Calcite precipitation from CO_2-H_2O-$Ca(OH)_2$ slurry using RESS (Rapid Expansion of Supercritical Solution)

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The mineral carbonation can sequester CO_2 permanently by converting CO_2 into a thermodynamically stable form of carbonates using Ca or Mg rich raw materials. The direct aqueous mineral carbonation is a method to react CO_2 with Ca or Mg contained raw materialas in aquous solutions to produce carbonates.

In this study, the rapid expansion of supercritical solution (RESS) process was applied to the direct aqueous mineral carbonation to evaluate the feasibility of the RESS process for the direct aqueous mineral carbonation using Ca rich materials. The aquous mineral carbonation test was conducted on H_2O-$Ca(OH)_2$ slurry with supercritical CO_2 at elevated temperature and pressure conditions in a batch reactor to produce micro-sized calcium carbonate. Supercritical CO_2 and Ca solution were reacted at 50 ^oC, 90 bar and 80 ^oC, 120 bar for 30 minutes ~ 4 hours, and then reacted Ca slurry was rapidly sprayed through a nozzle to produce calcium carbonate. The crystallized calcium carbonate was analyzed by SEM-EDX and quantitative analysis on polymorphs of calcium carbonate was performed using FT-R and TGA.

The carbonation efficiency was the greatest in the test reacted for 1 hour, regardless of temperature and pressure conditions. At the 50 ^oC and 90 bar conditions and 1 hour reaction time, the carbonation efficiency was about 93%. In addtion, the calcite content was the highest for 1 hour of reaction and the contents of aragonite and vaterite increased after 1 hour of reaction. At the 80 ^oC and 120 bar conditions, similar results were obtained from the test at the 50 ^oC and 90 bar conditions, but the changes in the fraction of polymorphs and particle size of crystals were relatively small. These results indicate that carbonate minerals with different polymorphs and sizes can be rapidly produced by controlling temperature, pressure, and reaction time in the direct aquous mineral carbonation by using the RESS process.