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Editorial: The challenge and opportunity of CCUS in the development of unconventional resource

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Editorial on the Research Topic
The challenge and opportunity of CCUS in the development of unconventional resource

1 Introduction

The decline in conventional oil production and the rise in costs for exploitation have led to a shift in global interest towards unconventional resources. To address environmental issues, the development of unconventional resources aims to increase oil and gas production without increasing emissions (Li et al., 2017a; Li et al., 2021). The use of low-carbon technologies, which emit low or zero CO_2 emissions, is crucial in reducing CO_2 emissions and promoting carbon neutrality. Key to this is the application of low-carbon technology in the development process to reduce emissions and increase CO_2 utilization and storage (Li et al., 2014; Li et al., 2017b; Li et al., 2020).

This Research Topic, which accompanies the Research Topic of Frontiers in Energy Research, places an emphasis on the fundamental innovations and compiles 11 current publications on original applications of *the challenge and opportunity of CCUS in the development of unconventional resource*.

2 Review of the research presented in this Research Topic

The works presented in this section focus on different aspects of unconventional hydrocarbon reservoirs, including hydraulic fracturing operations, acid fracturing techniques, non-aqueous fracturing techniques, CO_2 flooding, casing deformation, micro-scale reservoir properties, interplay mechanisms for enhanced oil recovery, geological-engineering integration, and natural gas pipeline leaks.

Chen's presented two novel models for predicting the Drag Reduction (DR) in hydraulic fracturing operations with slickwater, based on dynamic similarity and offering reliable

predictions with deviations ranging from −10% to 10% and −6%–6% for models 1 and 2, respectively (Chen et al.).

In Liu's research, the acid rock reaction and acid-etched fracture conductivity experiments of Qixia Fm tight carbonate are investigated to optimize the main acid type and acid frac technique. In addition, the feasibility of open-hole packer and sliding sleeve staged acid fracturing is discussed, and the staged acid frac tool string is optimized (Liu et al.).

In Peng's study, Supercritical CO_2 has been found to be a promising non-aqueous fracturing technique for low-pressure tight sandstone, with reduced formation sensitivity damage observed in tight sandstone cores from the Jinqiu Gas field in the Sichuan Basin after interaction with supercritical CO_2 (Peng et al.; Peng et al.).

In Wang's Research, CO_2 flooding and burial efficiency in the Daqing Oilfield can be improved by using multiple linear regression to establish a screening standard for suitable CO_2 flooding reservoirs. A total of 15 factors are used as independent variables and the results are consistent with the oilfield's production history, with over 70% of well groups having an evaluation value greater than 0.50 and an annual oil exchange ratio above 40%. This provides effective guidance for the development of the Daqing Oilfield (Wang et al., 2022).

In Shen's paper, the casing deformation (CD) prediction model was established for 105 gas wells in the Luzhou shale gas area to analyze the impact of CD on shale gas fracturing progress and stimulation effect using the fracture operation curve diagnosis method (Shen et al.).

In Guo's research, a digital core reconstruction method was applied to study the fluid distribution and pore structure of the Xujiahe Formation in Yuanba. Results showed that water residues could reduce pore sizes and affect their connectivity. This study provides an applicable method to understand micro-scale reservoir properties and fluid distribution mechanisms in tight sandstone gas reservoirs (Guo et al.).

Li's work presented a model that simulates the impact of hydraulic fracturing and shut-in period on pore pressure and water saturation in shale gas wells, which are key factors in well production. The model uses an efficient simulation technique (EDFM) and accounts for the fracture propagation and matrix flow (Li et al.; Li et al.).

In Hao's work, the interplay mechanisms for enhanced oil recovery were studied using laboratory and numerical models, which showed that CO_2 injection at the lower well can move upward to the higher well and increase oil recovery. Pilot tests in China showed a 2.27×104 m^3 crude oil recovery with a high oil/CO_2 exchange ratio of 3.92. The well-to-well interplay is a promising approach for EOR with better CO_2 utilization efficiency (Hao et al.).

Zeng established a geological-engineering integration model to optimize the development of tight sandstone gas reservoirs in Jinqiu Gas field with low porosity and permeability, leading to increased well productivity from 50,500 to 434,300 cubic meters per day through customized stimulation strategies (Zeng et al.).

In Nie's work, both laboratory tests and reservoir simulation were done to study the feasibility and benefits of associated gas injection. The experiments and simulation showed that oil recovery was increased by 16.8% compared to depletion development by natural energy through the optimization of depletion development and gas injection development strategy (Xu et al.).

Xu presented a leakage diffusion model and simulation scheme for exposed natural gas pipeline leaks in mountainous areas, providing insight into the diffusion pattern and influence range of leaks under different factors, helping to form emergency response strategies and provide a theoretical basis for risk analysis in these areas (Xu et al.).

The works presented here offer valuable insights into different aspects of unconventional hydrocarbon reservoirs, and their findings can be applied to improve the efficiency and effectiveness of hydrocarbon extraction operations. The studies also highlight the importance of continued research into unconventional reservoirs, particularly in the face of increasing global energy demands and environmental concerns. Additionally, gas hydrates, another unconventional hydrocarbon reservoir, also offer significant potential for energy production, but further research is needed to better understand their properties and develop efficient extraction techniques.

3 Conclusion

In conclusion, this Research Topic of Frontiers in Energy Research has provided valuable contributions to the development of unconventional hydrocarbon reservoirs. The studies have explored various techniques and approaches, ranging from hydraulic fracturing operations to non-aqueous fracturing techniques, CO_2 flooding, casing deformation, micro-scale reservoir properties, interplay mechanisms for enhanced oil recovery, geological-engineering integration, and natural gas pipeline leaks. These findings are significant for improving the efficiency and effectiveness of hydrocarbon extraction operations, while also addressing environmental concerns through the use of low-carbon technologies. Moreover, this research highlights the importance of continued investigation into unconventional reservoirs, as they offer significant potential for energy production to meet increasing global demands. The application of these studies will be instrumental in achieving carbon neutrality, and their fundamental innovations will guide future research towards a sustainable energy future.

Author contributions

The author confirms being the sole contributor of this work and has approved it for publication.

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Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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