Separation and Purification Technology 338 (2024) 126558

Contents lists available at ScienceDirect

Separation and Purification Technology

journal homepage: www.elsevier.com/locate/seppur

A review on carbon storage via mineral carbonation: Bibliometric analysis, research advances, challenges, and perspectives

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ARTICLE INFO

Keywords:
Mineral carbonation
Bibliometrics
Solid wastes
Carbon capture and storage
Sustainable development

ABSTRACT

Mineral carbonation as a way of carbon storage has received a particular attention in the reduction of carbon dioxide (CO_2) emission . This work gives a comprehensive description of the research trends and hotspots in the field of mineral carbonation for carbon storage based on bibliometric analysis. A total of 1507 articles were collected from the Web of Science database from 2010 to 2022 and analyzed in details, using a Citepace and VOSviewer software. Keyword cluster analysis indicates that research on mineral carbonation mainly involves natural minerals, industrial wastes, and cement-based materials. Research advances on carbon storage via mineral carbonation are summarized from the aspects of magnesium-based feedstocks and calcium-based feedstocks. Direct aqueous carbonation and indirect carbonation are the most promising methods. Mining tailings and industrial wastes are promising feedstocks for mineral carbonation. The slow kinetics and low carbonation capacity of feedstocks are the main obstacles for industrial application. Finally, challenges and prospects in mineral carbonation are put forward, which is conducive to its rapid and balanced development. This work provides the basis for the future development of cheap, efficient, and green large-scale mineral carbonation processes for carbon storage.

1. Introduction

The rapid development of global industries has led to the extensive consumption of fossil fuels, causing a sharp rise in atmospheric CO_2 levels. The CO_2 emissions of China reached 10.87×10^9 tons in 2021, accounting for about 31 % of the global total CO_2 emissions [121]. The primary sources of the CO_2 emissions include coal-fired power plants, iron and steel industries, and cement industries. CO_2, a potent greenhouse gas, is a major contributor to global warming and causes serious threats to the earth. The reduction of CO_2 emissions has become imperative and gains increasing worldwide attention. The United Nations Intergovernmental Panel on Climate Change proposed the goal of limiting the global average temperature increase to 1.5–2 °C, as outlined in its Special Report on Global Warming of 1.5 °C. Carbon capture, utilization, and storage (CCUS) has been a promising strategy and plays a crucial role in the pursuit of low-carbon sustainable development [114,120]. CCUS encompasses the separation, capture, transportation, utilization, and storage of CO_2 emitted from various production processes [132]. The purified CO_2 can be recycled to produce commercially valuable CO_2-related products or injected into deep geological reservoirs for storage. In this way, CCUS contributes significantly to carbon reduction. CO_2 storage serves as a crucial technology for the widespread implementation and advancement of large-scale CCUS initiatives.

There are three primary routes for CO_2 storage, including ocean storage, geological storage, and mineral storage (Fig. 1). Ocean storage involves the transportation of captured CO_2 by ships or pipelines to the deep-sea floor for storage. However, this method is costly and cause the risk of ocean acidification and thus have detrimental effects on marine life [89,82]. Ocean storage is still in the experimental stage and has not yet been widely implemented. The conventional geological storage involves injecting supercritical CO_2 into geological formations, including abandoned oil fields, unexploitable coal seams, and saline aquifers, to effectively reduce CO_2 emissions [33]. This process is particularly relied on the geological sites being porous and permeable enough to accommodate and sequester CO_2. Geological storage allows large-scale CO_2

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https://doi.org/10.1016/j.seppur.2024.126558
Received 3 December 2023; Received in revised form 24 January 2024; Accepted 25 January 2024
Available online 1 February 2024
1383-5866/