International Journal Of Engineering Research And Development
e- ISSN: 2278-067X, p-ISSN: 2278-800X, www.ijerd.com
Volume 20, Issue 10 (October, 2024), PP 66-71

Improvement methods for student education of offshore petroleum engineering majors in Chinese petroleum universities under the goal of achieving carbon neutrality

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Abstract: *In response to the call for global climate governance, China has proposed the goal of carbon neutrality. To meet the development needs of the carbon neutrality goal, the offshore petroleum engineering major needs to optimize the education mode. This article briefly describes the current situation of student education in offshore petroleum engineering, analyzes the shortcomings of student education in offshore petroleum engineering under the goal of carbon neutrality, and proposes improvement methods for student education in offshore petroleum engineering. It can provide reference for improving the student education mode of offshore petroleum engineering in Chinese petroleum universities under the background of carbon neutrality.*
Keywords: *university, educational methods, carbon neutrality, students*

Date of Submission: 01-10-2024 Date of Acceptance: 12-10-2024

I. Introduction

As the catastrophic impact of climate change becomes increasingly prominent, the urgency of reducing carbon emissions globally is becoming more apparent. Since the industrialization era, greenhouse gas emissions, mainly carbon dioxide, have sharply increased (as shown in Figure 1)[1], leading to a continuous rise in greenhouse gas concentrations and exacerbating the greenhouse effect. Although the growth rate of global carbon emissions has slowed down in recent years, carbon dioxide emissions have not yet peaked, indicating that the problem of climate change will remain severe in the future. Climate change has caused profound damage to human society and the natural environment, with frequent extreme weather events, rising sea levels, and threats to crop growth[2,3]. Therefore, controlling carbon emissions to mitigate global climate change and ensure the healthy development of human society has become a global issue of common concern. Reducing carbon emissions to address climate change has gradually become a global consensus. Through various climate conferences, the international community has formed phased emission reduction principles and targets, among which "carbon neutrality" has been established as an important goal[4].

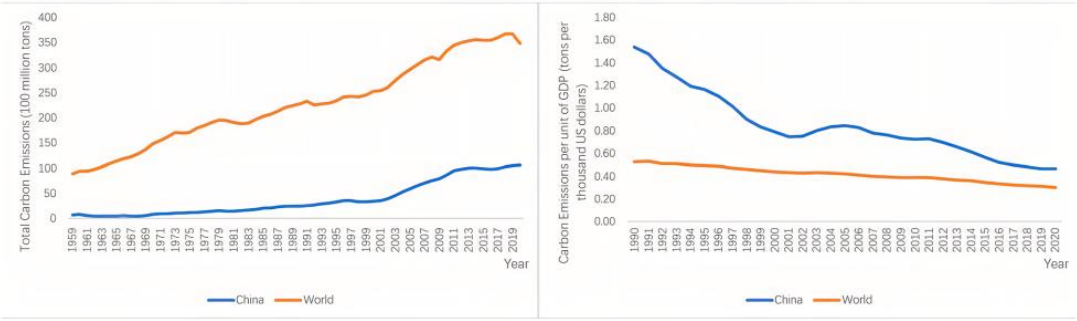

Figure1 Carbon emission trendes in China and the world.[1]

China has actively responded to the call for global climate governance and proposed the goals of peaking carbon dioxide emissions and achieving carbon neutrality. China has committed to peaking carbon dioxide emissions by 2030 and achieving carbon neutrality by 2060. Its importance is reflected on multiple levels and is the core driving force for promoting the construction of ecological civilization and high-quality development. Through green development and technological innovation, the goal of carbon neutrality accelerates the green transformation of the economic structure, not only meeting people's aspirations for a better life, but also demonstrating China's firm determination to build an ecological civilization[5,6]. The carbon neutrality target also demonstrates the win-win effect of environmental quality and industrial development. The promotion of

clean energy and the improvement of energy efficiency have not only optimized the energy structure and improved environmental quality, but also driven the rise and development of emerging industries, achieving a harmonious coexistence between the environment and the economy[7].

As an important source of carbon dioxide emissions, petroleum is about to usher in a new round of technological and industrial transformation with the implementation of carbon neutrality policies. Petroleum related higher education, as an important part of serving national needs and promoting national energy and economic development, provides talent and intellectual support for China's social development. To meet the urgent demand for new technologies in response to China's carbon neutrality goals, petroleum related higher education should closely focus on the national energy strategy and the carbon neutrality strategy, accelerate the upgrading and transformation of traditional energy related advantageous disciplines, improve talent education programs, integrate green and low-carbon concepts into curriculum construction, and achieve precise education for industrial transformation and national development[8,9].

