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Increasing the carbon capture efficiency of the Ca/Cu looping process for power production with advanced process schemes

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ABSTRACT:

The Ca-Cu process is a novel concept for hydrogen production with inherent CO2 capture that has received great attention in the last years as potential low-CO2 emission technology for power generation and hydrogen production from natural gas. The process is based on the reforming of natural gas in the presence of a CaO-based sorbent and a Cu/CuO chemical looping combustion loop that provides the energy needed for CaCO3 calcination. The process is proposed to be carried out in adiabatic, dynamically operated fixed bed reactors operating in parallel. Simulations with a 1D dynamic pseudo-homogeneous reactor model were performed for the different stages of the Ca-Cu process, considering a reasonable set of process assumptions. It has been demonstrated that the formation of a high temperature plateau during the sorption-enhanced reforming stage of the process, caused by the decoupling between the steam methane reforming and the carbonation reactions in different positions along the bed, decreases the carbon capture efficiency that can be achieved in this process. Concretely, a maximum overall carbon capture efficiency of almost 82% could be obtained with selected operating conditions in the Ca-Cu process. With the aim of overcoming this limited capture efficiency, a novel alternative scheme for the Ca-Cu process has been proposed, consisting in splitting the sorption enhanced reforming stage into two steps with intercooling. Simulations of this case demonstrated that an overall carbon capture efficiency of 88% can be achieved.

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