Short communication

A critical assessment of the testing conditions of CaO-based CO_2 sorbents

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A critical assessment of the testing conditions of CaO-based CO_2 sorbents

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Abstract

Calcium (or carbonate) looping (CaL) is a high-temperature process to capture CO_2 from industrial installation using CaO-based materials as the sorbent. A large number of natural and synthetic CaO-based sorbents for CO_2 capture have been developed and investigated in the laboratory by cycling the material between a low-temperature carbonation stage and a high-temperature calcination stage. We demonstrate the importance of the exact experimental protocol chosen to transition from the carbonation to the calcination step by varying the CO_2 concentration and the heating rate while keeping the conditions during the actual carbonation (650°C, 15 vol.% CO_2) and calcination (950°C, 80 vol.% CO_2) stages constant. The experiments were performed in a thermogravimetric analyser, the equipment most frequently used in investigations of the cyclic CO_2 uptake, using a natural limestone as the sorbent. Our results show that the reaction conditions under which the $CaCO_3$ is decomposed to CaO determines the cyclic performance of the sorbent, whereas the effect of the CO_2 concentration during the set calcination stage (which usually begins after most of the $CaCO_3$ has been converted to CaO) appears to be insignificant. Higher heating rates facilitate a higher cyclic CO_2 uptake because the carbonate phase, known to be prone to sintering, is exposed to higher temperatures for a shorter time. The reaction conditions during the transition period crucially affect the CO_2 uptake determined in laboratory tests and hence need to be reported in full detail, yet this is currently hardly the case. Otherwise it is unclear whether differences in the CO_2 uptake of different CO_2 sorbents are due to modifications of the material or variations in the testing protocol.

Keywords: Calcium looping, CO_2 capture, CaO-based sorbent, Calcination, Carbonation