CO_2 UPTAKE CAPACITY OF MAGNETITE LOADED CARBON FINE PARTICLES IN A SOUND ASSISTED FLUIDIZED BED

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CO_2 adsorption with solid sorbents is one of the most promising options for post-combustion CO_2 capture strategies. The performances of solid sorbents under typical post-combustion flue-gas conditions (CO_2 1−15% vol. and atmospheric pressure) are currently poorly investigated. In that conditions, the CO_2 uptake capacity is governed primarily by the chemical functionality of the sorbent. For this reason materials with a distinctive surface chemistry (presence of activated surface atoms or sites) could find large applications in adsorption technologies. Recent studies of CO_2 adsorption on low-cost iron metal oxide surfaces strongly encourage the possible use of metal oxide as sorbents, but the tendency of magnetite particles to agglomerate causes a lowering of CO_2 uptake capacity. The dispersion of magnetite nanoparticles on a carbonaceous matrix appears to be a suitable strategy to overcome this shortcoming.
In this study composite materials were prepared by coating a low-cost commercial carbon black (CB) with magnetite fine particles. Five different carbon-magnetite composites at different CB load (from 15 to 65 wt.%) have been synthesized by co-precipitation strategy and fully characterized. The CO_2 uptake of the five composites was evaluated on the basis of the breakthrough times measured at atmospheric pressure and room temperature in a lab-scale fixed bed micro-reactor. An optimal CB load allowing the better dispersion of magnetite particles into the composites was assessed on the basis of CO_2 uptake. The best adsorbing composite (50 wt.% of CB load) has been selected to verify the possibility of carrying out a two stage operation and the thermochemical stability in a sound assisted fluidized bed. To this aim the reactor has been firstly operated for CO_2 adsorption and then for regeneration. The effect of multiple cycles of adsorption and desorption steps has been also quantified.
The investigation of the CO_2 adsorption behaviour in typical post-combustion flue-gas conditions indicated that carbon-magnetite composites act as CO_2 adsorbent with very high CO_2 uptake capacity and demonstrated that the presence of carbonaceous matrix inside the composites does not compromise FM ability to fix CO_2 molecules. Sound assisted fluidization considerably enhances the CO_2 uptake of the best adsorbing composite (up to 20 m_{adsCO2}/g), that can undergo several CO_2 adsorption and desorption cycles without modification in adsorption properties. The obtained results are interesting in prospect of a cyclic operation in two interconnected fluidized bed, since the time needed to adsorb almost the total CO_2 uptake is comparable to that necessary to completely regenerate the adsorbent.

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