

# **Educating and Training of HVAC Engineers and Technicians in China**

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## **1. History of Chinese HVAC professional education**

Since P. R. China was founded in 1949, the main approach of training heating, ventilating, and air conditioning (HVAC) engineers and technicians is by professional education in a few universities and two-year colleges and technical schools/polytechnics. After economic reform of the 80s, higher education in China has been well developed, and universities have become the main resource of educating HVAC engineers for design and R & D. Meanwhile, some universities are involved in higher vocational education of HVAC engineers and technicians who will be in charge of system operation and management. Some technical schools offering subject area of hotel services management also train HVAC technicians and skilled workers for hotel HVAC&R system installation, operation and maintenance.

The Chinese higher education in the HVAC field started in the beginning of 50s. Following the education system and the subject setting of the former Soviet Union, the undergraduate program of 'Heating, ventilating and gas supplying' was first set up in 1952 in the following universities: Harbin Technical University, Tongji University, Northeast Institute of Technology, and Tsinghua University. These universities started admitting undergraduate students of HVAC subject since 1953, and the first two-year college students graduated in 1954. Until 1966, a total of eight Chinese universities have undergraduate courses in the HVAC subject, graduating about 500 students per year.

The curriculum model of HVAC in the 50s mainly followed the universities of former Soviet Union and some adjustments were made to meet the need of Chinese development status. The entire curriculum model of HVAC is basically 5-year system except Tsinghua University's 6-year system. The program of the HVAC subject is aimed at meeting the need for professional HVAC engineers. Therefore, both fundamental theories and professional courses are emphasized. The teaching arrangement for the program is fixed, and students must follow the fixed procedure and lack of flexibility. There were many professional courses with long hours and quite idiographic contents. The practical training was emphasized. It included 'installation practice', 'section chief practice' and 'operation practice'. Trained by so many professional courses, student became competent in practical design and installation work upon or a couple of months after graduation. It met the immediate demand for HVAC engineers and technicians in the 50s and 60s.

Until the 80s, the Chinese HVAC industry was limited to heating in the area north to the Yellow River, and ventilation and air-conditioning in some industrial buildings. With China's high economic development since the 80s, HVAC applications have been significantly expanded. The heating region has been extended to mid-south China, the newly developed high-tech industrial buildings need much more advanced indoor climate control, and room air-conditioners have been widely used in urban families. The rapid increase in HVAC application brought on not only the HVAC product sales 10 times increase in 20 years, but also the rapidly increasing demand of HVAC professional practitioners. The number of the universities and colleges offering HVAC

undergraduate courses increased from eight in 1977 to 90 in 2001. These universities and colleges graduate over 6000 students per year in the HVAC area. These graduates are working in the fields of HVAC system planning and design, installation, installation survey and management, HVAC product R&D, operation and maintenance management, TAB and commissioning, research and consultancy, etc. Considering the current speed of construction development in China, the number of professional practitioners is still far from sufficient.

## **2. Evolution of HVAC education mode in Chinese universities**

With the development of new technologies in the 90s, the HVAC practitioners are required to be much more comprehensive than ever, because the problems of energy, natural resource, environment, and human health have to be considered collectively. More and more building design firms complain that too few comprehensive HVAC engineers can be found and employed although they have very good heating engineers, ventilation engineers or refrigeration engineers with very idiographic knowledge of their work. It is more difficult to find engineers who are familiar with all the subject areas of water supply and sewerage, lighting, building automation, and HVAC system. Traditional education mode used to cut the knowledge system into many idiographic technique aspects, and had them at student's finger ends. It cannot meet the new demand for the comprehensive HVAC practitioners and has to be changed.

With the economy development in China, people pay more and more attention to their comfort and health. Sustainability has become an emphasis in Chinese urban construction. A building should be more efficient in energy and resource utility consumption, more natural friendly and healthier to the occupants. Therefore, the tasks that an HVAC engineer has to face to will be:

- ◆ HVAC system planning and design, or P & D consultancy
- ◆ HVAC system installation or installation survey and management
- ◆ HVAC equipment R & D
- ◆ Urban energy system (heating, gas piping, etc.) planning and design, or P & D consultancy
- ◆ HVAC system optimal operation and maintenance, or O & M management
- ◆ Building automation system design, installation, TAB or commissioning
- ◆ Building energy and environment/HVAC system commissioning
- ◆ .....

Therefore, the HVAC practitioners should acquaint themselves with knowledge covering fundamentals of environment, resource, mechanics, electrics, and the relationship among human, building and nature. They should well understand how the various climate types, resource conditions, culture and folk-customs and economy levels throughout such a far-flung territory effect on the HVAC system design, operation and product characteristics. That is why an HVAC engineer is required to be much more comprehensive than ever. In order to meet the new demand for HVAC practitioners, the HVAC subject in universities has been newly named 'Building Environment and Services Engineering (BE&SE)'. Thus, to build a built environment rather than the limited measures becomes the most important task of HVAC engineers.

Supported by Chinese Ministry of Construction, Chinese HVAC academia studied the education modes from different developed countries, such as education modes of US generalist mechanical engineer, Japanese building services engineer with solid knowledge of architecture and framework, UK building services engineer with encyclopedical professional knowledge and so on. They are trying to accumulate excellences from the successful countries to set up a new education

mode to meet Chinese demand.

