



# Application and Research of Project-based Teaching in Practical Training Course of Refrigeration Equipment Selection Design

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**Abstract.** Refrigeration equipment selection design training course is a comprehensive and concentrated practice course for energy and power engineering. The application and research of project-based teaching in the practical training course of refrigeration equipment selection design can run the engineering project through the whole teaching and stimulate students' interest in learning; The transfer of knowledge is closely linked to the project, so that students can apply what they have learned. Cultivate students' practical application ability. With the aim of school-enterprise collaborative education reform, this paper introduces project-based teaching, and on the basis of highlighting "student-oriented, teacher-oriented", carries out teaching reform on the course of "refrigeration equipment selection design practical training", including improving the course objectives; Introducing practical projects and updating course content; Reform the teaching organization and promote the implementation of the project; Do a good job in project innovation and improve the quality of education and teaching.

**Keywords:** Project-based teaching; Curriculum objectives; Course content; Project innovation.

## 1 Introduction

Under the background of "double carbon", refrigeration equipment bears indispensable responsibilities and obligations in the cause of national energy conservation and emission reduction. The course "Refrigeration Equipment Selection Design Training" is a comprehensive and concentrated practical course for energy and power engineering. At present, the curriculum mainly adopts the method of theoretical teaching, students' learning is passive, the classroom is dull, students have fewer opportunities to operate skills and broaden their horizons, and students lack the cognition of the refrigeration equipment industry. The introduction of project-based teaching is a process of improving students' ability to combine theoretical knowledge with project application, and an important way to cultivate students' professional application ability.

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Project teaching method is a teaching process under the overall planning and guidance of teachers, in which learning teams are reasonably formed according to students' interests, preferences, learning basis and personality characteristics, with the content and requirements of projects as the direction, teachers as the guidance, students as the main body, students in charge of relatively independent projects, and teachers and students participate in the completion <sup>[1]</sup>.

## 2 Perfect Curriculum Objectives

According to the requirements of application-oriented personnel training, the "Refrigeration equipment selection and design practical training" course should update its objectives to make it more in line with the professional personnel training objectives and meet the talent needs of relevant enterprises in the refrigeration equipment market. After the reform, the course objectives are updated as follows: On the basis of highlighting the "student-oriented and teacher-led", it is oriented to the graduation requirements of students. The current course goal is to train students to become compound refrigeration talents who understand theory, can apply, think well and love their profession. It will lay a solid theoretical foundation, lay a practical foundation and cast a solid quality foundation for students' future refrigeration work, so that students can better master knowledge and skills in practice and improve their problem-solving ability and innovative thinking <sup>[2]</sup>. Strive to enable students to master the design basis, composition and application, operation principle and parameter calculation of refrigeration equipment in the knowledge goal. In terms of capability objectives, I can select and design refrigeration equipment without prompting, and I am skilled in operating refrigeration simulation software and valve component software introduced by schools and enterprises. In terms of quality goals, combined with the "double carbon" goal, students can establish the concept of green, low-carbon and environmental protection, and cultivate students' ability of independent learning and scientific and technological innovation. The main text should be written using Times New Roman, 10pt, fully justified. Italics can be used for emphasis and bold typeset should be avoided.

### 2.1 Knowledge Objective

- (1) Memorize the design basis, composition and application of refrigeration equipment.
- (2) Explain the operating principle of the refrigeration equipment.
- (3) Calculate the parameter values required by the refrigeration equipment.

### 2.2 Capability Objective

- (1) Skilled in operating refrigeration simulation software, valve parts software introduced by schools and enterprises, and able to select valve parts.

- (2) Will use p-h diagram to analyze the problem of high pressure and low pressure of refrigeration equipment, and can describe the solution to the problem.
- (3) Can write the design process of refrigeration equipment.

### **2.3 Quality Objectives**

- (1) Good at the combination of learning and thinking, can have correct values and a strong sense of social responsibility.
- (2) Be good at combining knowledge and action to enhance students' teamwork awareness and communication skills.
- (3) Be good at persevering in learning, pay timely attention to the technological development of energy and power engineering related fields, and establish the concept of energy conservation and emission reduction.

## **3 Introduce Practical Projects and Update Course Content**

### **3.1 Knowledge Objective**

(1) Project collection and learning. Based on the characteristics of "authenticity, practicality, cross-scientific, and cooperation" of project-based teaching, the teacher team collected items related to the selection and design of refrigeration equipment, such as water-cooled chiller unit selection and design, ground source heat pump selection and design, air source heat pump unit selection and design, by visiting enterprises, enterprise practice, and outside training before the course began. In-depth study of the project design process and the software and technical manuals used.

