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Editorial

CO_2 Geological Storage and Utilization

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Citation: Huang, L. CO_2 Geological Storage and Utilization. *Atmosphere* **2023**, *14*, 1166. https://doi.org/10.3390/atmos14071166

Received: 17 July 2023
Accepted: 18 July 2023
Published: 19 July 2023

With increasing greenhouse gas emissions caused by human activities, climate change is affecting the survival and development of human society. It is critical that we find effective solutions to this problem. As a means to deal with climate change, carbon capture, utilization, and storage (CCUS) technology has received extensive attention and research in recent years. Among them, geological CO_2 storage and utilization technology has become a key measure in dealing with global climate change due to its relatively mature and reliable technical basis.

This Special Issue of Atmosphere, entitled "CO_2 Geological Storage and Utilization", comprises six original papers on three topics. The papers by Hou et al. [1] and Xiao et al. [2] mainly studied CO_2 injection technology to improve oil and gas reservoir recovery. The papers by Lai et al. [3] and Che et al. [4] mainly studied the feasibility of CCUS technology, especially CO_2 geological storage and utilization technology, and its applications in the petroleum industry. The papers by Yang et al. [5] and Wang et al. [6] mainly studied the corrosion of CO_2 on gathering pipelines and the monitoring of the corrosion rate. The main contributions of each paper are summarized below.

The paper by Hou et al. [1] investigated the microscopic adsorption pattern of CH_4 and the competitive adsorption behavior of CH_4 and CO_2 in sodium-based montmorillonite using molecular simulation methods. The results show that the adsorption capacity of CH_4 on montmorillonite decreases with increasing temperature, initially increases and then decreases with increasing pressure, and decreases with increasing pore size. The repulsive efficiency of CO_2 increases with the increase in CO_2 injection pressure, and the competitive adsorption ratio of CO_2/CH_4 decreases with the increase in pressure. The gas storage capacity of CO_2 decreases with the increasing temperature and increases with the increasing injection pressure. The study reveals the microscopic adsorption law of CH_4 in sodium-based montmorillonite and the competitive adsorption law of CH_4 and CO_2, which not only has certain guiding significance for the improved extraction of shale gas via CO_2 injection, but also has reference value for the geological storage of CO_2 in shale.

Looking at the problem of low oil production after volume-fracturing in an A83 block of Ordos Basin, Xiao et al. [2]'s paper used the Pearson correlation coefficient (PCC) and the Spearman rank correlation coefficient (SRCC) to analyze the dominant factors of productivity in this block. It was found that the main reason for the low production in the A83 block was its insufficient formation energy. Based on this, the CO_2 pre-pad energized fracturing method was proposed. To study the feasibility of CO_2 pre-pad energized fracturing in an A83 block, a comprehensive numerical simulation model of the reservoir is established to simulate the production of conventional volume-fracturing technology and CO_2 pre-pad energized fracturing technology in an A83-1 well within 5 years. The results show that, compared with conventional volume fracturing, the cumulative oil production of CO_2 pre-pad energized fracturing is increased by 11.8%, and the water content is reduced by 16.5%. The CO_2 pre-pad energized fracturing technology can not only further increase oil production, but also effectively realize the geological storage and utilization of CO_2, thus greatly reducing the greenhouse effect.

The paper by Lai et al. [3] first studied the research status of CO_2 geological storage technology, the formation characteristics of shale gas reservoirs, and the characteristics of abandoned shale gas wells in the Sichuan Basin, analyzing the feasibility of CO_2 geological storage technology in shale gas reservoirs in the Sichuan Basin. At the same time, by coupling the competitive adsorption mechanism of CO_2/CH_4, the CO_2 storage equation is modified and applied to the shale block in the Sichuan Basin, which proves that the abandoned shale gas wells in this block have good CO_2 storage potential. The research results provide a reference for the practical implementation of the geological storage of CO_2 in unconventional oil and gas reservoirs, which is critical for the use of abandoned shale gas wells for CO_2 storage, further mitigating greenhouse gas emissions and improving the recovery factor of shale gas resources.

The paper by Che et al. [4] clarified the importance of the oil industry in the process of carbon emission reduction by studying the application, advantages, and disadvantages of carbon capture, storage, and utilization technology in China's petroleum industry. The challenges and risks faced by China's petroleum industry in the operation of CCUS projects are analyzed, and suggestions are made. The research provides a systematic reference and assistance for the application of CCUS in China's petroleum industry.

Yang et al. [5] focused on the problem of corrosion intensification in the oil–water mixed system pipeline during a period of high water content. Taking the gathering and transportation system of HH oilfield as an example, 20 # steel was used as the sample, and the dynamic corrosion evaluation experiment was carried out using a high-temperature and high-pressure dynamic corrosion scaling evaluation instrument under different single factors of high water content conditions. The effects of temperature and pressure, CO_2 content, SRB content, Ca^{2+} + Mg^{2+} content, and Cl^- content on the corrosion law of 20 # steel with high water content were investigated, and the main controlling factors of corrosion were determined using SPSS data analysis software. The results showed that the correlation between the factors and the corrosion rate was CO_2 partial pressure > SRB content > Cl^- content > Ca^{2+} + Mg^{2+} content > temperature pressure. CO_2 partial pressure is the main controlling factor of corrosion, which provides a theoretical basis for the protection of high-water-content oil-gathering pipelines.

The paper by Wang et al. [6] focused on the problem of the difficulty in implementing the corrosion detection of submarine pipelines. The corrosion rate of submarine multiphase flow pipelines in the South China Sea was simulated using the De Waard 95 model, and the corrosion factor and corrosion rate data were obtained., Multiple linear regression (MLR), multi-layer perceptron neural network (MLPNN), radial basis function neural network (RBFNN), and other models were improved and optimized based on principal component analysis (PCA). A combined PCA-MLP prediction model was proposed. The results show that the combined PCA-MLP prediction model has a higher prediction accuracy and better prediction performance in the CO_2 corrosion prediction of submarine pipelines, providing scientific guidance for this area.

In summary, this Special Issue aims to explore the specific applications of the geological storage and utilization of CO_2 in the oil and gas industry, covering two aspects of theoretical research and field application, including three directions of research topics. We thank the authors for their valuable contributions and hope that this Special Issue can serve as a reference for future research on the geological storage and utilization of CO_2.

Funding: This work was funded by the National Natural Science Foundation of China, Grant Nos. 52204031, 41972137 and 42002157, and the Natural Science Foundation of Sichuan Province, Grant No. 2023NSFSC0947.

Acknowledgments: The editor would like to thank the authors for their valuable contributions, and the reviewers for their constructive comments and suggestions that helped to improve the manuscript.

Conflicts of Interest: The author declares no conflict of interest.

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