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Study on the Cultivation of Innovation Ability of New Energy Science and Engineering Speciality by Practical Training

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***Abstract*—New energy science and engineering specializes are oriented towards the new energy industry. It is a multi-disciplinary emerging industry requiring practitioners in this field to have interdisciplinary backgrounds, knowledge innovation and comprehensive application capabilities. The innovation ability can only be accumulated in long-term practice training. This paper expounds the example of strengthening practice training in the construction of the practice teaching system of the new energy science and engineering specialty. The results show that the reform of autonomous practice teaching based on innovation ability can strengthen the cultivation of students ' practical ability and improve their creative ability.**

Keywords—New Energy Science and Engineering Specialty, Innovative Ability, Practice Training, Practice Teaching Reform

I. INTRODUCTION

The development and utilization of renewable energy are very poor in China. In order to promote the rational exploitation of new energy sources and make up for the gaps in new energy specialized technical personnel and research team, the Ministry of Education took the New Energy Science and Engineering as a strategic emerging industry specialty in 2011, aims to cultivate national energy professional personnel. The New Energy Science and Engineering specialty is oriented towards the new energy industry, which is a new multidisciplinary industry that involves machinery, fluid, material, electric, and control science. It needs more practitioners with interdisciplinary background and ability of syncretizing knowledge. The practitioners should not only have broader background knowledge, but more importantly, have the ability of knowledge innovation and comprehensive application. In short, innovation is the essential characteristic of new energy engineer, and the cultivation of innovation ability can only be formed through long-term practice training [1,2].

Undergraduate Education and Teaching Research and Reform Project of Tianjin Agricultural University (2016-B-08)

The training objective of the Tianjin Agriculture University's New Energy Science and Engineering major is to cultivate the compound application talents who have the knowledge and ability of the exploitation, transportation, utilization, management in the fields of renewable energy and automation equipment's control in terms of energy production, bring out talents that meet the needs of companies, educational institutions, research institutes in areas of new energy industry. The major has been already setting much value on cultivating undergraduates' innovative spirit and practical ability. Innovation is a process of continuous practice and a creative practice, only by applying innovative skills in practice can we discover the essential essence of things, generate, test and imply innovative ideas and solutions, form new theories, propose new methods, and develop new technologies, create new products. Therefore, practice is the soil of innovation, innovation practice is the key to the formation and development of innovation capabilities [3,4].

In the process of building a practical teaching system for New Energy Science and Engineering, this major has improved the traditional practice teaching system by strengthening the practice and training session, carrying out independent practical teaching reforms based on the cultivation of innovative abilities in many aspects, which effectively improved the students' practical and creative ability.

II. GUIDING PRINCIPLES OF THE PRACTICE AND TRAINING SESSION

Tianjin Agriculture University's New Energy Science and Engineering major mainly trains professionals who are innovative in developing and utilizing unconventional energy resources in rural areas and agriculture. Since its research field is biomass energy, graduates need background knowledge and practical hands-on experience in the development,

transportation, utilization, management of biomass power and automation equipment and control in energy production. By combining and giving full play to the characteristics of academic research, the New Energy Science and Engineering major has built the New Energy Science and Engineering laboratories. At the same time, the major also integrated available practical teaching resources, combined scientific research superiority, made combination of school and enterprise, and constructed a practical teaching system with the aim of training students' practical skills. This system is composed of five parts: practical training, innovation training programs, innovation competition activities, participation in research projects, and social practice. They constitute an organism, form a complete system, and all parts complement each other and play a role in cultivating students' innovative ability from different perspectives. Among them, practice and training, social practice are required in the training plan, which is mainly reflected in the course design and visiting or practice at outside-school practical bases, organized and managed by the major. Innovation training projects, innovation competition activities, participation in research projects regard students as main body, independently initiated by students under the guidance of teachers; it is also an indicator of the effect of practical teaching on the promotion of students' innovative ability.

Course design, which is a bridge between theory and practice, is an important part of practical training. It can helps students digest and consolidate related curriculum knowledge, and is an important way to acquire practical skills, cultivate engineering awareness and improve creative ability. The construction of New Energy Science and Engineering curriculum design session for practical ability cultivation is an important part of the professional practice teaching system construction. Through the cultivation of students' practical ability, students' creative ability is effectively improved.

