Exploration of Course Teaching Reform of Fundamentals of Combustion in Internal Combustion Engines

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***Abstract*—Based on the analysis of teaching problem of Fundamentals of Combustion in Internal Combustion Engines, a teaching reform was adopted to improve the educational effect. By optimizing the teaching content, introducing information technology, case discussion of combustion technology, advanced research results of combustion of internal combustion engine, and multiple experimental teaching methods, better teaching results and students' affection were obtained.**

***Index Terms*—teaching reform, combustion in internal combustion engines, case discussion**

I. INTRODUCTION

Fundamentals of Combustion in Internal Combustion Engines (FCICE) is a professional elective course of energy and power engineering in Shandong University of Technology. This course may help students master the basic principles and applications of combustion, understand the normal and abnormal combustion process and its causes in spark ignition and compression ignition internal combustion engines, expand the knowledge of advanced combustion technology in internal combustion engines[1]. It provides professional knowledge and skills for students who specializes in internal combustion engines and Lays a solid professional foundation for students to further develop their research work[2].

However, there are many problems in the teaching of FCICE.

First of all, the course is more difficult, and requires students to master the basic courses such as advanced mathematics, fluid mechanics, engineering thermodynamics, heat transfer and so on.

Secondly, the content of the course is not only the relevant knowledge of combustion but also the related technology of internal combustion engine[3-5], the systematicness of which is poor, while the amount of class hours is insufficient (only 32 hours). So it is urgent to optimize the teaching of this course.

Thirdly, the combustion of the internal combustion engine is enclosed in the combustion chamber, and the speed of which is very fast, so that it can not be directly observed with the naked eye, so the relevant content of FCICE is quite abstract, which is hard to accepted by the students.

Moreover, due to the large amount of advanced courses, FCICE is arranged in the seventh term, during which students are busy finding jobs and studying postgraduates, so it is difficult to form a good learning atmosphere, as the students pay less attention to professional courses.

In view of the above-mentioned teaching problems, a curriculum reform was adopted to improve the educational effect, consolidate the professional foundation of students.

II. TEACHING REFORM MEASURES

In order to solve the above problems, the following reform measures are adopted.

A. Optimizing Teaching Contents

As the course is comprehensive and difficult, it is divided into two parts: Basic knowledge of combustion and Combustion technology of internal combustion engine. In order to lower the course difficulty, the derivation of a large number of theoretical formulas is abandoned, and the analysis of combustion phenomena and the application of combustion technology are emphasized.

In the part of basic knowledge of combustion, the teaching aim is focused on students' ability to analyze combustion phenomena with the basic theory of combustion, the ignition theory, premixed and diffusion combustion theories are emphasized.

While in the part of combustion technology of internal combustion engine, the teaching aim is focused on broadening students' vision in the professional field, so that the analysis of normal and abnormal combustion in engines and advanced combustion technology for internal combustion engines are emphasized.

B. Introducing Information Technology to Enrich Teaching Methods

Combustion phenomenon is very common in daily life, the method of teaching content from combustion phenomenon can arouse students' enthusiasm for learning, especially the discussion of development of forest fire, flame propagation of a bomb explosion, and Olympic torch relay underwater and on mount qomolangma. These topics are quite popular, and these process can be exhibited with videos, photos and cartoons, which makes teaching content more vivid.

As the course need a lot of basic knowledge, network platform testing is adopted for the testing of required

knowledge, in order to promoting students' preparation and review, and ensure better class effect. As this part of knowledge has been studied in other course, it is quite easy to get high marks, therefore, students' enthusiasm for completion is high. Also, the self evaluation function of the network platform test saves a lot of time for the teachers.

In line with the above measures, reform of examination method has also been adopted, in which attendance, tests, drawing homework, and case analysis performance account for 40%. The drawing homework is introduced for consolidating students' mastery of cognition of jet structure, droplet combustion structure, thermal ignition point characteristics and ignition peninsula structure of hydrogen and oxygen combustion. Case analysis is based on the technical case discussed in class, the development, principle and application of the technical cases were summarized by referring to the literature, and the discussion is presented in class in the form of ppt, so that the ability of document retrieval and sorting and language expression of professional knowledge was trained.

C. Introducing Technical Case Discussion of Internal Combustion Engine Combustion

The case study of combustion technology of internal combustion engine is combined with the basic knowledge of combustion. For example, after the comparison of gas, liquid and solid fuels characteristics, gas engine was discussed, including the matters needing attention in design of gas engine, the reasons why gas engines always uses ignition instead of compression ignition, and the reasons for dynamic deterioration of gas engine modified by gasoline engine. By this way, students are trained to apply the knowledge they have just learned to solve problems.

The scientific research achievements of the teachers were introduced into the teaching process, arousing the students' interest in learning and completing the propaganda of the research group at the same time.

Introducing the latest achievements of combustion research of internal combustion engine and the latest advanced technology applied by international internal combustion engine manufacturers into teaching process, such as the micro internal combustion engine technology and super knock development process, Improving students' interest in learning and enhancing students' confidence in professional development.

D. Introducing Multiple Experimental Teaching Methods

Practical operation experiments such as atomization angle measurement experiment, flash point measurement experiment and Bunsen lamp gas combustion characteristic experiment were constructed to consolidate combustion knowledge and train students' practical ability.

Demonstration experiments of candle burning, lighter burning, wood burning, alcohol lamp burning and syringe liquid column breaking are introduced in classroom teaching to analyze the physical process in combustion, the breaking and atomization mechanics, in order to educate students how to observe and think about the experimental phenomena.

Virtual experiments such as detonation process of internal combustion engine and explosion limit of fuel measurement are developed. The numerical simulation results are combined and animated according to the operating parameters. The problem that the combustion process of internal combustion engine can not be observed directly is solved, and the experimental operation with potential safety hazards is avoided.

E. Introducing Modern Fire Fighting Concept

Fire safety knowledge was introduced into the teaching of combustion science, combining the process of fire initiation, development, prevention and self-rescue with the relevant knowledge of combustion, citing fire examples and the analysis of the city's fire situation, at the same time, instilling advanced modern fire-fighting concepts into the minds of students to improve the social efficacy of the course.

III. CONCLUSION

By optimizing the teaching content, introducing information technology, case discussion of combustion technology, advanced research results of combustion of internal combustion engine, and multiple experimental teaching methods, and adding the cultivation of modern fire fighting concept, the course of FCICE has been improved. These improvements have been gradually applied to the teaching of students at grades 2013 to 2015, and better teaching results and students' affection were obtained.

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