(2) Combine theory with practice to enrich the course content. Based on the collected projects and learned experience in enterprise design, combined with the theoretical knowledge of professional courses such as Heat Transfer, Fluid Mechanics, Pumps and Fans, Heat pump Technology, Refrigeration Principles and Equipment, Refrigeration compressor, Refrigeration Device Design, etc., the faculty team selects high-quality projects suitable for teaching, and integrates them into the "double carbon" strategic goal curriculum with reference to the enterprise project design process. Enrich the "refrigeration equipment selection design training" course content.

### **3.2 Curriculum Project Implementation**

(1) Set up the project team. Based on the principle of "full participation and balance between groups", the project team was formed according to the roles of team members required by the project task, and comprehensively considered the characteristics, specialties, gender and other factors of students. Mutual evaluation within each group to accumulate experience in cooperation; Conduct evaluation among groups to obtain the opinions of other group members on the design works; Teachers conduct summative evaluation, and evaluate emotional experience, team consciousness, participation

degree, learning ability and other aspects according to their own observation and understanding of individuals and groups to form overall opinions [3].

(2) Check and feedback. Each project will design multiple specific goals according to the covered knowledge and skills. During the completion of each project, teachers will check and give feedback on the specific goals to ensure the learning effect of students. Based on the characteristics of "authenticity, practicality, cross-scientific, and cooperation" of project-based teaching, the teacher team collected items related to the selection and design of refrigeration equipment, such as water-cooled chiller unit selection and design, ground source heat pump selection and design, air source heat pump unit selection and design, by visiting enterprises, enterprise practice, and outside training before the course began. In-depth study of the project design process and the software and technical manuals used.

### 3.3 Course Project Effect

Based on the education goal of training applied engineers and design engineers, the method of "simulating the acceptance and reporting process of enterprise projects" is adopted to invite teachers to participate in the acceptance of student projects to ensure that student projects meet the standards, so that students can apply what they learn and apply what they learn.

## 4 Reform the Teaching Organization and Promote the Implementation of the Project

### 4.1 Knowledge Objective

When explaining the composition, application and operation principle of refrigeration equipment, on-site teaching method is adopted. Through on-site observation and practical experience, students can enhance their in-depth cognition of refrigeration equipment, promote students' further familiarity and consolidation of theoretical knowledge, cultivate students' ability to apply knowledge to practice, and arrange students to draw and explain the schematic diagram of refrigeration equipment. For an example see Figure 1.

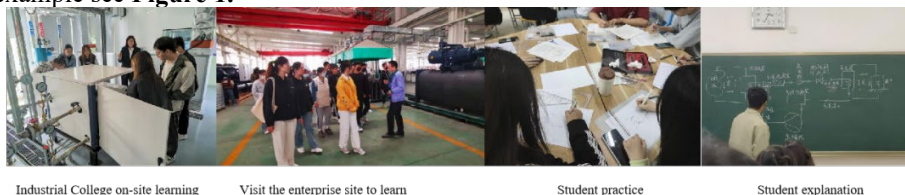


Fig. 1. Site visit study method.

## 4.2 Adopt Group Teaching Method

This course focuses on the development and design of refrigeration equipment under the goal of "double carbon". Students operate the refrigeration simulation software and the valve component software introduced by the school and enterprise. When calculating the parameter values required by the refrigeration equipment, the group teaching method is adopted to facilitate students' communication and cooperation, and help students develop their software operation ability, teamwork ability, communication and expression ability and problem solving ability<sup>[4]</sup>.For an example see **Figure 2**.



**Fig. 2.** Group teaching method.

## 5 Project Innovation

In the classroom teaching adhere to the "student development as the center", the use of project-based teaching method, participatory teaching method to train our students to understand the theory, can apply, good thinking, love the profession composite refrigeration talents. Combined with the "double carbon" strategic goal, students establish the concept of green, low carbon and energy saving.

### 5.1 Ideological and Political Integration

The energy efficiency limit value and energy efficiency grade of refrigeration equipment are organically integrated into the national major strategic goal - "double carbon" goal, and the development and design of energy-efficient refrigeration equipment is an effective way to achieve the "double carbon" goal,for an example see **Figure 3**.Cultivate students' innovative awareness of energy conservation and emission reduction and a high sense of social responsibility, and guide students to actively participate in energy conservation and emission reduction competition and refrigeration and air conditioning innovation competition.

