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Failure mechanism of carbon dioxide transport infrastructure: A comprehensive review

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ABSTRACT

Carbon dioxide capture and storage (CCS), the bottom covering technology for environmental protection and energy transformation, plays a vital role in reducing CO_2 emissions and has become an international research hotspot. The safe operation of CO_2 transport infrastructure is crucial to ensure the smooth implementation of carbon reduction actions. However, the understanding of disasters in carbon transmission infrastructure is not comprehensive and profound enough since CCS is still developing, which leads to few engineering standards on disaster prevention and mitigation of CO_2 transport infrastructure. This paper provides detailed reviews, including the composition and characteristics of carbon transmission infrastructure, failure mechanisms. It is concluded that the characteristics of CO_2 transport infrastructure damage fundamentally stems from the working fluid and environment, and novelty pointed out that future research hotspots are damage under multi-field coupling, damage detection and monitoring, design to reduce damage and repair after damage. The summary of existing research will be helpful for future academic research and engineering practice of CO_2 transport infrastructure disaster prevention and mitigation.

1. Introduction

The use of fossil fuels, such as coal, oil, and natural gas, has directly or indirectly significantly accelerated the development of the economy, science, technology, and culture of human civilization since industrialization (these fossil fuels provide for over 85% of the world's energy needs) (Wigley et al., 1996; Wang et al., 2021). However, the emission of a large number of greenhouse gases (such as CO_2 and CH_4) has considerably impacted the global climate and environment (Sabine et al., 2004; Thomas et al., 2004; Griggs and Noguer, 2002). Global warming and environmental pollution have aroused the international community's vigilance, and reducing carbon emissions has become the consensus of all countries (Chao, 2016). The International Energy Agency (IEA) has put forward a series of targets, with the ultimate goal of global annual storage of CO_2 exceeding 70 million tons by 2050 (Wang et al., 2021; Ritchie et al., 2020; Zhang et al., 2021).

Energy transformation and upgrading are the fundamental way of reducing greenhouse gas emissions which means replacement of traditional fossil fuel based energy with clean energy (such as wind, hydropower, and solar) (Benson and Surles, 2006; Li et al., 2019; Wigley et al., 1996). However, breaking through the bottleneck of energy transformation research and commercial applications in the world is challenging in a short time. Under such a stage background, extensive international attention is given to CO_2 capture and storage (CCS), a bottom covering technology for emission reduction and also a transition technology during the bottleneck period of energy transformation and upgrading (Duncan et al., 2014), which since its short term realizability of delaying global warming.

Several industrial-scale projects are under development and operational in Norway, the United States, Australia, the United Kingdom and the China, which about 45 global carbon capture points, and more than 36 planned to be built in more countries by 2030. At the same time, 33 lines for carbon transport and storage are in operation, 30 of which are transported through pipeline transport. Plans for new CCS projects are now being announced at a rate of several each year (Benson and Surles, 2006; Oen, 2003; Turan et al., 2021). The basic principle of CCS technology is to collect the CO_2 generated by industrial production and residents at the capture point, transport it after treatment, and inject it into the target geological structure. Finally, part of the CO_2 will be converted into carbonate minerals, thus becoming a part of the rock

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