In response to the student education model of ocean petroleum engineering majors commonly offered in Chinese petroleum universities, and in combination with the strategic goal of carbon neutrality, this study investigates the shortcomings of the existing education programs for college students majoring in ocean petroleum engineering in Chinese petroleum universities, and explores methods for improving education methods, providing reference for the education of carbon neutral ocean petroleum engineering professionals in China.

II. Research background

The proposal of carbon neutrality goals is a good opportunity for the development of the offshore petroleum engineering profession. Through educational and teaching reforms, it can to some extent contribute to the high-quality achievement of carbon neutrality goals and promote the progress of offshore petroleum engineering education.

Based on the current background of carbon neutrality in China, through educational and teaching reforms, relevant courses are added, curriculum teaching content is optimized, and students are guided to actively think about the close relationship between decarbonization measures such as carbon capture, carbon flooding, carbon sequestration, and carbon conversion and oil and gas development. The implementation of these measures can not only achieve carbon sequestration goals, but also greatly increase oil and gas production.At the same time, Considering the current international situation and industry development, many industries, including offshore oil, still face many challenges. Although many technologies have been localized in China, some core instruments, equipment, etc. still need to be imported. In the current context of carbon neutrality, educational reform can help guide students to shoulder heavy responsibilities and missions, aspire to solve key technical problems, and overcome industry technological barriers.

Carbon neutrality is an important support area for China's future development, and it is also the trend of the energy industry. For students majoring in energy such as offshore oil engineering, achieving high-quality carbon neutrality goals is also their own responsibility[10,11].

III. Current status of education program in offshore petroleum engineering at Chinese petroleum universities

3.1 Major features

The main discipline of this major is petroleum and natural gas engineering. The main degree courses studied include general geology, oceanography, engineering mechanics, engineering fluid mechanics, permeability mechanics, general chemistry, reservoir physics, marine drilling engineering, marine oil and gas production engineering, reservoir engineering fundamentals, ship and offshore platform engineering, etc. The main practical teaching activities include general geological internship, production internship, offshore petroleum engineering course design, offshore ship and platform internship, engineering education, graduation project, etc. In the process of student cultivation, we insist on carrying out industry university research cooperation education, so that students can receive education in production positions, promote knowledge learning and practical application, and continuously improve the quality of student education; Strengthen practical teaching activities, cultivate independent hands-on ability and the ability to analyze and solve complex problems in oil and gas development.

3.2 Educational objectives

This major cultivates applied engineers with strong social competitiveness and collaborative work abilities, possessing fundamental knowledge of engineering and basic theories of offshore petroleum engineering. They are proficient in professional knowledge such as marine drilling and completion, extraction, oil and gas gathering and transportation, ships, and marine engineering, and can engage in related design, construction, and management in the field of offshore petroleum engineering. Graduates are able to comprehensively apply basic and professional knowledge of offshore petroleum engineering, and engage in engineering design, construction, production management, and scientific research. They are able to analyze complex problems in offshore petroleum engineering and provide solutions. They can continuously update their knowledge and improve their abilities through various channels, and keep up with the development of new technologies in the field of offshore petroleum engineering.

3.3 Requirements for education

On the basis of studying basic courses such as mathematics, physics, mechanics, foreign languages, and computer science, students in this major deepen their understanding of the fundamental theories and knowledge of offshore petroleum engineering. They receive professional education in marine drilling and completion, oil reservoirs, oil and gas production, oil and gas gathering and transportation, and marine engineering, and possess engineering design, construction, and management abilities, as well as certain innovative abilities. They have good humanistic, scientific, and engineering literacy, and have certain scientific research and practical work abilities. Graduates should acquire the following abilities:

(1) Engineering knowledge: Possess the mathematical, natural science, engineering science, and professional knowledge required in the field of offshore petroleum engineering, which can be used to solve complex engineering problems in offshore drilling and completion, oil and gas development, extraction, and marine engineering. Ability to conduct reasonable analysis based on relevant background knowledge of offshore petroleum engineering, evaluate the impact of engineering practices and solutions to complex engineering problems in offshore drilling and completion, oil and gas development and exploitation, and offshore engineering on society, health, safety, law, and culture, and understand the responsibilities that should be undertaken.