In particular, students of this specialty need to have basic drawing capability, mechanical design capability, energy transfer development planning capability, electronic device selection, welding and commissioning capability, tool usage capability, and biogas development capability. According to these ability demands, three new energy science and engineering course design is planned. The first one is "the design of tube and shell heat exchanger", which is focused on the basic mechanical design drawing ability and energy transmission planning ability. The second one is "electric practice", which is for students' electronic devices selection capability, welding and debugging skills. The third one is "series type household biogas digester curriculum design", which is for cultivating the ability of biogas development ability. The teaching content of the three course design is organically combined, covering the basic core practical abilities that the students in this major need to master.

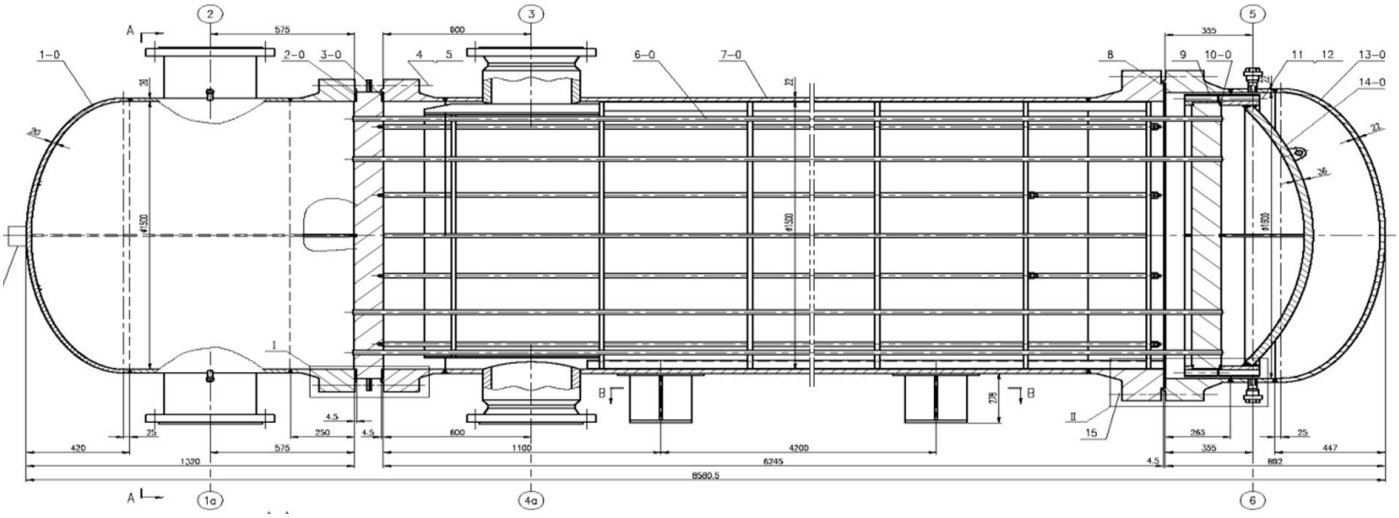

Fig. 1. Example of the heat exchanger general drawing

III. Direction of heat exchange - design of Shell-and-tube Heat Exchanger

The specific content of this course design is: design a set of Shell-and-tube Heat Exchanger, compile the design calculation manual, and draw the heat exchanger general drawing and the parts drawing. Given the initial conditions and basic requirements of the design, the design requirements include thermal calculation of the heat exchanger based on the given basic conditions, structural design and calculation based on the thermal calculation results, calculation and verification of flow resistance, and preliminary strength calculation (optional). Drawing tasks include drawing heat exchanger general drawing (A1), tube sheets part drawings (A2), tube-chambers part drawings(A3) (one component drawing, one pass partition plate part drawing), baffle plate part drawings (A3), vessel head part drawings(A3), tie rod part drawings (A3), distance tube part drawings (A3), and baffle part drawings (A3). Fig.1 is the example of the heat exchanger general drawing [5].

Through the implementation of this course design, students have developed the theoretical calculation and development capabilities of energy delivery equipment. By selecting heat

exchangers and designing detail drawings, students' drawing capabilities are cultivated and inspected, which enabled students to get an actual engineering training, consolidate theoretical knowledge, foster their ability to use theoretical knowledge to solve practical engineering problems.

