Experimental and numerical investigation on chemical looping carbon capture based on solid particles

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ABSTRACT

Nowadays a considerable amount of research is being pursued in the advance of clean coal technologies. In this framework ENEA the Italian National Agency for New Technologies, Energy and the Environment is investing efforts in the construction of a test plant to demonstrate the feasibility of a gasification technology as a possible route to produce energy and hydrogen from coal. Such a plant, named ZECOMIX, can be broken into a chemical island and a power unit. The former consists of a reactor where the hydro-gasification of coal takes place producing synthetic fuel gas and a reactor where the gas leaving the gasifier is successively decarbonised. In the power unit an oxy-combustion occurs and power is produced by means of an innovative thermodynamic cycle. This is a kind of combined cycle that uses water steam as a working fluid, in both a topping and bottoming section. The key element of this plant is the integration of the gasification process, characterized by a certain water steam demand with the power island where high-pressure steam is produced.

Recently, ENEA and University of L'Aquila have been conducting experimental and modelling investigations to study the feasibility of a chemical looping carbon capture. Thermo-gravimetric analysis was carried out to determine the conversion of calcined dolomite and its capacity for CO_2 uptake as well as scanning electron microscope analysis after a cyclic CO_2 capture. Particularly, the SEM analysis has led us to propose a grain model to study the main parameters affecting the rate of CO_2 separation from the bulk of the syngas by means of the investigated sorbent. Moreover we have assumed that the diffusion coefficient through the solid reaction-product changes with the calcium oxide conversion. Numerical results obtained by means of such a grain model show a good agreement with experimental data collected in a multi-cycling CO2 capture at different temperatures.

Keywords: Chemical looping carbon capture, grain model, variable product layer diffusion coefficient.

Proposed Topic: CO_2 capture: Precombustion