(2) Problem analysis: Able to apply the basic principles of mathematics, natural sciences, and engineering sciences to identify and express complex engineering problems in fields such as ocean drilling and completion, oil and gas development, exploitation, and ocean engineering. Through comprehensive analysis of literature, technical data, and other information, effective conclusions can be obtained. Being able to develop, select, and use technologies, professional software, instruments, equipment, and tools related to offshore oil engineering using computer, network, and professional knowledge to simulate, predict, and analyze complex engineering problems in offshore drilling and completion, oil and gas development, extraction, and offshore engineering, and understand their limitations.

(3) Design/develop solutions: Able to comprehensively consider social, health, safety, legal, cultural, and environmental factors, propose solutions to complex engineering problems in the field of offshore oil engineering, complete designs for offshore drilling and completion, oil and gas development, extraction, and offshore engineering, and demonstrate innovative thinking in the design process.

(4) Research: Able to conduct experimental and theoretical research on complex engineering problems in marine drilling and completion, oil and gas development, exploitation, and marine engineering based on scientific principles in the field of offshore petroleum engineering, using scientific methods. Through data processing, analysis, interpretation, and information synthesis, reasonable and effective conclusions can be obtained.

IV. Shortcomings in the education program for offshore petroleum engineeringmajors in Chinese petroleum universities under the goal of carbon neutrality

4.1 Lack of targeted and forward-looking educational programs

Due to the recent emphasis on carbon neutrality goals, some Chinese petroleum universities have continued to develop talent education programs based on previous plans. These programs may not have timely responded to the demands of carbon peak and carbon neutrality, resulting in a lag in professional development and an inability to cultivate professionals who are suitable for the national energy strategy development trend[12]. However, as a more refined extension of the traditional petroleum engineering field, the marine oil and gas work major currently relies mainly on the education model of traditional oil and gas majors and has not yet been combined with carbon neutrality goals. At the same time, in terms of curriculum design, the teaching

content may still remain in traditional fields, lacking in-depth explanations of cutting-edge knowledge such as green low-carbon technologies and carbon trading, which cannot meet the demand for professional talents for carbon neutrality goals.

4.2 Insufficient supporting educational resources

The teaching staff of the ocean petroleum engineering major mainly come from related majors such as petroleum engineering, ocean petroleum engineering, and ocean engineering. These teachers have relatively little teaching experience in carbon neutrality knowledge. However, in the context of carbon neutrality, specialized teachers not only need to possess professional knowledge in offshore petroleum engineering, but also need to have technical knowledge and relevant laws and regulations on green low-carbon and carbon trading. In the fields of carbon peaking and carbon neutrality, few teachers have rich practical experience and theoretical knowledge teaching experience, which makes it difficult to meet teaching needs. In addition, there are also shortcomings in the construction of laboratories related to carbon neutrality courses. Some universities have not invested enough in carbon neutrality experimental teaching, research platforms, and other aspects, making it difficult to provide comprehensive learning and time conditions for students in related majors. Students may have difficulty obtaining opportunities to participate in practical projects and understand industry trends.

4.3 Insufficient integration of industry and education

Due to the short time since the carbon neutrality target was proposed, the system construction of domestic universities in this direction is still in its infancy, and the mode of student education in schools often lags behind the forefront of the industry, resulting in the knowledge content of university professors being difficult to meet the actual needs of the industry in a timely manner[13]. In addition, due to limitations in educational resources, many schools have weak research and development capabilities in the field of carbon neutrality. University researchers tend to focus more on theoretical foundations rather than timely proposing solutions to technical problems faced by enterprises. As a result, the enthusiasm of enterprises to carry out deep integration of industry and education is low, leading to a disconnect between student education and market demand.

V. Improvement methods for the education program of offshore petroleum engineeringmajors under the goal of carbon neutrality

5.1 Strengthening professional development and reforming educational curricula

The curriculum system is the sum of teaching content and teaching methods. The existing offshore petroleum engineering curriculum system can no longer meet the education needs of professional talents under the goal of carbon neutrality. It needs to be adjusted and improved appropriately, and the curriculum content needs to be enriched and optimized to promote curriculum reform. In order to adapt to the development of carbon neutrality goals, the student education mode of offshore petroleum engineering should be optimized based on the characteristics of the profession, from the aspects of students' professional knowledge, comprehensive quality, etc., to cultivate high-quality applied and innovative talents with carbon neutrality concepts and skills.