The course design content is a practical application of the professional basic course "Principle and Design of Heat Exchangers". This kind of teaching methods that fits theoretical knowledge and applies theoretical knowledge to practical problems can excavate students' deep interest in learning, guide and inspire students' curiosity, cultivate students' independent thinking ability and exploration ability, students' learning initiative have improved significantly. Design content and drawings are required to be drawn manually, which exercised the basic skills of students' hand-painting ability. It also avoids the possibility of specific students directly copying the results of others, making the check results fairer. The way of designing and drawing is the main method of the product design and development of the company, the design content of this course is similar to the R&D process of the enterprise, which trains students' ability to actually engage in product research and development. The evaluation adopts a combination of standard scoring and teachers' on-site evaluation to enable students to not only have the reference to the objective standards in the process of completing the tasks, but have the presentation session after the task is completed, which enables students to realize the product design specifications and trains students' communication skills for technical issues. The evaluation is divided into the basic requirements and advanced requirements, which not only allow most students to exercise and exert their abilities, but also allow students with a better foundation to have sufficient space for promotion, which helps proceeding teach according to their ability.

IV. DIRECTION OF INDUSTRIAL CONTROL - SOLAR MOBILE PHONE CHARGER SYSTEM

The concrete content of this course design is: complete the design, welding and debugging of the solar mobile phone charger system. The requirements of design report is to write the design idea, the reasons for the selection of components and related parameters calculation process, analyze the problems appeared in the design and the solutions. Fig.2 is the diagram of charger circuit module, and Fig.3 is the flow chart of control circuit software [6].

Through this process, making students learn welding techniques, realize the correct way to using electric iron; understand different welding methods of various electronic devices and welding the required electronic products by themselves. The students will be familiar with the structure and functions of electronic components and master the operation of electric iron and other related tools. They will also learn and master the circuit board design and draw the actual circuit diagram, grasp the basic functional modules of the SCM, master the working principle of the electronic products and the installation and debugging techniques through this process, train their operating ability, cultivate the ability to connect theory with practice, improve the ability to analyze and solve problems. At last, through operation practice, students learn and realize electronic technology knowledge for further study, learn to draw electronic circuits and identify a map using design software.

The course design content is a comprehensive skills training that integrates "Electric Engineering", "Electronics Technique", "Power Electronics " and "Testing Technology Basics", this kind of teaching methods that fits theoretical knowledge and applies theoretical knowledge to practical problems can excavate students' deep interest in learning, guide and inspire students' curiosity, cultivate students' independent thinking ability and exploration ability. The execution result shows that students' learning initiative has obviously been improved.

