Enhanced Ex-Situ Mineral Carbonation at Ambient Conditions with Industrial Waste

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Abstract

Carbon dioxide sequestration by conversion to carbonates has become a promising option for CO_2 storage. Experiments were conducted to determine the feasibility of CO_2 sequestration at ambient conditions using a Ca-rich industrial waste in a carbonate solution. The Ca-rich industrial waste used in this study was lignite fly ash. Fly ash was chosen because it is cheap, available near large CO_2 point sources, already in powder form, and reactive due to amorphous properties. In the experimental set-up, CO_2 absorption was inferred by monitoring feed and exhaust gas CO_2 concentrations. The addition of an alkali to a fly ash-distilled water solution provided a 50% increase in CO_2 absorption of the solution. Absorption time also increased by 50% compared to a fly ash-distilled water solution. TGA analysis was used to determine the extent of CO_2 sequestration in the carbonate form. At a liquid to solid ratio of 20:1, the conversion of "free" calcium to carbonates was 75%. A CO_2 balance on the system concluded that at the current operating conditions 42% of the total CO_2 fed to the system was sequestered in the carbonate form. Performing SEM-EDS analysis on the fly ash particles, before and after reaction with CO_2, found that the carbonate compound being formed was calcium carbonate. The analysis identified rhomboidal structures on the surface of the fly ash particles after reaction with CO_2, but not before. These rhomboids are characteristic of calcium carbonate formation and they had higher Ca, C, and O concentrations than the host spheres, suggesting calcium carbonate formation.