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Ideological and political reform of chemical courses based on the “double carbon” target

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Abstract: Since President Xi Jinping made a promise to achieve carbon neutrality and carbon peak at the UN General Assembly, "double carbon" targets are gradually attracting attention. The ideological and political teaching reform of chemical engineering courses has a positive guiding effect on the improvement of students' subject quality and the development of the future society. This paper discusses the "double carbon" policy, the importance of curriculum reform, the reform of daily teaching content, the optimization of experimental teaching content and curriculum innovation. The "double carbon" concept is integrated into the curriculum to strengthen students' awareness of green and low carbon, and at the same time to cultivate professional responsibility and feelings of family and country, so as to cultivate college students who conform to the development of the times.

Keywords: Double carbon; chemical courses; reform; innovation

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1. Introduction

With the development of industry, carbon dioxide emissions keep increasing for a long time, which has a great impact on the environment. Being influenced by this situation, the China Central Government became aware of the importance of green and low-carbon development and put in place a number of policies. In September 2020, President Xi Jinping proposed at the 75th session of the United Nations General Assembly. He said that China aim to have carbon dioxide emissions peak before 2030 and achieve carbon neutrality before 2060. It shows China's direction for the development of the green low-carbon industry. In December of the same year, the President made specific demands on CO_2 emissions and non-fossil energy use at the Climate Ambition Summit. The carbon peaking and the carbon neutral are important strategic decisions made by the Party Central Committee to coordinate the international and domestic situation. It can promote economic development based on the efficient use of resources and protection of the environment and has an impact on the restructuring of the industrial chain. At the same time, it determines the development of new international standards. So this target will affect the development of the chemical industry in the future [1].

The Ministry of Ecology and Environment issued the "Measures for the Administration of Carbon Emissions Trading (for Trial Implementation)" and "Guidelines for the Verification of Enterprise Greenhouse Gas Emissions Reports (for Trial Implementation)" in 2021. Two documents provide preliminary regulations on carbon emissions. Subsequently, the State Council issued the "Action Plan for Carbon Peaking by 2030", which contains many detailed indicators and tasks as the overall deployment of the carbon peaking phase. Including the promotion of energy-saving and carbon-reducing transformation in the petrochemical and chemical industries. In order to effectively promote the achievement of the “double carbon” goal, China will build more and more laws and regulations to ensure that there are laws to abide by. In order to provide talent support for the dual-

carbon target, the Ministry of Education issued the "Work Plan for Strengthening the Cultivation System of Carbon Neutral Higher Education Talents" in April 2022. This scheme points out the goal and direction for the chemical engineering course education in colleges and universities. And it also indicated chemical engineering students' employment direction in the future.

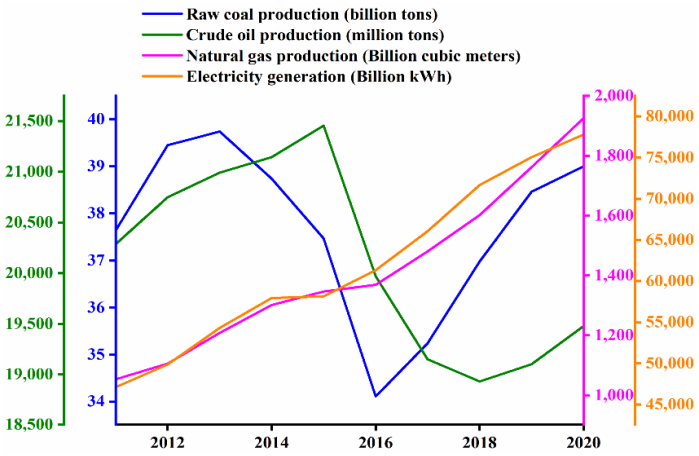

Figure 1. China's trend of total production of major energy types from 2011 to 2020 [2]

2. Significance

The concept of low carbon is derived from Marxist philosophical thinking. Marxism believes that man and nature are an interdependent and mutually constraining relationship, and the two should be harmonious and unified. Long-term excessive emissions of carbon dioxide gas have an impact on the environment. Passing the concept of low carbon to students will help them to raise awareness of green environment protection and enhance the concept of sustainable development. Establish a correct view of ecological civilization. This concept is also a reflection of the organic integration of moral education and teaching, penetrating Xi Jinping's thought of ecological civilization into the talent training system of higher education. It is of great help to the ideological and political education of college students in the future. It can promote the all-round development of excellent talents in colleges and universities.