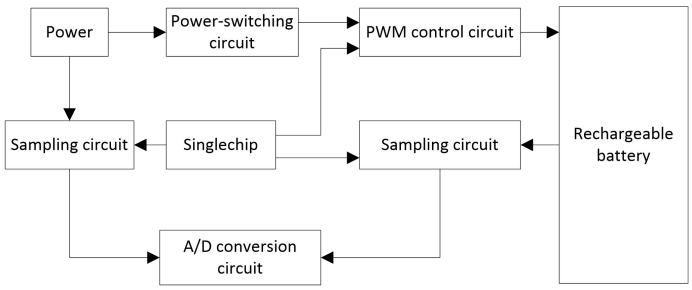

Fig. 2. The diagram of charger circuit module

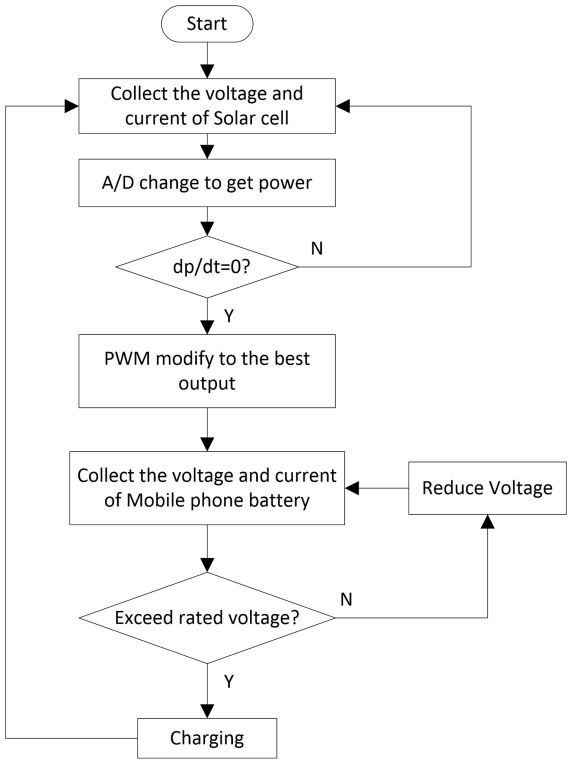

Fig. 3. The flow chart of control circuit software

V. DIRECTION OF BIOGAS UTILIZATION – THREE-COMBINATION HOUSEHOLD BIOGAS DIGESTER DESIGN

The specific content of this course design is: According to the designated fermentation raw material yield, nature and related design data, design a three-combination household biogas digester, design and calculate the related parameters of biogas digester. Complete the fermentation raw material ratio calculation, calculate and check the feed rate, calculate and design the hydraulic biogas digester, draw the design drawings and detailed part drawings of biogas digester, select the construction site and construction craft, carry out overall layout and draw sketches, design and calculate the gas transmission pipeline, design and select the pipes and pipe fittings, draw piping system diagram, estimate the social benefit, environmental benefit and economic benefit. Fig.4 is the diagram of three-combination household biogas digester [7].

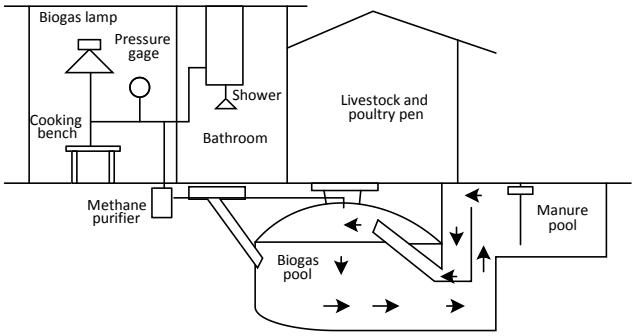

Fig. 4. Diagram of three-combination household biogas digester

The course design content is a practical application of the professional course "Biomass Energy Conversion Principles and Technologies". Compared with the "Design of Shell-and-tube Heat Exchanger", its content is more in line with real life, considering the senior students have already experienced the "Course Design of Shell-and-tube Heat Exchanger", this practical content of applying theoretical knowledge to actual problems to solve practical problems can indeed improve students' initiative in learning and improve the quality of design. The last step of the implementation process is the part of the assessment of students' presentations after course design, students are required to make presentations and explain on-site, which can cultivate the students' ability to express and communicate technical problems.

VI. DIRECTION OF BIOMASS POWER GENERATION - WASTE POWER PLANT

The Tianjin Taida Garbage Power Plant in Jinnan district was selected as a professional practice base. The Taida Garbage Power Plant is the only national "science and technology demonstration project" identified by the Ministry of Construction in the areas of waste power. The business content of the company is in line with the training of the New Energy Science and Engineering major of Tianjin Agricultural University, and the purpose of choosing this company is to let students realize the basic principles, basic processes and major equipment of biomass electricity generation. The main practice content includes understanding the process of domestic waste incineration for electricity generation, understanding the main facilities and equipment for biomass electricity generation and understanding the automatic control process of the project. The main part of the educational teaching practice consists of two parts; one is about listening to the introduction of the entire factory by the engineer who gives students technical explanations and safety precautions. The second is industrial visiting, which means students arrange into production plant in batches under the guidance of the teacher. Through this teaching practice, students' understanding of related course such as "Treatment and Resource Utilization of Solid Waste", "Fundamentals of Control Technology", "Principles and Design of Heat Exchangers", "Principles and Applications of PLC" has been improves, which helps to improve the ability of students in comprehensive practicing..

VII. SUMMARY

The students' creative ability has been effectively improved by carrying out proper reform of practice and training sessions, which enables students to reach a deepen awareness, understanding and interests for innovation activities, thus promote the innovation level and motivate the enthusiasm of students effectively. It provides necessary ideas and basis for the construction of a competence-centered practical teaching model. The work of these sessions lays a solid foundation for cultivating students' ability to analyze and solve problems, developing students' creativity and innovatory consciousness.

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