According to the document of education program of Chinese National Higher Education BE&SE Academic Discipline Committee, the purpose of BE&SE professional education in Chinese 4-year university/college (Bachelor program) is to “bring up the advanced practitioners with solid background of fundamentals, comprehensive knowledge, high capacity and creativity to meet the demand for 21 century of China. The graduates should be able to do work related to building environment control for industrial, commercial, and residential buildings. They should have the abilities of design, installation and operation of HVAC system, urban energy system and water supply/sewerage system, the abilities of working out the scheme for building automation system (BAS), and the primary abilities of R&D. They should be competent for technical work, management and business in such places as design office, research institute, facility management and industrial enterprise.”

This statement indicates that educating HVAC engineers with ability of R&D and management is the goal of China’s higher education in HVAC. Some reputable universities such as Tsinghua university aims at educating chief engineers and advanced researchers in the field of building environment control. In addition, some universities set the Master of Engineering programs (2~3 year after Bachelor) to bring up chief engineers and advanced researchers.

Recently, many universities have done lots of good work to expand coverage area of both the academic and professional curricula to replace the traditional idiographic polytechnic training. From their different background and major employers of their graduates, universities will decide their own direction. For example, some universities specialize in manufacturing the mechanical equipment such as chillers whereas some other universities specialize in urban district heating system. However, their graduates are all required by the demand for having comprehensive knowledge of HVAC system and the relationship between HVAC system and occupants and between HVAC system and building. The current academic curricula of HVAC subject in most universities include mathematics, physics, chemistry, mechanics, hydrodynamics, thermodynamic, heat transfer, built environment, electricity, measurement, automation, computer science, fundamentals of architecture, etc. The professional curricula include HVAC system, refrigeration and energy system, building automation, urban district heating, clean room technology, energy conversion and conservation, lighting, water supply and sewerage, etc.

Project curriculum is one of the very important comprehensive trainings to the students. This program aims at training students first to grasp key points from the view of energy conservation and system performance, then to use science fundamental to solve professional problems. For example, in the course of HVAC system design, the first task is technical economy study from the view of energy, environment, performance, economy and the application requirement. The best balance should be fully discussed in the report of this stage. After students decide what kind environment control strategies should be adopted, what kind of HVAC system and plant system should be used in their building, they will continue the extended design and finally submit construction drawings. Such design courses usually take at least half year. Some universities require students to take a half-year intern in a design firm. Some other universities, such as Tsinghua University, encourage students from architecture and building services to work jointly to design a building. In this way students with different backgrounds are trained to work together. It has been proved by practice that project curriculum is very important in developing the basic concepts of HVAC engineers.

On-site practice is another effective method in training HVAC engineers. The practice includes

metal processing practice, HVAC system installation and construction, HVAC equipment manufacturing, HVAC system total adjusting and balancing (TAB), and building optimization and fault diagnosis and detection (BOFDD). The metal processing practice is required to all engineering undergraduate students, and it usually takes place the first summer of sophomore year. There are two required site practices related to students' major. They are usually arranged in the summer, each lasts about four weeks. Different universities have different emphasis of practice according to their own educational objectives. Those focusing on training HVAC design and construction engineers usually have installation and construction practice. Those focusing on educating mechanical engineers usually have HVAC equipment manufacturing practice. Those focusing on educating chief engineers of building equipment and BAS engineers usually have HVAC system TAB/Commissioning/BOFDD practice. Advisors include professors who are familiar with practices, trained graduate teaching assistants, and HVAC engineering practitioners. At the end of the practice, students are required to submit summary reports to the building owner or design firm, and the reports are used as the basis for evaluating students' performances. The difficulty for site practice is finding appropriate projects and lack of financial support. Nevertheless, universities have done their best to make it happen. For example, one way to solve the financial problem is that the practice team solves actual HVAC system problems for the building owners. They get paid as a reward.

In order to enhance students' research capability and creativity, it is necessary to provide students with necessary research training. Many universities require students to take some simple research projects. At the end of the projects students are required to deliver research reports and defend. Some prestigious universities require students to conduct research for about half year. The subject is usually a complete HVAC application problem. Sample project titles are "Status and problem of the VAV system in Beijing," "Optimized operation plan of an ice-storage air conditioning system." In many universities, such research projects are required for graduation (so called "graduation thesis").

Students must complete the required course credits, all the required on-site practices, design training, and research project before being awarded for a bachelor's degree. The degree is required for partial fulfillment of HVAC assistant engineer.

### **3. Perspective**

Presently, students graduated with bachelor's degree are first hired as an assistant engineer. They can be promoted to engineer after necessary training and gaining more experience, and further to the level of vice senior engineer and senior engineer (equivalent to professor). Their qualifications are certified by the National Ministry of Human Resources and are recognized nation wide.

In order to conform the international track and differentiate between the employer's professional position with the professional qualification, the Ministry of Human Resource and Ministry of Construction established the registered (licensed) engineers system for exploring and design. The registered building services engineers system will start in 3 to 5 years. The educational certification for registered building services engineers is being initiated. The certification committee composed of members from engineering and academia has been established. Relevant policy, standard, and method have been set up. Several universities will first be certified in 2002. Students graduated from certified universities can apply to take the registered building services engineer tests. It takes much longer time for graduates from uncertified universities to take such tests.

Presently, Chinese higher education is still mainly focused on degreed education. However, the

fast development of HVAC industry in China has lead to insufficient supply of technical professionals. Meanwhile, the fast renew of technology required new technology structure of HVAC technical personnel (design, construction). The HVAC system operation and maintenance people (technicians, technical worker) of many commercial buildings need to be better trained to maintain the HVAC system. Thus, professional training to these people is very promising. The emergency and spread of remote education in China in recent years makes it possible. At the time, the remote educational network for training building equipment systems and technical personnel is being set up in Beijing. The network can cover the whole country. It can offer better technical courses and advanced professional courses to both university students and non-degree professional education.