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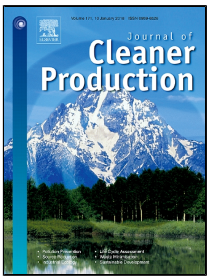

Experimental investigation and thermodynamic analysis of effective hydrogen production driven by mid- and low-temperature solar heat

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Experimental investigation and thermodynamic analysis of effective hydrogen production driven by mid- and low-temperature solar heat

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Abstract: To realize a short- and mid-term goal of sustainable development of solar fuel production, the possibility of effective hydrogen generation via methanol steam reforming at temperatures of 200-300 °C inside a novel solar collector/reactor was experimentally demonstrated. With solar irradiation of 1000 W/m^2, the solar collector-reactor achieved hydrogen generation rates up to 68.1 g/(m^2·h), with solar-to-hydrogen efficiencies up to 41.3% and total energetic efficiencies (considering solar and fuel inputs) up to 76.6%, which is competitive with other solar fuel production technologies using high-temperature solar heat. Furthermore, the mechanism of upgrading the energy level of solar heat at 200-300 °C was revealed based on the second law of thermodynamics and experimental results, where the catalyst was found to play a key role by decreasing the reaction temperature. The results obtained here indicate the possibility of utilizing the low- and mid-temperature solar heat for hydrogen production with high efficiency by upgrading the energy level of solar heat, and provide an enhancement to solar fuel production technologies with the development of this low-grade solar thermochemical technology in the near future.

Nomenclature

Latin symbols

A = Energy level