An Experimental Study of CO_2 Mineralization

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Gypsum ($CaSO_4{\cdot}2H_2O$) is a waste product produced at coal-fired power plants by flue gas desulfurization (FGD) systems via the lime/limestone forced oxidation process. Although FGD gypsum can be utilized as a soil amendment in agriculture and in cement, wallboard and plaster manufacturing, approximately half of it is stored in ponds or in stack piles at power plant sites. This study investigates the beneficial use of FGD gypsum as a feedstock for CO_2 mineralization as a potential long-term carbon storage method.

Experiments were performed in a stirred reactor, varying pH levels through additions of NaOH (pH=12, 13, 13.5 and 14). The effects of varying P_{CO2} (10, 30, 60, and 250 psi) and solid:liquid ratio (1:10 and 1:100) were also examined at each pH to determine their control on the rate and extent of CO_2 mineralization. After 6 hours reaction time, the reacted fluids were separated from solid products via centrifugation, then filtered, acidified and analyzed by ICP-OES. Solid products were dried and examined by XRD and SEM/EDS.

Experimental results showed varying degrees of FGD gypsum conversion to calcite. Solution pH played a major role in the mineralization reaction, with complete conversion of gypsum to calcite at pH=14. In contrast, almost no calcite was produced at pH=12. P_{CO2} also affected the conversion reaction, with higher pressures producing less calcite due to decreased solution pH. Nearly 100% conversion of FGD gypsum was achieved at ambient temperature, using a solid to liquid ratio of 1:100, P_{CO2}=10 psi, and pH=13.5. ICP-OES data showed that potentially hazardous trace elements, such as B, Cd and V, were released at low levels from the FGD gypsum during the conversion reaction, but trace element release was minimized at lower P_{CO2} values. The results of this study suggest that FGD gypsum could provide an inexpensive waste feedstock for sequestration of CO_2 through mineralization in calcite.