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The status and role of advanced chemistry in the civil engineering personnel training

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ABSTRACT

Advanced chemistry is a basic required course to implement the education idea of strong foundation, broad extension and multi direction, and cultivate the compound and practical civil engineering talents, which plays a very important leading role in the whole course system. Study the teaching mode, teaching methods, training goal and its application in civil engineering and demonstrate its important position in civil engineeringby the way of example, investigation and comparative analysis. (1) Analyze the chemical action and reaction between materials, and demonstrate the important role of advanced chemistry to the design, construction and operation of civil engineering. (2) Study the mechanical characteristics of engineering structure and the chemical properties of materials, thus put forward the important theoretical foundation and technical support provided by advanced chemistry to the development and improvement of engineering materials. (3) Establish the teaching mode of combining classroom teaching and project examples, and demonstrate the irreplaceable position and functionof advanced chemistry in the field of civil engineering. The course should be adjusted continuously in the education system and curriculum system, enriched and perfected in the optimization process to meet the needs of talent training and the demand of teaching of new era.

Key words: advanced chemistry; civil engineering; talent training; training objectives; position and function

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INTRODUCTION

Advanced chemistry is a theoretical, experimental, exploratory and appliednatural science which mainly studies atom, molecule, biomolecule and supermoleculeand the composition, structure, property, chemical reaction of their condensed state and its law and application. Health, environment, food and resource utilization which is most concerned by people are closely related chemical science. Chemistry is in the center of natural science and at the same time as the axis of physics and natural science. Therefore, it is imperative to establish the status of chemistry in the whole society.

Abroad studies of advanced chemistry started earlier. E. V. Suleimanov,N. G. Chernorukov[1]studied magnesium and calcium with chemical principle and applied the research results to the improvement of geotextile materials to improve its strength and performance. Erik E. Santiso,MarcoBuongiornoNardelli,Keith E. Gubbins[2]studied the chemical properties of hydrocarbyl structure with organic chemistry principle and verified the chemical properties with experiments. E. A. Shokova,V. V. Kovalev[3]analyzed the structure of atom and molecule according to the theory of chemical reaction and theoretically studied with the organic and inorganic chemistry. The domestic research mainly focus on the study of German higher chemical education mode done by Cheng Guang-bin who put forward some concrete measures to adapt to the innovative talents training in the new century and construct the training mode of new chemical engineering talents from the aspects of teaching content, the unity of teaching and research, teaching system and goals. GuoTong-kuan put forward that higher chemical education should foster all

kinds of “high quality” chemical expertise to adapt to the establishment and development of market economic system. Sun Xi-meng stressed that chemistry is a compulsory course for non chemistry majors, and introduced the necessity of chemistry learning combined with the teaching plan and knowledge structure of civil engineering. Luo Ling proposed to explore a set of scientific and feasible teaching methods of chemistry course in civil engineering to improve the teaching quality and train qualified personnel for modernization construction. In addition, Shen Pan-wen, Zhan Shu-zhong and ZongLan also conducted a lot research on higher chemical education and achieved fruitful achievements.

However, most researchers only focus on the advanced chemistry itself and talk little about the effect and significance of advanced chemistry in civil engineering talents training. At present, there are limitations and differences in the opening of advanced chemistry. Some universities only have this course for chemistry majors, and it is still in the imperfect stage for non chemistry majors. Meanwhile, the deduction and induction methods are hardly used in the college chemistry course.

In order to pay more attention to the advanced chemistry and improve the chemical quality of non chemistry majors, the chemical educators are facing arduous task. They should not only cultivate advanced chemical talents, but attach great importance to chemical education suitable for the development of the times and for non chemical majors. This paper will launch a series of new states of advanced chemistry in the aspects of civil engineering structures, mechanics and materials to reflect its status and function in the civil engineering personnel training.

THE IMPORTANCE AND NECESSITY OF ADVANCED CHEMISTRY IN THE MAIJOR OF CIVIL ENGINEERING

As a basic subject synchronously with economy and basic construction, civil engineering raises a higher demand for talents training. Along with the intercommunication between advanced chemistry and civil engineering, it is a professional requirement for the students of civil engineering to master elementary chemical knowledge. Advanced chemistry analyzes the chemical reaction and interactions between materials from the micro and macro views which will play an important role in the design, construction and operation management of civil engineering. In a word, explore a set of scientific and feasible chemistry teaching methods in the major of civil engineering and improve the teaching quality is of great significance to the training of civil engineering talents[4].

The rapid development of science and technology and the changing demand for talents initiate the great reform in the cultivation mode of engineering talents[5]. The universities are revising the training program constantly to meet the social demand for talents. In the study of advanced chemistry, the civil engineering majors experience the connection of chemistry and their major which urge the students to understand, analyze and solve problems from different angles, cultivate the students’ sense of participation, decision-making ability, scientific and humanistic spirit so as to improve their comprehensive ability. This will lay a significant foundation to cultivate all-round, professional and application-oriented talents of civil engineering, and highlight the importance and necessity of advanced chemistry in civil engineering education.