Secondly, under the guidance of the "double carbon" target, chemical industry will be affected in the future. Due to the special nature of the chemical industry, its high temperature and high-pressure operating environment will lead to the production of many harmful gases. The reaction process of chemical products also requires a lot of energy consumption, emitting a large amount of carbon dioxide gas. These need to improve and refine the chemical production process to meet the carbon emission standards. The design of a chemical production process requires consideration of many components, such as raw materials, catalysts, reaction routes, reaction conditions, product separation and purification, etc. To reduce carbon emissions, each of these processes must be analyzed and improved. Chemical engineering students need to master sufficient professional knowledge so that they can flexibly apply and innovate low-carbon industrial process, contribute to the construction and development of a "double carbon" society. Low carbon is a major trend of industrial production in the future. Early infiltration of low-carbon ideas can stimulate students' awareness of the need to improve carbon emissions. When they enter the workforce in the future, they can adapt to the demands of the times. They make full use of their professional knowledge at work to contribute to the "double carbon" goal.

Finally, students are guided by the policy to learn chemical expertise. Make their own contribution to the country in low-carbon environmental protection. Cultivating their family and country feelings and mission responsibility.

3. Teaching reform and innovation

3.1. Integrate the "double carbon" goal into the teaching content

First of all, teachers of chemical courses should develop new lesson plans and adjust the syllabus around the "double carbon" goal. Integrate the "double carbon" concept in the teaching design process. Integrate the idea of reducing CO_2 emissions into the teaching of the whole chemical course. Teachers should fully understand the policy and add specific regulations to lesson plans and courseware, so that students' learning will not only stay in the classroom knowledge teaching, but also be connected with social hotspots. For example, the technical methods of carbon capture, the serious hazards of excessive carbon dioxide emissions, and the safety accidents that may be caused by the casual emission or improper treatment of industrial waste gases, etc, so as to expand students' knowledge. This process makes students aware of the contribution they can make to society with their solid professional knowledge and increases their sense of social responsibility. While explaining the absorption unit of the chemical operation process, teachers can introduce the Carbon Capture, Utilization and Storage (CCUS) technology, which has been a hot technology in the international fight against climate change in recent years. Under the current "double carbon" target, CCUS is the only technology that can realize the large-scale low-carbon utilization of fossil energy, and it is an important part to accomplish the carbon neutral target in the future [3]. It will be used on a large scale in the use of fossil energy and play an irreplaceable role, but this technology is not yet widely used because of environmental and economic costs and technical risks. China heavily dependent on fossil energy, it is of great practical importance to study CCUS technology in depth [4]. The introduction of this technology in chemical courses is therefore of great benefit to students' professional horizons and future career development. For example, on the resource utilization of carbon dioxide, introduce the typical route of converting carbon dioxide into fuel by using ionic liquids, as shown in **Figure 2**.

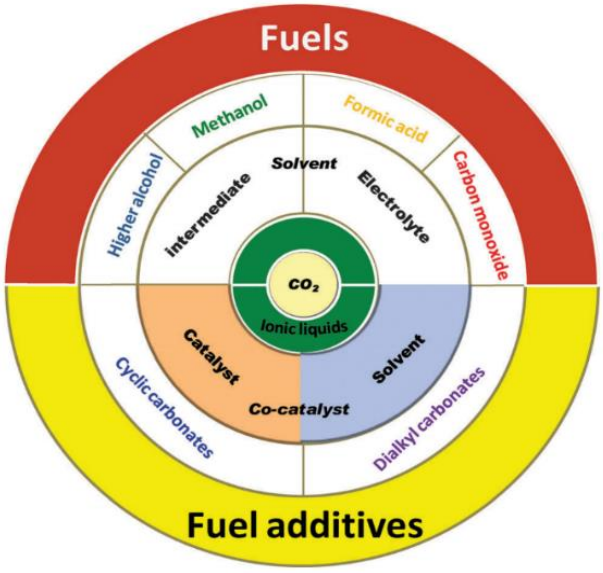

Figure 2. Typical routes for the conversion of CO_2 to fuels and fuel additives with ionic liquids [5]

