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ABSTRACT:

Renewable Hydrogen through Thermochemical Cycles: Materials and Processes

G. Landi[1]

[1]Institute of Sciences and Technologies for Sustainable Energy and Mobility - CNR, Napoli, P.le Tecchio 80, 80125, Italy.

Concentrated Solar Thermal (CST) technologies use solar radiation as a heat source, which can be used to drive endothermic reactions, thus enabling thermochemical energy storage (TCES). TCES processes generally consist of chemical looping, where a solid material cycles through two or more reaction steps [1]. Thermochemical water splitting is a notable example, producing hydrogen, with oxygen being the only by-product [1]. The process is based on the high-temperature reduction of a metal oxide in a solar reactor, followed by oxidation in a steam stream. However, the reduction step requires temperatures of 1200–1500 °C and extremely low O_2 partial pressures. Innovative materials (ceria- and perovskite- based) can be designed with the aim of increasing the oxygen emission and reducing the reduction temperature [1-2]. The same goal can be achieved by modifying the cycle by introducing a reducing agent during the reduction phase, thus allowing for more moderate operating conditions and the simultaneous production of syngas [3]. Finally, novel cyclic process can be designed; for instance, renewable hydrogen from (poly)alcohols by the action of metaborates has been obtained at relatively low temperatures (around 300 °C) in batch reactors [4], with the simultaneous co-production of solid and liquid compounds (polymers, oxygenated organic compounds).

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