LOW CARBON CEMENT BASED ON HYDRATED MAGNESIUM CARBONATE

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Introduction

- This project aims at reducing the amount of CO₂ released into the atmosphere by dissolving CO₂ into an alkaline solution and mixing with a solution of Mg to precipitate carbonates. Both sources of CO₂ 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, MgCO₃·3H₂O, is the phase obtained at room temperature and ambient pressure; its CO₂ 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 (NaHCO₃, Na₂CO₃, and MgCl₂·6H₂O) but the controlled dissolution of CO₂ in a NaOH solution would give the same composition as a mixture of NaHCO₃ and Na₂CO₃ 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°, 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, sensor: 10 kN).

Results (1)

Synthesis

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

Preparation

- Nesquehonite loses H₂O before CO₂ 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.

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% CO₂ 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.

Acknowledgements

The authors would like to thank Gulf Organization for Research and Development (GORD, Qatar) for funding.