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Investigation of a fixed-bed reactor for the calcination of $CaCO_3$ by the simultaneous reduction of CuO with a fuel gas

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ABSTRACT:

The exothermic reduction of CuO to Cu using a fuel gas as a source of heat to carry out the simultaneous calcination of $CaCO_3$ in a fixed bed has been evaluated. A dynamic pseudo-homogeneous model has been developed to describe in detail the transient behaviour of this operation. The experimental tests have been performed in a lab scale packed-bed reactor (ID x L=38 x 920 mm) containing a mixture of CaO- and CuO-based particles (with 12 wt.% and 60 wt.% of active phase, respectively). Preliminary heat-transfer studies have been carried out using inert gases at different temperatures in order to estimate the overall heat transfer coefficient of the system. An overall heat transfer coefficient of around 5 W/m^2 K has been obtained, which is a sufficiently low value to claim an operation close to adiabatic conditions. Hydrogen has been chosen as reducing gas. A Cu/Ca molar ratio of 1.8 in the bed allows both the reduction and calcination fronts to advance together, with moderate maximum temperatures of around 870 ºC, leaving behind totally converted solids. The effect of the solids temperature on the operation has also been evaluated. A rapid and complete reduction of CuO with H_2 has been achieved, even with starting temperatures slightly higher than 400 ºC. However, the calcination of $CaCO_3$ was complete only in those zones of the bed where the temperature profile reached 870ºC.