IMPORTANT APPLICATIONS OF ADVANCED CHEMISTRY IN CIVIL ENGINEERING

In the civil engineering professional knowledge system, the courses of mechanics of materials, construction materials, and concrete structure design principle and masonry structure are all closely related with chemistry[6]. As a compulsory course, advanced chemistry not only provide theoretical basis and technical support for the professional courses and the development and improvement of geotextile materials, but also recognize that a large civil engineering involves environmental protection, engineering quality and anti corrosion structure which are related to chemistry.

We’ll state the extensive application of advanced chemistry in civil engineering from different perspectives to fully reflect its effect.

In the design and construction of Cross Sea Bridge, aiming at the corrosion problems of foundation steel structure and concrete structure, a series of technologies such as watertight and anti crack concrete, epoxy coating steel or stainless steel, anti-corrosion coating concrete surface should be used. Therefore, if there’s no relevant knowledge of chemistry, it is hard to successfully complete the design and construction of such a huge project.

To solve the problem of large span buildings, advanced chemistry provides the theoretical basis for the solution. For example, the Millennium Dome in Britain which located in the Greenwich peninsula at the Thames in East London is a landmark which is built by British government to meet the 21st century. The diameter of the dome is 320m, the circle is greater than 1000m with 12 masts which piercing the roof up to 100m, and the tensile membrane structure of spherical shape is used in the roof. The membrane is supported in the 72 radiating cables which cross section is 2×φ32. These cables are supported by the cable-stayed slings and lanyards with the space of 25m, and the slings and

lanyards stable the masts up at the same time. Due to the light weight of membrane material and the great tensile strength, membrane structure can fundamentally overcome the difficulties (no intermediate support) encountered in the traditional structure of large span buildings.

The development of civil engineering has experienced the ancient, modern and contemporary periods, and each period has its representative engineering materials. In ancient times, geotextile materials were mainly natural ones such as soil, wood, grass and stone. Later on, artificial fired tiles and bricks appeared and that was a turning point in the history of civil engineering. In modern times, cast iron, steel, concrete, reinforced concrete were widely used until the use of early prestressed concrete. Modern civil engineering is based on the modern engineering materials which tends to be light and of high strength. In recent years, the engineering materials such as aluminum alloy, coated glass, gypsum board, constructional plastics and fiber glass reinforced plastics develop rapidly. Meanwhile, by adding different chemical admixtures, a variety of concrete materials with special properties are developed. For instance, quick drying cement is made by the addition of gypsum, retarded cement is made by adding lignosulphonate and waterproof cement is made by adding fatty acid salt. The appearance of these new materials and the improvement of the traditional materials are in the background of the development of chemical theory and practice.

The implementation of many typical building projects around the world is related to new chemical building materials. For example, the special steel material Q460 used in the construction of large span steel structure of the National Stadium “Bird’s Nest” is made by regulating the proportion of carbon and iron and adding some alloy elements. The membrane structure of National Swimming Center “Water Cube” is a new building material form constructed by PTFE membrane which is light, heat-resistant, cold-resistant and corrosion resistant. All these properties are inseparable with the stable chemical structure, acid and alkali resistant of PTFE. The new plastic track inside the stadium is made of organic polymer, inorganic polymer and pigments. The project quality is closely related to the content of each component. Inorganic filler can make the track with corresponding strength, while more organic elastic components can keep the good toughness of the track[7].

The development of “green building materials” is the inexorable trend of China’s building material industry in 21st century. “Green building materials” is using clean production technology, less natural resources, large industrial solid waste and straw to produce non-toxic, pollution-free and non radioactive building materials which is beneficial to the environment and human health[8]. Meanwhile, green chemistry is advocated so that every inch of building materials is fully used[9]. To save energy and protect environment, our nation stipulate that heat insulating material which is polymeric foam material with chemical synthesis must be used in the external wall of the new buildings. Phenolic foam material, which is known as “the king of heat insulating materials”, is the most promising new heat insulating material which is internationally recognized. It has many high quality characteristics such as non-toxic, corrosion resistance, high temperature resistance, not easy to burn and no emitting toxic fumes and its comprehensive properties is incomparable by other heat insulating materials. However, polystyrene foam board is also used as the external wall heat insulation material at present. Although it is heat insulating, it is inflammable and has massive toxic smoke when burning, thus once on fire, the results must be serious. Hence we can see that the properties of these civil materials are determined by their chemical compositions.

Through the states from different angles, we deeply understand that advanced chemistry has profound significance and role in the civil engineering. At the same time, as a highly research subject, advanced chemistry has broad prospect to be thoroughly implemented into other science and engineering majors. So the research work of advanced chemistry must be completed to make its influence more extensive and far-reaching.

