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THERMOCHEMICAL HEAT STORAGE DEVELOPMENT FOR 24/7 SOLAR-DRIVEN GASIFICATION OF REFUSE-DERIVED FUEL

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Introduction

The presence of roughly half a million landfills on the European territory[1] represents a serious environmental and health hazard but also an opportunity for energy recovery from refuse-derived fuel (RDF) extracted by landfill mining. Plasma-assisted gasification has been recognised as an energy-efficient technology to upcycle RDF into (i) high-value syngas and (ii) inorganic slag suitable as building material. The carbon footprint of this process can be decreased even further by utilisation of concentrated solar energy to preheat the gasifying agent (air or steam) to the required temperature (~1,000°C). The 24/7 delivery of the constant-temperature gasifying agent can then be affected by integrating a thermal-energy storage (TES). A promising TES configuration for this purpose is a cascade of a sensible-heat storage (SHS) and a thermochemical storage (TCS).[2]

Although a SHS represented by a packed bed of high-thermal-capacity material allows for an efficient storage of heat, it suffers from a gradual decrease of the heat-transfer fluid (HTF) outflow temperature. The purpose of the TCS section, represented by a set of tubular packed-bed gas-solid reactors, is to keep this temperature constant *via* the controlled release of the energy stored in the chemical bonds of thermochemical storage materials. This controlled release of the reaction enthalpy is achieved by controlling the reaction kinetics *via* manipulating the partial pressure of the gaseous reactant within the TCS reactors.

This study focuses on (1) the selection of reversible gas-solid reaction systems that operate at the desired working temperature (~1000°C), (2) the development of kinetic models for the selected materials to predict the dependence of the reaction rates on the partial pressure of the gaseous reactants, temperature, and conversion of the solid reactants, and (3) the development of a two-dimensional heat, mass and momentum transfer model of the TCS tubular packed-bed reactor.

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References

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