At present, the curriculum of offshore petroleum engineering mainly consists of four parts: general courses, professional basic courses, professional courses, and practical courses. Adjust the professional settings and course content according to the demand for carbon peak and carbon neutrality, and strengthen the explanation of cutting-edge knowledge such as green low-carbon technology, energy management, and carbon trading[14,15]. In terms of curriculum design, on the one hand, we will continue to retain the relevant professional courses of traditional offshore petroleum engineering majors, and on the other hand, optimize the content of previous courses by appropriately adding elective or practical courses related to carbon neutrality technology, including carbon capture and storage (CCS) and energy conservation and emission reduction.

For the characteristics of the offshore petroleum engineering major, it is necessary to establish carbon neutral basic courses and add "dual carbon" related teaching content to related basic courses. Adding basic courses for carbon neutrality majors can not only encourage students to effectively combine their professional knowledge with carbon neutrality knowledge, but also promote university teachers to integrate carbon neutrality concepts and knowledge into the teaching process, thereby improving the education ability of carbon neutrality majors. Courses closely related to carbon neutrality goals, such as low-carbon emission reduction, low-carbon treatment of oilfield wastewater, low-carbon economy, and carbon trading, can be added to professional basic courses. On the one hand, promoting interdisciplinary and integration of arts and sciences, further deepening students' awareness of subject integration, and enhancing their ability to comprehensively analyze problems; On the other hand, it enables students to develop preliminary carbon reduction thinking, ideas, and methods, laying

a solid foundation and awareness for the application of carbon neutrality technology in the petroleum engineering industry.

5.2 Increase investment in educational resources

The cultivation of high-quality carbon neutral offshore petroleum engineeringmajors requires a team of teachers with high quality, specialization, and rich teaching experience in relevant fields. For teaching resources, a high-quality teaching staff is an important guarantee for cultivating high-quality talents. Under the "dual carbon" goal, universities need to build an interdisciplinary and specialized team of teachers with carbon neutrality concepts and rich knowledge.

The universities should actively recruit outstanding professional carbon neutrality talents, introduce interdisciplinary experts with rich experience in carbon neutrality research, and enhance the level of professional teaching. The achievement of carbon neutrality goals requires interdisciplinary integration, collaborative application, and innovation, involving various aspects such as engineering technology, economic management, and laws and regulations. Therefore, establishing a faculty team with interdisciplinary integration capabilities and rich teaching experience is imperative and crucial for cultivating carbon neutral application and innovative talents.

In addition, increase the education efforts for existing professional teachers, strengthen their awareness of carbon neutrality, and enhance the classroom teaching ability of frontline teachers. Only a team of carbon neutral teachers with high quality, specialization, and rich teaching experience can integrate the concept of carbon neutrality into all aspects of classroom teaching.Encouraging professional teachers to conduct in-depth exchanges and interviews with enterprises and research institutes, increase support for the establishment of carbon neutrality projects between professional teachers and enterprises, enhance the application, innovation, and research capabilities of professional teachers in carbon neutrality engineering, and provide support for cultivating "dual carbon" application and innovative talents that meet the needs of employers.

5.3 Enhancing the integration of industry and education

Regarding the construction of teaching laboratories, by analyzing the characteristics of majors closely related to carbon neutrality and carbon peaking, and combining them with the characteristics of offshore petroleum engineering, a carbon neutral teaching laboratory with professional features will be constructed to enhance students' practical abilities in the field of carbon neutrality knowledge and deepen the dual carbon goals and concepts.

In addition, universities should strengthen cooperation with enterprises and explore the feasibility of jointly developing talent education programs based on the demand for carbon neutrality goals. Actively seek deep cooperation with enterprises, establish long-term cooperation and collaborative education mechanisms, and provide students with more practical opportunities as a combination point. Enterprises can dispatch senior majors to schools to undertake teaching tasks and work together with universities to complete curriculum design and teaching content. In addition, universities should increase their research investment in the field of carbon neutrality, improve their research level and service capabilities[16], especially in key technologies such as offshore carbon dioxide capture and storage. Strengthen cooperation with enterprises in research and development and technological breakthroughs, promote the transformation and application of scientific research results, and provide collaborative guidance for students' internships, practices, and innovative courses.

VI. Conclusion

The proposal of carbon neutrality targets is an excellent development opportunity for energy majors in higher education institutions. Although there are already complete education objectives and programs for the existing marine oil engineering major, there are still problems such as a lack of targeted and forward-looking education programs, insufficient educational resources, and insufficient integration of industry and education in the context of carbon neutrality. Relevant universities can carry out optimization work by strengthening professional construction and curriculum reform, increasing investment in educational resources, and deepening the integration of industry and education to meet the needs of student education for marine oil and gas work majors in the context of carbon neutrality, and promote the construction of world-class disciplines in energy majors in higher education institutions.

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