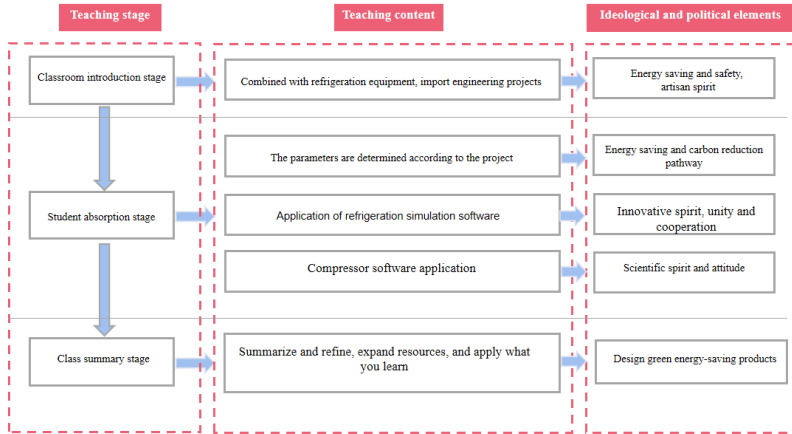


Fig. 3. Ideological and political integration in class.

### 5.2 Teaching Method Innovation

The "Refrigeration Equipment Selection and Design Practical Training" course implements the project-style teaching method and aims to cultivate application-oriented talents. The engineering project runs through the whole teaching process, as shown in Table 1. Before the beginning of the course, the students are divided into groups. Under the guidance of the teacher, the students in the group can apply what they learn and apply what they learn, improve their practical application ability, and stimulate their internal motivation of learning and potential creativity.

Table 1. Refrigeration equipment engineering project.

	Item 1	Item 2	Item 3	Item 4
Refrigerating capacity (kW)	70	35	120	200
Evaporator inlet/outlet temperature (°C)	12/7	12/6	10/5	12/8
Condenser inlet/outlet temperature (°C)	30/35	30/35	32/37	32/37
Refrigerant	R410A	R22	R134a	R22

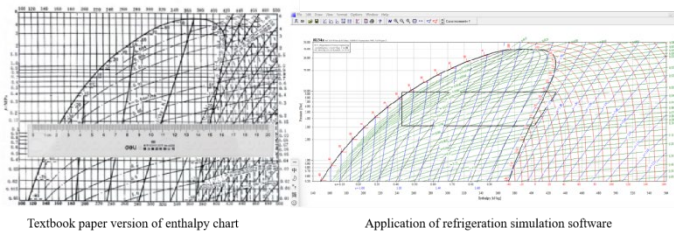
Compressor gas transmission coefficient	0.88	0.88	0.9	0.91
Degree of superheat (°C)	5	5	2	5
Degree of supercooling (°C)	5	5	5	5

### 5.3 Introducing Enterprise Software

Relying on project cases and introducing selection tools other than textbooks, students are clear about the tools used in the refrigeration industry and enterprises for the selection of refrigeration equipment. Cultivate students' practical ability and professional application ability.

(1) Refrigeration simulation software replaces the paper version of the enthalpy chart

Taking the application of enthalpy diagram as an example, enthalpy diagram is one of the necessary tools for energy and power engineering. When students use the pressure enthalpy chart in the textbook to query the parameters of each state point, it is time-consuming and laborious, inefficient and the query result is not accurate. In order to facilitate students to apply the pressure enthalpy chart, the refrigeration simulation software applied by enterprises is introduced to improve the application efficiency. For an example see **Figure 4**.



**Fig. 4.** Refrigeration simulation software to replace the paper version of the enthalpy diagram example.

(2) Compressor selection software

Combined with the theoretical cycle thermodynamic calculation of single-stage steam compression refrigeration, the theoretical selection of the compressor needs to calculate the unit mass cooling capacity, unit volume cooling capacity, mass flow of refrigerant, the actual gas transmission of the compressor and the theoretical gas transmission of the compressor in combination with the pressure enthalpy diagram. Determine the compressor model based on the calculated value and the compressor manual. In practical application, enterprises mostly use the selection software of compressor manufacturers for selection, and students need to apply convenient compres-

selection software on the basis of learning theoretical calculation to improve comprehensive ability.

## 6 Conclusion

The practical training of refrigeration equipment selection design is a professional course for energy and power engineering, which lays a good foundation for subsequent graduation design, employment and even assuming the responsibility of social energy conservation and emission reduction. This course introduces project-based teaching method, relies on project cases, condensed engineering projects in teaching, introduced enterprise valve component selection software, accumulated teaching experience, collected a large number of standard and practical teaching resources, and carries out the application and research of project-based teaching in the course of "Refrigeration Equipment Selection Design Practical Training". To enable students to master the application of product energy efficiency improvement and system energy saving technology to the maximum extent, that is, to provide better learning conditions, learning environment and learning methods for students of this major, and at the same time, to enhance the professional quality of students of other majors in the process of integrating theory and practice in selective learning<sup>[5]</sup>.

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