Separation and Purification Technology 298 (2022) 121512

Contents lists available at ScienceDirect

Separation and Purification Technology

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

Mineralization and utilization of CO_2 in construction and demolition wastes recycling for building materials: A systematic review of recycled concrete aggregate and recycled hardened cement powder

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ARTICLE INFO

Keywords:
Mineral carbonation
Recycling of construction and demolition wastes
Low-carbon cement and concrete
Recycled concrete aggregate
Recycled hardened cement powder

ABSTRACT

Climate change, which cause a series of extreme weather events like tropical storms, floods and droughts, is the result of increased anthropogenic greenhouse gas emissions, particularly CO_2. The decomposition of limestone and combustion of fossil fuels processes involved in the production of cement are a large source of CO_2 emissions. Carbon capture, utilization and storage (CCUS) is a critical emissions reduction technology for cement manufacture. Mineral carbonation of cementitious materials can be applied as a low-carbon cement and concrete production technology, which could provide a route for CO_2 permanent sequestration. Recycled concrete as a low-carbon cement and concrete could be produced by replacing the natural aggregate and Portland clinker with recycled hardened cement powder and recycled concrete aggregate produced from construction and demolition wastes. However, the performance of recycled concrete was inferior to those of Portland cement concrete with the same production process due to the existence of adhered old mortar of recycled hardened cement powder and recycled concrete aggregate. Mineral carbonation in recycled concrete aggregate and recycled hardened cement powder is that CO_2 chemically reacted with calcium hydroxide, calcium silica hydrate, etc., forming thermodynamically stable carbonate minerals to absorb CO_2, and improve the fine value, high porosity and water absorption of recycled hardened cement powder and recycled concrete aggregate. This paper reviewed currently primary methodologies for the mineralization of CO_2 in construction and demolition wastes recycling for building materials: one is property improvement of recycled concrete aggregate by mineral carbonation, while the other is the injection of CO_2 into recycled hardened cement powder. Moreover, the reaction mechanism of mineral carbonation, factors influencing reaction kinetics, performance of resultant products, and application of mineralization to decarbonation concrete production were discussed. Finally, based on current research state and existing problems, future prospect of construction and demolition wastes recycling for building materials by CO_2 mineralization were proposed.

1. Introduction

To date, global anthropogenic emissions of atmospheric CO_2 are larger than at any other time in human history, around 36.3 G tonnes in 2021 [1,2]. The cement industry is the second industrial emitter of CO_2, which accounts for over 7% of man-made CO_2 emissions [3].Carbon capture, utilization and storage (CCUS) has been considered as an important strategy to reduce CO_2 emissions and mitigate the negative impacts of climate change [4]. Mineral carbonation is an important technology of CCUS, in which calcium (Ca) or magnesium (Mg) from silicate minerals and alkaline industrial wastes is bound with CO_2 either *in situ* (below ground) or *ex situ* (above ground), forming stable calcium/magnesium carbonates [5,6]. Mineral carbonation could not only permanently fix CO_2, but also could produce valuable organic chemicals and inorganic material with the use of solid waste. Recently, Mineral carbonation has been applied to produce the sustainable construction materials, such as low-carbon recycled concrete [7].

The manufacture of Portland cement concrete consumes cement and

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https://doi.org/10.1016/j.seppur.2022.121512
Received 29 March 2022; Received in revised form 26 May 2022; Accepted 12 June 2022
Available online 20 June 2022
1383-5866/