The traditional learning approach includes three components: pre-course, in-class, and post-course review. In the student pre-reading section, the instructor can create some green issues related to the chapter. Guide students to independently review relevant literature and find relevant documents before class. Think about what kind of environmental problems will arise in industrial practice from the learning content of this course and

how to avoid the occurrence of such problems. Students will gradually develop the ability to apply their theoretical knowledge to solve practical production problems.

Integrate the concept of "double carbon" into classroom lectures. For example, when explaining "separation of non-homogeneous systems" in the course of "Chemical Principle", teachers use video animation to illustrate the hazards of dust pollution in enterprise production, and then cultivate the awareness of green low-carbon [6]; when talking about gas absorption, introduce the case of deacidification and dehydration of natural gas in Shaanxi Province, ask the questions of why and how to deacidify, explain clearly the purpose of absorption, the basis of absorption, the gas-liquid contact method of absorption operation, and introduce some green treatment methods of industrial waste gas from absorption; distillation as a very important unit in the chemical separation process, can be introduced in the explanation process to save energy in distillation [7]. During the course "Catalytic principles" we will explain the contribution of catalysts to green and efficient industrial processes, teachers can also introduce the catalysts currently used in the synthesis of carbon dioxide in order to build awareness of carbon dioxide resource utilization. In the classroom, the teacher can propose a discussion topic in conjunction with the "double carbon" objective. Use the flipped classroom model to increase the students' independent discussion part, and then organize students for group presentation, other students ask questions about the presentation. In this way, students can have a deeper understanding of the double-carbon target and grasp more industrial pollution treatment methods. Because chemical courses are practical courses, after explaining the core knowledge points, relevant exercises should be incorporated in time, so that students can have solid theoretical knowledge. After class, teachers should ask students to make a summary of their knowledge according to their own situation, and then refine the plan and thinking of realizing the double carbon target [8,9].

For the chemical engineering discipline, experiment is a good carrier to improve students' practical ability and problem-solving ability, and is an indispensable part of teaching. In the process of experimental teaching, add questions about low carbon in the pre-experimental part, such as "How to make harmless treatment or secondary utilization of the carbon-containing waste gas produced in the experiment?" "How to properly handle and recycle the waste from this experiment?" and so on. This will stimulate students' thinking and may be applied to practical industrial processes in the future. During the course of the experiment, in addition to reminding students to avoid dangers, we should also explain the methods of carbon dioxide absorption in the industrial field, such as the alcohol-amine method with wide application and high carbon dioxide recovery rate, the hot potassium carbonate method with high absorption capacity, and the propylene carbonate method with simple process and low energy consumption. At the same time, students are guided to understand the concept of green chemistry and enhance the awareness of green environmental protection. Teachers can also make full use of laboratory resources, combined with the green low-carbon concept to design new experiments to enrich the experimental teaching content.

In addition, students should be strongly encouraged to participate in the “The Challenge Cup”, “National university student social practice and science contest on energy saving and emission reduction”, “National college student chemical engineering design competition” and other disciplines. Scientific research thinking is the soul of scientific research, determines the height of research. Practical ability is the key to scientific research, determines the depth of research [10]. University knowledge should not only stay at the level of textbooks. It needs to be linked with the actual production and life. The competition has built a good platform for the talent development and school-enterprise cooperation, encourages students to communicate with each other and learn from each other, and then complete the event. It can increase team awareness, stimulate students' potential and improve the professional level. In the process of preparing for the competition, students

start from the needs of life, understand the social status quo, pay attention to social livelihood, solve social problems, and form a more three-dimensional understanding of the "double carbon" goal, understand the necessity and urgency of energy conservation and emission reduction. They will encounter many specialized knowledge that they have never learned in the classroom and cross-cutting problems with other disciplines. It not only promotes them to perfect their own knowledge system according to their own interests and hobbies, and trains high-quality talents with multi-disciplinary cross-integration, but also makes students deeply understand the social status quo of their own majors, good for their future career planning. For students, through the match to promote learning, improve scientific research and innovation ability, communication ability and the ability to solve practical problems. For teachers, helping students to participate in the competition can not only increase the exchange with students, but also enrich their own teaching content, understand students' interests, and then complete the reform of teaching [11,12].

