Cite this work as ***Chemical Engineering Science Volume 137, 1 December 2015, Pages 254–267***

$CaCO_3$ calcination by the simultaneous reduction of CuO in a Ca/Cu chemical looping process

*J.M Alarcón, J.R. Fernández**

Spanish Research Council, CSIC-INCAR, Instituto Nacional del Carbón C/ Francisco Pintado Fe, 26, 33011, Oviedo. Spain. *Corresponding author: José Ramón Fernández, email: jramon@incar.csic.es, Telephone:+34 985119090, Fax:+34 985297662

HIGHLIGHTS:

- The reduction of CuO can supply the energy required for CaCO3 calcination in a same bed.
- A dynamic model predicts the evolution of the reaction and heat exchange fronts.
- Calcination modifies the advance of the heat exchange front.
- Changes in Cu/Ca ratio and in fuel composition have a substantial effect on bed performance.

KEYWORDS:

CO_2 capture; CaCO3 calcination; CuO reduction; Chemical looping combustion; Adiabatic fixed bed

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 is evaluated. The absence of apparent large energy penalties, as in other chemical looping processes, is an indication that there is great potential for achieving a high level of energy efficiency with this Ca/Cu looping concept. A dynamic pseudo-homogeneous model has been developed to describe in detail the transient behaviour of this operation in a fixed-bed reactor under adiabatic conditions. A sensitivity analysis of the main operating parameters (i. e. the CuO/ $CaCO_3$ molar ratio, starting temperature and fuelgas composition)confirms the theoretical viability of this operation. A balanced CuO/

$CaCO_3$ ratio ensures a suitable bed performance allowing the reduction and calcination fronts to advance together, reach moderate maximum temperatures of around 900 ºC and leave behind totally converted solids. The use of CO as fuel gas significantly reduces the CuO/ $CaCO_3$ ratio required for the $CaCO_3$ calcination. A careful adjustment to bed composition must be carried out, since an excess of CuO in the bed will generate more heat than required for the calcination, and consequently hot spots higher than 1000 ºC will form along the bed. In contrast, an excess 24 of $CaCO_3$ will increase the energy demand and part of the bed will be left uncalcined.