

Abstract

A Solution to Reduce the Carbon Footprint: Mineralization and Utilization of CO₂ in Recycled Construction Aggregates [†]

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Abstract: This study introduces an innovative strategy to mitigate global carbon emissions by integrating carbon dioxide (CO₂) absorption and sequestration through the carbonation of recycled concrete aggregate (RCA). This approach not only promotes the recycling of concrete waste but also alleviates the demand for new natural resources, addressing both environmental impact and geographical challenges associated with mining. The integrated process utilizes ammonia to capture flue gas emissions from natural gas combined cycle (NGCC) power plants, employing the captured solution to carbonate RCA for effective CO₂ sequestration and to enhance the quality of RCA. The study comprehensively assesses the process's viability, considering capture performance, energy penalty, compliance with ammonia emissions standards, and capital costs. A techno-economic analysis (TEA) highlights the potential and economic feasibility of the proposed approach. Bench-scale experiments, conducted at low CO₂ concentrations (3~5%), focused on optimizing the carbonation process. The concentration of carbonated ammonia solution and its ratio to RCA were investigated to enhance the yield of carbonated RCA, resulting in an approximate 10% CO₂ capacity when using a 5% carbonated ammonia solution with a 0.25 ratio. The design of a large-scale plant, with an annual carbonated RCA production capacity of around 150 ktonnes, was formulated, and TEA calculations using Aspen Plus® V14 indicated a cost of approximately SGD 13 per tonne of carbonated product. These findings underscore the promising potential of the proposed process in efficiently reducing carbon emissions while providing economic viability at a larger scale.

Keywords: carbon capture; aqueous ammonia; recycled concrete aggregates; techno-economic analysis (TEA)



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