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Teaching Reform of Biomass Power Generation Engineering under the New Engineering Background

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***Abstract*—With the conception of new engineering putting forward and developing, it is particularly important to enhance the abilities of students to analyze and solve complex engineering problems under the background of "New Engineering". In this study, the reform of Biomass Power Generation Engineering curriculum was discussed combining with the school discipline and specialty, from the aspects of improving the quality of teaching contents, teaching methods and examination methods. On the basis of constantly improving teaching practice, the growing demands of students in professional knowledge, ability and quality could be met.**

Keywords—Biomass Power Generation Engineering; Teaching Reform; New Engineering

I. INTRODUCTION

Since February 2017, the Ministry of Education has actively promoted the construction of "New Engineering", in order to cultivate internationalized talents who can adapt to the incredibly speedy development of modern science and technology, as well as the coordinated progress of industry. The Ministry of Education has formed the "Fudan University Consensus" and "Tianjin University Action" successively, and issued the "Notice of the Department of Higher Education on the Research and Practice of New Engineering". Subsequently, the project of "New Engineering Research and Practice" was launched. One report from the Nineteenth National Congress also pointed out that "We should train and bring up a large number of strategic scientific and technological talents, leading scientific and technological talents, young scientific and technological talents and high-level innovation teams with international level".

The research content of new engineering can be summarized as new idea of engineering education, new structure of discipline specialty, new mode of talent training, new quality of education and teaching, and new system of classified development. Therefore, the training of applied and innovative talents in applied undergraduate universities is in line with the construction and the development objectives of new engineering [1].

In recent years, the biomass power generation industry has developed rapidly in China, many places added or expanded green power generation projects, built a large number of biomass direct-fired power plants using agricultural and forestry waste as fuels, and promoted the development of related industries. For example, biogas power generation technology is basically mature and has been industrialized in large and medium-sized farms and wastewater treatment plants. Waste incineration power generation plays an important role as an important way of reduction, harmlessness and resource utilization of municipal solid waste.

Relevant enterprises, research institutes and government agencies have shown great enthusiasm for biomass power generation. China attaches vast importance to the development of biomass energy, and takes various measures to encourage the development of biomass energy technology and industry.

The development of biomass power generation industry is of positive significance for supplementing power supply, protecting ecological environment and realizing low-carbon economy.

In such a background, the course of Biomass Power Generation Engineering is offered. Biomass Power Generation Engineering is a compulsory basic course for students majoring in New Energy Science and Engineering. The course of biomass power generation engineering is developed on the basis of previous basic courses (physics, advanced mathematics, inorganic chemistry, organic chemistry, physical chemistry, etc.). It is an important bridge and link between basic theory and professional application, and plays a step-up important role in professional teaching.

However, with the concept of new engineering put forward and developed, the traditional teaching contents and methods are facing corresponding challenges. Therefore, it is particularly important to study the teaching reform of biomass power generation engineering under the background of "New Engineering".

II. Selection of Teaching Contents

It is of enormous significance to focus on the cultivation of students' abilities to analyze and solve complex engineering problems [2]. To meet the needs of national rapid development, local talents and school orientation, the teaching objectives of biomass power generation engineering should be focused on the cultivation of professional ability, application ability and vocational ability of students, through a new teaching model of class teaching and school-enterprise cooperation, as shown in Fig. 1.

