

Carbonate mineralization using $\text{Ca}(\text{OH})_2$ suspensions for $\text{CO}_2(\text{g})$ capture and storage (CCS) at room temperature

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In the 21st C atmospheric $\text{CO}_2(\text{g})$ has become a major concern for the global warming due to the excessive anthropogenic production. Carbonate mineralization is considered as a potential approach to capture anthropogenic $\text{CO}_2(\text{g})$. Furthermore, it would be beneficial if the solid products of this process can be recycled for industrial utilization. Despite the easiness and the probable advantages, carbonate mineralization has not been proven to be economically feasible mainly due to the amounts of $\text{CO}_2(\text{g})$ generated during the whole process being larger than those captured by the process. Consequently, the development of novel techniques to overcome the limitation is necessary for the practical application of this process. This study examined the reaction processes of carbonate mineralization using $\text{Ca}(\text{OH})_2$ suspensions. Pure $\text{Ca}(\text{OH})_2$ was used as an ideal model compound for providing Ca^{2+} ions and alkalinity, which are essential for carbonate solid formation.

Batch experiments were conducted by reacting pure $\text{CO}_2(\text{g})$ with varying concentrations of $\text{Ca}(\text{OH})_2$ suspension ($[\text{Ca}(\text{OH})_2]_0 = 20, 27, 135, 270, 675 \text{ mM}$) at room temperature. $\text{CO}_2(\text{g})$ was purged into the suspensions for 60 min at 0.1 L/min. The initial pH of the $\text{Ca}(\text{OH})_2$ suspensions was stable at 12.5 ± 0.2 . After injecting $\text{CO}_2(\text{g})$, the pH of the suspensions decreased rapidly to 6.3 ± 0.2 in every case, except of 675 mM $\text{Ca}(\text{OH})_2$ (12.5 ± 0.2). Concurrently, $[\text{Ca}^{2+}]$ decreased to a minimum value ($1.0 \pm 0.5 \text{ mM}$) mainly due to the precipitation of CaCO_3 . Subsequently, $[\text{Ca}^{2+}]$ rebounded and reached a value corresponding to the solubility of calcite (10.0 mM) at the pH of the suspensions (6.3 ± 0.2). Semi-quantitative XRD analyses indicated that 95% wt. of the initial $\text{Ca}(\text{OH})_2$ was rapidly transformed to CaCO_3 within 15 min at $[\text{Ca}(\text{OH})_2]_0 = 135 \text{ mM}$. These results suggest a positive prospect of controlling carbonate mineralization process for the potentiality of its practical application.