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EDITORIAL

Brief overview and perspective on Advances in CO_2 Geological Storage and Utilization (CGSU)

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1 Introduction

All over the world, with the intense longing for carbon emission reduction and the demand for clean energy (Feng et al., 2020; Iddphonce et al., 2020; Zhao et al., 2022), a promising and far-reaching technology called CO_2 geological storage and utilization (CGSU) has attracted increasing attention (Iddphonce et al., 2020; Ma et al., 2020). This CGSU technique enjoys huge potential and broad prospect, because it usually enables dual rewarding consequences – to sequester CO_2 and to acquire energy from geological formations, such as geothermal rock, oil and gas reservoirs (Iddphonce et al., 2020; Klewiah et al., 2020; Liu et al., 2020). In fact, the CGSU has been followed by interest of scientists all around world since geological storage was first proposed in the 1970s as a way to dispose of the CO_2. Meanwhile, the CGSU technique is not mature enough and usually involves a complicated THMC coupled process, making it necessary to deploy more insightful investigations to boost the development of CGUS technique in a robust, safe and cost-effective manner (Liu et al., 2021b; Zhao et al., 2021; Liu et al., 2023). Basically, this theme is expected to enhance the knowledge about the crucial role of CGSU in achieving the carbon emission reduction – an issue concerned to the world (Liu et al., 2021a; Xie et al., 2021; Zhao et al., 2021; Zhao et al., 2022). Therefore, this special issue is organized and tends to present newest achievements regarding the CGSU, such as the theory expansion, economic analysis, experimental investigation and numerical simulation.

2 Overview of special issue papers

The 19 papers in this special issue can be categorized into three groups according to their research points, including basic investigations for CGSU, experimental works and numerical achievements.

2.1 Basic investigations for CGSU

In this issue, there have 6 articles reported this item. Zhang et al. investigated the infill well pattern based on the dynamic change of reservoirs during coalbed methane development. Yan et al. exhibited the geochemical characteristics of produced fluids from CBM in Daning-Jixian block, Ordos Basin, China. Zhang et al. introduced a method for predicting the probability of formation of complex hydraulic fracture networks in shale reservoirs. Sun et al. reported pore structure evolution of mudstone caprock under cyclic load-unload and its influence on breakthrough pressure. Zhang et al. worked on the coal and rock dynamic disaster prevention and control technology

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in the large mining face of a deep outburst mine. Besides, Tan et al. made an achievement on the global and regional controls on carbon-sulfur isotope cycling during SPICE event in south China. Basically, since the underground reservoir is the target to get CGSU behavior, these basic investigations (mainly on reservoir characterization) are of guidance.

2.2 Experimental works on CGSU

In this issue, 7 articles reported experiment-related work on CGSU. Zhao et al. measured the CO_2 geological sequestration potential of the low-rank coals in the southern margin of the Junggar Basin. Lu et al. reviewed the low-field NMR application in the characterization of CGSU related to shale gas reservoirs. Zheng et al. made a measurement on CO_2 adsorption capacity with respect to different pressure and temperature in sub-bituminous. Sun et al. showed the effects of sub-/super-critical CO_2 on the fracture-related mechanical characteristics of bituminous coal. Zhou et al. exhibited the effect of damage zone around borehole on CO_2 injection promoted gas extraction in soft and low-permeability coal seam. Li et al. compared the porosity, mechanical and CO_2 adsorption characteristics between coal and shale. In addition, Chi et al. made the CO_2 immiscible gas flooding and characterization of seepage resistance. In general, experimental investigations offer a direct observation and measurement on how injected CO_2 works in geological reservoir, being helpful for understanding he mechanism of CGSU.

2.3 Numerical achievements on CGSU

In this issue, totally 6 articles work in a numerical methodology. Wang et al. used COMSOL simulation to study on in situ stress testing method based on Kaiser Effect of acoustic emission. Fan et al. investigated the reasonable start time of carbon dioxide injection in enhanced coalbed methane recovery involving thermal-hydraulic-mechanical couplings. Liu et al. assessed the cost reduction potential of CCUS cluster projects of coal-fired plants in Guangdong Province in China. Wang et al. exhibited the effect of permeability and its horizontal anisotropy on enhanced coalbed methane recovery with CO_2 storage. Bai et al. studied the pressure variation law and enhancen CBM extraction application effect of CO_2 phase transition jet coal seam fracturing technology. Besides, Chi et al. made a novel numerical simulation of CO_2 immiscible flooding coupled with viscosity and starting pressure gradient modeling in ultra-low permeability reservoir. These numerical works work with more operating conditions and larger scale, compared to experimental measurements, which is effective as the verification before practice of CGSU.

3 Summary and perspectives

As for the carbon emission reduction, the geological CO_2 sequestration is treated as promising and is getting more important. Basically, the CGSU issues are of significance to enable CO_2 to be sequestrated, ensuring its attractive traits. However, CGSU is not easy to practice, where the safety issue is one of the points awaiting to be faced, that is, how to sequestrate CO_2 underground in a safe and economic manner. Hopefully, this CGSU-related special issue offers a preliminary acquaintance and also brings enlightenments on this item.

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