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Review of CO_2 capture in construction-related industry and their utilization

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ABSTRACT

The construction industry is one of the largest CO_2 emitters worldwide. This review outlines all existing CO_2 capture technologies in the construction-related industry which are mainly found in the cement, steel, iron and construction material production industry. This review found that carbon capture and utilization (CCU) is the preferred alternative for carbon capture in the construction-related industry due to its ability to produce value-added products. Among the CCU pathways, alternatives that capture CO_2 *via* carbon mineralization have received the most attention due to their capabilities to valorize industrial waste to produce carbonate products. Unlike the production of liquid CO_2, hydrogen, purified CO_2 and biofuels from the majority of the carbon capture system (excluding hydroxide absorption and accelerated carbonation system), carbonate products can be directly utilized for construction application, reducing costs associated with product transportation. Although CCU technologies have potential sustainable carbon-capturing processes, outlined barriers such as high operating cost, low CO_2 capture capabilities and low maturity hinder their commercialization. To overcome these limitations, continuous development is crucial. Recommendations for the development of CCU technologies such as the creation of standards for carbonate products, incorporation of promoters or hybrid mixing, integration of IR 4.0' principles and process intensification into existing CCU technologies are deliberately discussed.

1. Introduction

The construction industry is one of the top contributors (González and Navarro, 2006; Tracker, 2021) towards global CO_2 emission (nearly 33% (Wibowo and Uda, 2018)), especially in rapidly urbanizing countries such as Japan (Ikaga et al., 2002) and China (Chen et al., 2017; Lu et al., 2016; Zhang et al., 2021). Ikaga et al. (2002) stated that up to a third of the total CO_2 emitted in Japan was attributed to construction operations. On the other hand, China was reported to have the highest carbon emissions within the construction arena since 2013 (Chen et al., 2017; Lu et al., 2016; Zhang et al., 2021; Li et al., 2019). Between 2011 and 2013, China produced up to an average of 9 to 10.2 billion t_{CO2} annually (approximately 28% of global CO_2 emission), largely contributed by its construction industry (Chen et al., 2017; Shi et al., 2017). Since then, the global CO_2 emissions percentage attributed to China had increased to 30% in 2017 (Li et al., 2019) and its annual CO_2 emission has been estimated to be at least 13.2 billion t_{CO2} heading by 2030. Apart from China, the United States of America, the European Union and India are also considered as large CO_2 contributors within the construction industry (IEA, 2021).

Carbon capture technologies are the potential alternatives carbon reduction alternatives that are recognized by the United Nations Framework Convention on Climate Change (UNFCCC) and the Intergovernmental Panel on Climate Change (IPCC) to combat global warming (Lipponen et al., 2017; Tamme and Scowcroft, 2020). There are numerous research that incorporates carbon capture into the construction-related industry particularly in the construction material production sectors (i.e., cement (Nussbaumer et al., 2011; Barker et al., 2009; Bosoaga et al., 2009), concrete (Ravikumar et al., 2021), carbonates (Pan et al., 2012), steel and iron (Dreillard et al., 2017; Mastropasqua et al., 2019; Han et al., 2014)).

The majority of carbon capture research in the construction-related industry focuses on cement, steel and iron production as they are considered as some of the largest industrial CO_2 emitters. In 2020, the cement industry have emitted up to 2.53 billion t_{CO2} which was estimated to make up 7.27 % of the global CO_2 emission (IEA, 2020; Tiseo,

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