THE TEACHING METHODS OF ADVANCED CHEMISTRY IN CIVIL ENGINEERING

(1)Organizing teaching syllabus based on “strengthening foundation, widening caliber, combining foundation and frontier”.

Teaching syllabus is the specific embodiment and implementation of the teaching plan, and is the programmatic document guiding the teaching work and specifying the teaching behaviors. According to the teaching plan of civil engineering and the teaching syllabus of inorganic chemistry, the selection of this course laid the foundation for the follow-up major courses.However, there are some problems as teaching material lagging and less class time in the teaching of advanced chemistry related to engineering majors. Aiming at this situation, we should strengthen the extensive exchanges with the domestic counterparts. On the basis of sufficient argumentation, aiming at the cognitive rules of undergraduate engineering students and based on “strengthening foundation, widening caliber, combining foundation and frontier” to write the teaching, experiment and examination syllabus of inorganic chemistry and the lesson outlines of undergraduate inorganic chemistry teachers[10]. The above teaching materials should focus on the optimization of inorganic chemistry curriculum content, put forward clear requirements for undergraduate inorganic chemistry teaching content, have a detailed description of the emphases, difficult points and doubts of each chapter,

newly increase the frontier research content of civil engineering materials[11].

(2)Grasp the function of the introduction class
The teacher plays the role as helper and facilitator in students study and its main duty is to guide and organize students, not just impart knowledge. In the introduction class, the teacher should clearly put forward the teaching methods of advanced chemistry and systematically connect with civil engineering. If the two can be closely combined, the questions of "what to teach" and "what to learn" of engineering inorganic chemistry can be solved. More importantly, through this way of teaching, the students can know the frontier development situation of civil engineering materials, stimulate the curiosity of students and increase their initiative of grasping new knowledge[12].

The introduction class will play a leading role if the students show strong interest in advanced chemistry. In the classroom teaching, we should focus on linking theory with practice and reflect the properties of intersection and integrity. Update and enrich the teaching content according to the need of specialty, increase the freshness to arouse the students' interest and improve the teaching effect.

(3)Lay stress on the combining of cases in the teaching process
Introduce the latest achievements in scientific research and some new examples in the hinterland of chemistry development in the classroom teaching as the theme research methods. 1) When teaching thermo chemistry, introduce the effect of hydration heat of cement to the mass concrete works as blast furnace foundation, pier, dam, etc... If the cement gives off a lot of heat in the process of hydration, the internal temperature of the building will rise, resulting in inhomogeneous interior stress and even cracks which will affect the quality of the project[13]. 2) When teaching the corrosion and anticorrosion of metal materials, introduce a new approach to prevent iron rusts in very unfavorable conditions such as low temperature and moisture, which is the antirust coat based on the polyaniline[14]. 3) When teaching non metal material Portland cement, introduce that the corrosion of cement pier caused by the erosion of the sea is because of the reaction of magnesium sulfate in the seawater and calcium hydroxide and tricalcium silicate in the cement. Magnesium hydrate without condensation ability will gradually replace calcium hydroxide in the hydraulic cement, thus decrease the strength of cement concrete piers, and the reaction of calcium sulfate can be further reacted with the hydration calcium plumbate in the cement to generate three sulfur hydration calcium sulphoaluminate which can make the volume greatly increased and the structure crack. The polymer such as impregnated concrete can greatly improve the strength and corrosion resistance of the concrete[15]. 4) When teaching organic polymer compound, introduce that a kind of the world's most advanced shockproof technology is developed in Japan after the Great Hanshin Earthquake. That is injecting rubber material in the beam column, even in the face of a 7 or more magnitude strong earthquake, the whole road will shake like spring but not damaged. With all these examples, the interest of the students of civil engineering in learning advanced chemistry is greatly improved.

CONCLUSION

(1)The curriculum reform of higher education has entered a new historical period. The issue of new undergraduate professional directory of civil engineering made the major formally specified in the framework of "Large Civil Engineering". As a basic course, advanced chemistry cultivate the engineering ability and innovation ability of civil engineering students step by step from the aspects of theoretical teaching, experimental teaching, extracurricular technological innovation activities and mechanics competition.

(2)By studying a large number of engineering examples, analyze the chemical action and reaction between materials and the structure and mechanical properties of civil engineering from the micro and macro perspectives. Study the chemical property of construction materials; provide theoretical and technical support to the development and improvement of professional courses and the materials in civil engineering, and demonstrate the role and status of advanced chemistry in the design, construction and operation management of civil engineering.

(3)Advanced chemistry started late in the school courses and extracurricular practice, and still has larger development space in the performance analysis of engineering materials and the deep research of professional theories. In the teaching mode and system, only by constantly enrich and perfect the teaching goal, content and methods of this course can play its role and status in cultivating civil engineering talents.

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