LOW CARBON CEMENT BASED ON HYDRATED MAGNESIUM CARBONATE

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Introduction

- This project aims at reducing the amount of CO_2 released into the atmosphere by dissolving CO_2 into an alkaline solution and mixing with a solution of Mg to precipitate carbonates. Both sources of CO_2 and Mg could be wastes from industrial processes (*e.g.* an exhaust gas stream from a plant and a brine from a seawater desalination process).
- Nesquehonite, $MgCO_3{\cdot}3H_2O$, is the phase obtained at room temperature and ambient pressure; its CO_2 content is about 32 mass%.
- A possible industrial application as a building material has been considered for nesquehonite; results obtained so far on nesquehonite-based products for bulk density and compressive strength are presented.

Materials and methods

- Syntheses reported were prepared from chemicals ($NaHCO_3$, Na_2CO_3 and $MgCl_2{\cdot}6H_2O$) but the controlled dissolution of CO_2 in a NaOH solution would give the same composition as a mixture of $NaHCO_3$ and Na_2CO_3 solutions.
- The mineralogy of the samples was determined with a Panalytical X'Pert Powder diffractometer (radiation: Cu-Kα, operating parameters: 45 mA and 40 kV, step size: 0.013 ˚2θ, atmosphere: static air) and their morphology was observed with a Hitachi S-520 Scanning Electron Microscope (acceleration voltage: 20 kV, preparation: gold coating under flowing Ar).
- The compressive strength of the cubes was measured on a Hounsfield Universal press (loading speed: 1 mm.min^{-1}, sensor: 10 kN).

Results (1)

Figure 1. Typical SEM photo of nesquehonite

Synthesis

Kg-size batches of nesquehonite (typically forming as prismatic needles, Figure 1) were successfully prepared.

Preparation

- Nesquehonite loses H_2O before CO_2 when subject to thermal treatment.
- When the thermally activated powder is mixed with water, nesquehonite reforms and exhibits cementitious properties so that shapes can be prepared.

Results (2)

Properties

Figure 2 shows the evolution of bulk density and compressive strength as a function of activation temperature and water/solid ratio for samples prepared under different conditions (activation temperature, water/solid ratio, cube size…). Both properties seem to reach a maximum for an activation temperature between 150 and 200 °C and tend to increase with decreasing water/solid ratio.

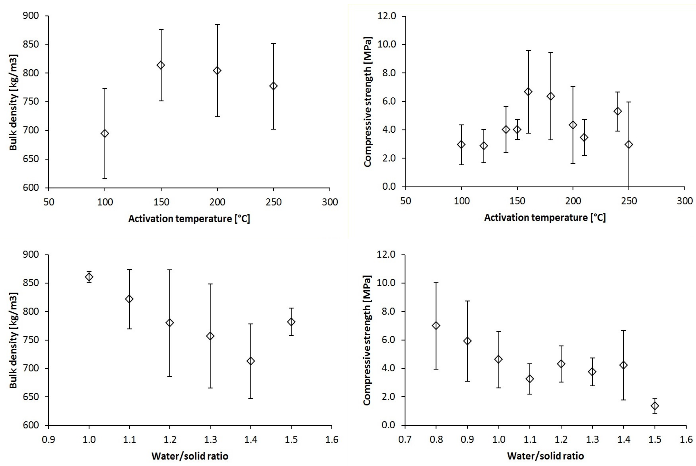

Figure 2. Evolution of the bulk density (left) and compressive strength (right) as a function of activation temperature (top) and water/solid ratio (bottom)

Conclusions

- Nesquehonite can be synthesized from industrial wastes and can be thermally activated to exhibit cementitious properties upon rehydration.
- The products obtained contain ~ 32 mass% CO_2 and, when washed properly, are virtually chloride-free, which allows their use in construction without danger of accelerating steel corrosion.
- The bulk density and compressive strength of cubes prepared from activated nesquehonite appear promising for construction-related applications
- The use of industrial wastes at different stages in the process would also help to classify these products as low carbon materials.

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