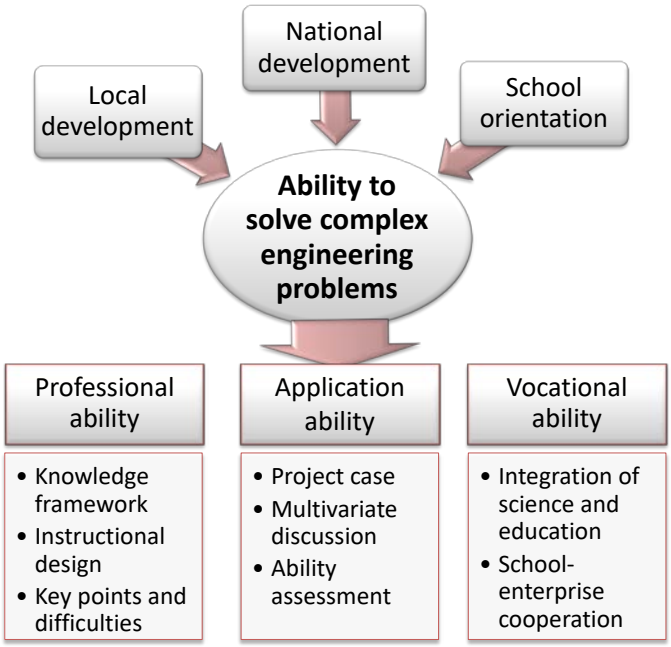

Fig. 1 Training objectives of biomass power generation engineering under the new engineering background

In our practical teaching, the course consists of 64 hours, and the teaching contents are divided into 6 parts, as shown in Fig. 2.

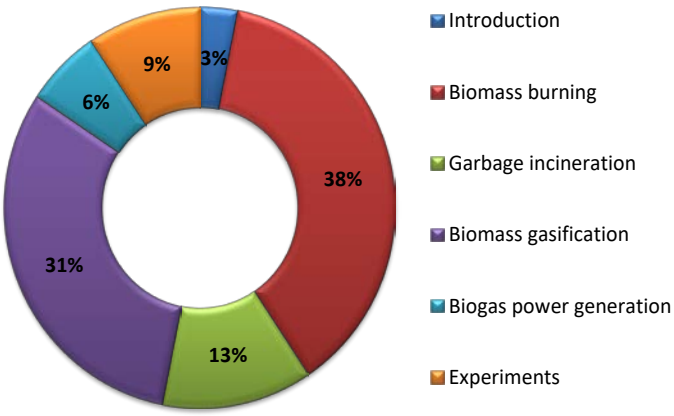

Fig. 2 Time allocation of biomass power generation engineering teaching

Among them, the biomass burning accounted for the largest proportion (24 class hours, 38%), followed by biomass gasification (20 class hours, 31%). The part of biomass burning mainly introduces the biomass combustion equipment and boilers, biomass direct-fired power plant system, and biomass mixed combustion for power generation. In the part of biomass gasification, the knowledge on the biomass gasification technology and equipment and the biomass gas engines is introduced.

A small proportion of garbage incineration is also included (8 class hours, 13%), including introduction for process and equipment of waste incineration, pollutant control and ash treatment of waste incineration power generation, etc. Additionally, in order to raise the practical capability of students, we add the experiments about the design of equipments related to biomass power generation engineering (6 class hours, 9%).

TABLE I summarizes the specific teaching contents of each part for biomass power generation engineering. According to the training objectives of New Energy Science and Engineering major and the hot issues of biomass energy research, we will focus on explaining to students the basic theory of biomass energy and the basic rules of related engineering technology unit operation. For example, in explaining the content of biomass direct combustion technology, we will emphasize the principle and characteristics of biomass combustion, the material balance and energy balance of biomass combustion, as well as the combustion utilization mode of biomass energy.

