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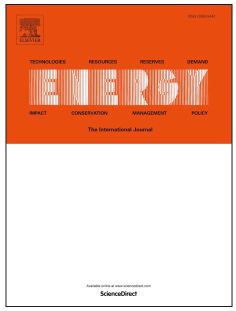

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Process integration of Calcium-Looping thermochemical energy storage system in concentrating solar power plants

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Abstract

The Calcium-Looping process is a promising thermochemical energy storage method based on the multicycle calcination-carbonation of $CaCO_3$-CaO to be used in concentrated solar power plants. When solar energy is available, the $CaCO_3$ solids are calcined at high temperature to produce CaO and CO_2, which are stored for subsequent utilization. When power is needed, these reaction by-products are fed into a carbonator reactor where energy is released from the exothermic carbonation reaction. In comparison with currently commercial energy storage systems, such as solar salts, the Calcium-Looping process presents several benefits such as the feasibility to work at significantly higher power cycle temperatures, a high energy storage density and the possibility to store energy in the medium-long term. The present manuscript analyzes a number of novel Calcium-Looping configurations for energy storage combined with CO_2 cycles in a solar tower plant. The high overall efficiencies achieved (32- 44%, defined as the ratio between net electric power production and net solar thermal power entering the calciner) indicate a potential interest for the integration of the Calcium-Looping process in Concentrating Solar Power Plants, although major technological challenges related to the design of the solar receiver and of the high temperature solid handling devices will need to be faced.

1. Introduction

Dispatchability is a main challenge for the commercial deployment of intrinsically variable major renewable energies such as wind and solar. Thus, efficient, cheap and non-toxic thermal energy storage (TES) is a key issue for Concentrating Solar Power (CSP) plants to provide a significant share of electricity generation. Currently, over 40% of commercial CSP plants around the world incorporate TES systems typically based on a two-tank TES system to use the sensible heat stored in molten salts, which allows CSP plants to operate up to 15 hours in the absence of solar radiation [1].

In the last years, research on Thermochemical Energy Storage (TCES) systems as an alternative to molten salts has gained a considerable momentum [2]. TCES applied to CSP uses the heat available in the solar receiver to drive an endothermic reaction. When energy is needed, the by-products of the reaction are brought together at the necessary conditions for