Process Intensification Efforts Towards Efficient, Modular, Solar-Thermochemical Production of Liquid Fuels

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Abstract

Concerning the reduction of fossil-energy use from industrial processes, power generation and transportation, concentrated solar power from dish reflectors is well suited for driving highly endothermic reactions that valorize CO2 and/or light hydrocarbons. In this study, a directly-irradiated, openable, lab-scale reactor - integrated with high-temperature gas recuperation features - is presented as a flexible platform for solar thermochemical upgrading of low value feedstocks. Coupled on a single lamina-plate, steam reformation of methane and water gas shift reactions are simulated as a route to hydrogen production. The 1-step syngas-to-dimethyl-ether reaction is also explored as a pathway to products. COMSOL modeling (non-isothermal flow & coefficient form PDE modules) has demonstrated high thermal-to-chemical energy efficiency (>69%). This integrated concept also shows potential to reduce operational capacity cost compared to the state-of-the-art, solar-thermochemical system. A scaled-up design for implementation on a 10kW dish reflector is investigated.

Figures used in the abstract

Figure 1: Block diagram illustrating integrated concept for solar-thermochemical fuel production.