Modelling of calcium looping reactors for CO_2 capture

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Abstract:

Mitigation of man-made CO_2 emissions is essential to sustainable development. Calcium looping is a competitive technology that enables capturing CO_2 from industrial processes and fossil fuel based power plants. The CO_2 in a gas mixture is converted into $CaCO_3$ by reacting with CaO in a carbonator. The $CaCO_3$ is then decomposed into CO_2 and CaO in a calciner (regenerator) where heat is normally supplied by oxy-combustion of fuels. In this way, CO_2 is separated from the gas mixture. As a promising 2nd generation technology for CO_2 capture, calcium looping has attracted increasing research interest in both experimental and modelling studies [1]. The two reactors, i.e. carbonator and calciner, are the key components that are different from the reference process without CO_2 capture. Modelling of the two reactors is essential for preliminary process design and cost estimation as well as further process optimization. While considerable literature research work focuses on the carbonator modelling [2], there are only a few studies that investigate modelling of the calciner. Even fewer studies have included both reactors although the two reactors are known to be interconnected and dependent on each other.

This paper presents a modelling study of the calcium looping reactors. Reaction kinetics, solid flow behaviours and vertical distributions in the reactors are taken into consideration [1-3]. The models have been used for preliminary sizing and cost estimation in a performance evaluation study of natural gas combined cycle (NGCC) based power plants with CO_2 capture [4-5]. Process improvement and optimization studies will be performed to further reduce energy consumption and plant cost.

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