ISERME 2024 Proceedings
2nd September 2024 – Sapporo, Japan
https://doi.org/10.31705/ISERME.2024.48

Enhancing CO_2 Mineralisation in Steel Slag with Amines for Developing a Waste to Construction Material

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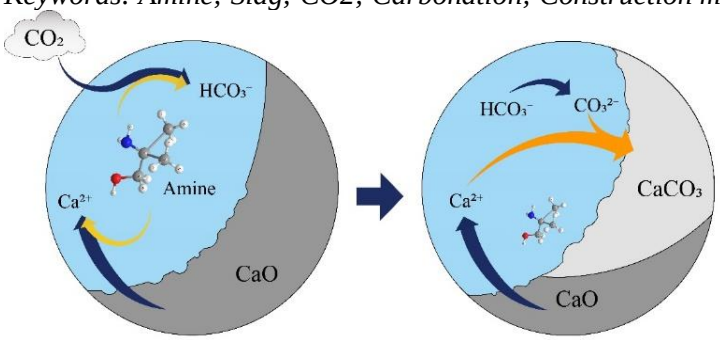
Abstract

Global warming has become an urgent issue due to the increasing atmospheric emission of CO2. In Japan, the steel industry emits a large amount of CO_2 and produces steel slag as an alkaline waste product. Using this steel slag to absorb CO_2 in flue gas is an effective approach for CO_2 emissions and recycling. This study introduces a novel technology utilizing amines to facilitate CO_2 sequestration in blast furnace slag. This innovative approach demonstrates significant potential and flexibility compared to conventional CO_2 capture technologies. In this study, changes in the carbonation efficiency of slag with three types of amines (N-Methyldiethanolamine (MDEA), 2-(Methylamino)ethanol (MAE), 2-Amino-2-methyl-1-propanol (AMP)) were investigated. In addition, this study examined the effect of Portland cement on the carbonation efficiency. In wet carbonation, the CO_2 fixation process entails the introduction of 1 mol/L of amine, water, slag, and cement, followed by a 24-hour leaching process and subsequent 24-hour carbonation. The results showed that adding AMP and cement exhibited the most significant increase in carbonation efficiency, resulting in the formation of 11.07% of the solid weight as $CaCO_3$, as confirmed by thermogravimetric analysis (TGA). Changes in calcium ion concentration and pH were also investigated in this study. The results showed that a small amount of Ca^{2+} dissolution and an increase in pH occurred in the early stages of the reaction and that the majority of Ca^{2+} dissolution occurred simultaneously with carbonation. In dry carbonation, slag cement paste, made by mixing amine, slag, and cement, was carbonated for 28 days after a 28-day curing period to determine changes in its properties. W/S ratio is 10, slag/cement ratio is 19, amine concentration is 1 mol/L, and CO_2 concentration is 0%, 0.04%, 5%, and 15%. Strength tests showed an increase in strength in the slag cement paste with the addition of MDEA.

Keywords: Amine; Slag; CO2; Carbonation; Construction materials



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