TABLE I. THE CONTENTS AND CHARACTERISTICS OF EACH PART FOR BIOMASS POWER GENERATION ENGINEERING

	Course name	Specific contents and characteristics
1	Introduction	Basic concept of biomass energy; Main forms of biomass power generation; current situation of biomass power generation and related policies and regulations
2	Biomass combustion equipment and boilers	Basic characteristics of biomass combustion; Biomass burners; Combustion of biomass in stratified combustion furnace; Combustion of biomass in fluidized bed
3	Biomass direct-fired power plant system	Process and thermal cycle of power plant; Pollutant emission from biomass combustion and ash treatment; Engineering application of biomass direct-fired power plant
4	Biomass mixed combustion for power generation	Concept and form of mixed combustion; Application of biomass-fired power generation technology; Effect of mixed combustion on system operation and emissions
5	Power generation by waste incineration	Process and equipment of waste incineration; Pollutant control and ash treatment of waste incineration power generation; Garbage gasification power generation process
6	Biomass gasification technology and equipment	Principle and process of biomass gasification; Biomass pyrolysis; Fixed-bed gasifier; Fluidized bed gasifier; New types of gasification devices
7	Biomass gas engines	Properties of biomass gas; Working principle of gas engine; Development of biomass gas engine
8	Biogas power generation system	Biogas power generation system; Landfill gas power generation system

III. INNOVATION OF TEACHING METHODS

A. Classroom teaching

Teachers play a guiding role in classroom teaching, stimulate students' interests, broaden students' horizons, and guide students to study independently and deeply. In view of the characteristics of this course, case teaching should be emphasized, supplemented by modern educational technology, so as to upgrade the teaching effect and enhance the effective interaction between students and teachers [3,4].

On the one hand, case-based teaching should be properly introduced into situational teaching, and the corresponding contents of case-based teaching should be added in the way of creating problem situations, finding problems, raising problems, thinking orientation and defining problems.

On the other hand, we should actively adopt modern educational technology. Since the basic combination, working principles and internal structures of various machines are mostly involved in the course of teaching, we are going to use videos, physical objects, models, three-dimensional animation and three-dimensional pictures to teach students comprehensively and intuitively. For key content, students are also recommended to watch relevant video materials after class.

Furthermore, in the actual teaching process, we should also pay attention to the effective interaction between teachers and students, which can be carried out in the form of questions or subject reports, so as to greatly stimulate students' enthusiasm for participating in teaching activities. This is conducive to promote classroom teaching atmosphere and students' interests in learning.

B. Practical learning

Students can be trained jointly through school-enterprise cooperation [5,6]. Enterprises can participate in the formulation of training plans. The school teachers and enterprise executives jointly carry out the practical teaching of students to form a practical innovation base based on Beijing-Tianjin-Hebei enterprises.

For example, we organize students to visit garbage incineration stations and make students have a deep understanding of garbage incineration power generation technology. Teachers should encourage students to ask more questions to staff, stimulate students' interests, and pay attention to interaction with students. In this way, students can broaden their perspectives and raise their practical capabilities.

Additionally, practice is not limited to visiting internships, and students can go deep into the biomass-related enterprises and communicate with front-line technicians in the project. Through cooperation with enterprises, students can personally experience the specific operation of each stage, so that students can accumulate a certain amount of practical engineering experience in the school. This process can lay a sound foundation for the future work of students.

IV. REFORM OF EXAMINATION METHODS

Examination is an important link in the teaching process, which is the main form of checking students' mastery of knowledge or skills, and an effective way to evaluate teaching quality [7,8]. Reasonable assessments will directly or indirectly affect students' learning attitudes and learning manners.

To promote the comprehensive development of students' quality and to raise the teaching quality, we adopt the method of comprehensive assessment in the biomass power generation engineering course. Course performance is assessed comprehensively by usual performance and final examination results. According to the requirements of the school, 70% of the closed-paper theoretical examinations were conducted at the end of the term, and some of the questions in the examination papers are related to practice. Usual performance mainly includes attendance, homework, classroom tests and literature reports.

V. CONCLUSION

The teaching reform of biomass power generation engineering can be carried out through the careful selection of teaching contents, the reform of teaching methods and the reform of examination methods. The aim is to make students fully grasp the knowledge of biomass energy development and utilization, and to improve the abilities to deal with problems and to innovate. It is of great significance to cultivate students' comprehensive quality, develop students' open thinking and improve the quality of professional teaching. The teaching of biomass power generation engineering is a systematic project,

which needs to be further explored and applied in the long term teaching.

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