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Performance of natural sorbents and wastes CO_2 capture under more realistic conditions of Ca-looping for cement industry

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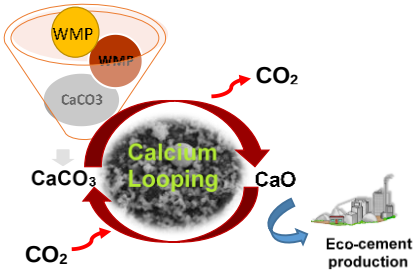
The cement industry is the second largest CO_2 emitting industry accounting for over 5% of anthropogenic global CO_2 emissions. Between the approaches to reduce the CO_2 emissions in cement industry, the Calcium-Looping Cycle (Ca-looping) is one of the most promising processes for CO_2 capture based on the reversible chemical reaction between CaO-based sorbents and CO_2 to form $CaCO_3$. The high adsorption capacity (0.78 g CO_2/g CaO), high selectivity, the use of cheap sorbents and the possible utilization of these exhausted sorbents as raw materials for the cement industry are the main advantages of this CO_2 capture process and can lead to the increasing development and use of eco-cements. The main drawback of Ca-looping process is the sorbents deactivation due to the sintering and pores blockage along the carbonation-calcination cycles.



During the last decade, several studies had been done about the improvement of the CaO-based sorbents carrying capacity and the enhancement of sorbents sintering resistance, but mostly of them are performed under mild calcination [1] temperatures, which does not correspond to the industrial reality.

The present work focuses on the comparative study of two different waste marble (from Estremoz and Vila Viçosa) [2] and two natural limestones (one from West Bank and a Portuguese one) in a laboratory fluidized bed reactor (FBR) unit along 20 carbonation-calcination cycles. During the experimental tests was used a gas mixture with a CO_2 concentration within the range of the cement industrial flue gas emissions (25% of CO_2) and the calcination was carried out under industrial realistic conditions (930 °C and 80 % of CO_2). The effect of particles size on the CO_2 carrying capacity was evaluated for three range of particles (200-250 µm, 250-355 µm and 355-500 µm. For a better understood of severe calcination conditions on the sorbents deactivation, the fresh and used sorbents were characterized by N_2 sorption and X-ray diffraction. The sorbents resistance to the fragmentation and abrasion during the fluidization in the FBR was evaluated thought the particles size distribution of fresh samples and after 20 cycles.

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References

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