3.2. Teaching innovation

(1) At the end of each semester, teachers organize a discussion session on the topic of "carbon neutral and carbon peaking". Special courses are more flexible than other courses, and can be updated in time according to actual conditions [13]. The traditional teacher-led one-way teaching method is changed to a two-way teaching method with teacher-student interaction [14]. Students will form their own groups and discuss the results of their research, combining what they have learned throughout the semester and the information and literature they have collected. The results of their research will be presented in a unified manner in class and will be assessed and summarized by the instructor. For example, at the end of the " Chemical Principle " course, the topic of "Carbon Capture" is discussed. After students' discussion, teachers summarize the chemical and physical absorption methods that are widely used in the field of carbon capture, and then use a table to summarize them. This provides new perspectives and ideas in addition to the methods proposed by the students to further improve their knowledge system [15]. Thematic lessons can also be conducted by analyzing actual factory cases, analyzing the measures taken by factories to reduce CO_2 emissions and presenting the difficulties faced in applying the theory to practice, thus expanding students' horizons. In each thematic course, students not only integrate the classroom learning content into the thematic discussion, but also independently integrate the new content related to "double carbon". It cultivates students' exploration spirit, cooperative consciousness and ability to solve problems independently. Achieves the combination of theory and practice and significantly improves students' comprehensive ability to achieve the goal of "double carbon" [16].

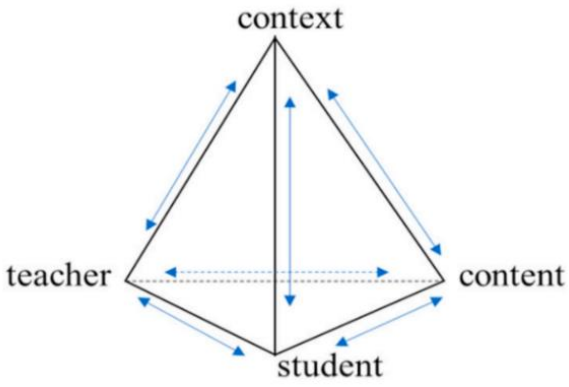

Figure 3. A teaching model on the interlink of student, teacher, content and context [17]

(2) Conduct social practice activities on "carbon neutral and carbon peaking". Students are encouraged to go to chemical plants to understand and examine the process of

chemical product preparation. They should record the carbon dioxide emissions and analyze the data after the research. Teachers should prompt them to take full account of environmental factors, pollutant treatment and other content related to resources and environment when analyzing chemical complex process [18]. The class is guided by teachers to analyze the situation of the chemical plant and evaluate the actual process of the chemical plant in conjunction with the daily teaching content, and finally the students complete the research report as a test of the practical learning outcomes.

(3) Improve the role of teachers' words and actions in guiding students. Teachers should clearly adhere to the principle of "education for people, moral education first", strengthen the cultivation and refinement of moral education awareness [4]. Teachers should raise their own attention to the carbon peak and carbon neutral goals in their daily communication with students, mention more about the relevant knowledge and their own practical application in the scientific research. Furthermore, the “double carbon” knowledge is integrated into the classroom in many aspects, angles and methods. Improve students’ awareness of reducing carbon emissions and knowledge literacy under the subtle guidance.

4. Conclusion

Carbon peak and carbon neutrality is a major strategic decision of the country in terms of the environment, which has guided the direction of the chemical industry in the future. In this context, it also brings many inspirations to the teaching of chemical courses. With the future exploration of teaching reform, teachers should further integrate the idea of "double carbon" into the teaching of courses, so as to form a complete knowledge system. Improve students' professional ability and awareness of green environment, and make our generation's efforts for green water and green mountain of the country.

Acknowledgement

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