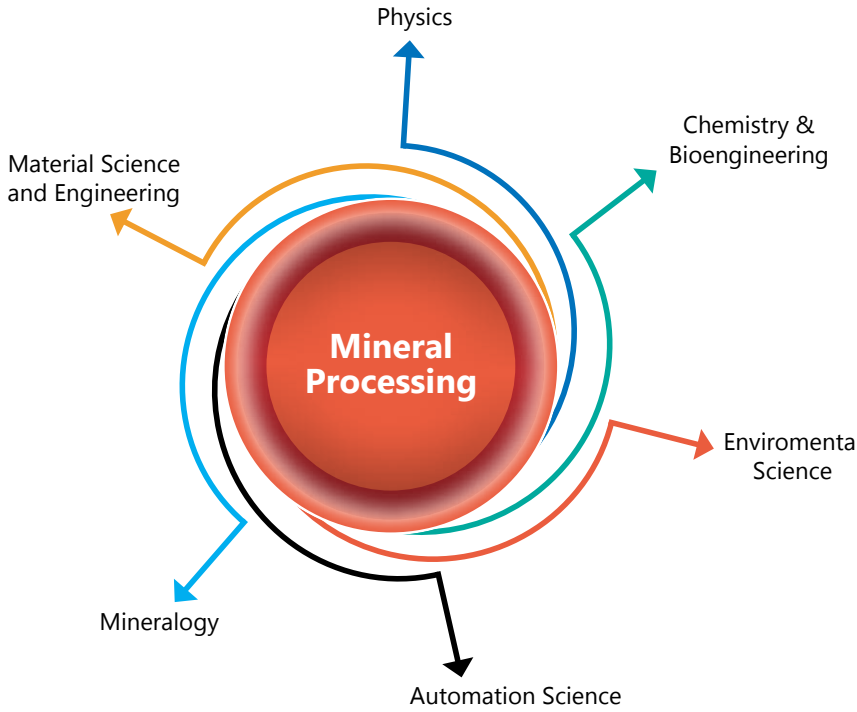
Chinese Postgraduate Education in the Future

The mineral processing education suffers many challenges in China:

1. The increasing pressure of obtaining employment after graduation due to the influence of the current economic downturn
2. The less attractiveness of mineral processing as a profession to graduates
3. The imbalances of skill training between different colleges.

Interdisciplinary developments offer new opportunities for growth in developing mineral processing in China. The graduates with wider knowledge and more skills could obtain more opportunities in the future.

Figure 6: Mineral Processing as a multi-disciplinary area



Summary

Postgraduate education in China been developing and improving rapidly for nearly a decade. Mineral processing has made a significant contribution to the economic development of China; The postgraduate education pays close attention to solving practical problems of industrial production in China. With the transformation of economic structure, the mineral processing education in China also faces many challenges. There are also opportunities, and interdisciplinary development provides a new opportunity for growth in developing mineral processing in China.