

Electrically assisted POCS-catalytic reactor with integrated dense Pd–Ag membrane for low-carbon hydrogen production via dry reforming of methane

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According to the environmental and energy efficiency challenges that the scientific community is facing to solve the issues related to the reforming reactions energy input (conventionally provided via fossil fuels combustion), this work proposes an innovative design of an electrically-assisted Periodic Open Cellular Structure (POCS) structured membrane reactor. This configuration provides the energy input required for sustaining the dry reforming reaction through the Joule heating effect, enhancing the energy efficiency of the membrane reactor over 90%, and constituting an interesting solution to adopt renewable electricity coming from the grid, without emitting collateral CO₂ in the atmosphere. Thus, this work focuses on the development of an electrified catalytic reactor based on a high-thermal conductivity Ni-alloy POCS integrated with a fully H₂ perm-selective self-supported Pd-Ag membrane for decarbonised H₂ production via dry reforming of methane. Operated at 500-550°C, 3-4 bar and WHSV=8-12 h⁻¹, this pioneering configuration exploits direct heat transfer to the catalytic bed through electrical heating, while the Ni/La₂O₃-CeO₂ coated POCS further flattens temperatures profiles. This innovative integrated design enables H₂ yields beyond thermodynamic predictions: 100% as well as 30% enhancements were obtained at 500°C, 3 bar, 4 h⁻¹ and at 12 h⁻¹ and 4 bar, respectively (Figure 1). Moreover, higher sweep gas flows resulted in improved H₂ recovery and energy efficiency, which exceeded 90% at 550°C and 12 h⁻¹. These results clearly highlight the innovative potential of combining structured electrified catalysts with Pd–Ag membranes to intensify DRM and deliver high-purity, low-carbon hydrogen.

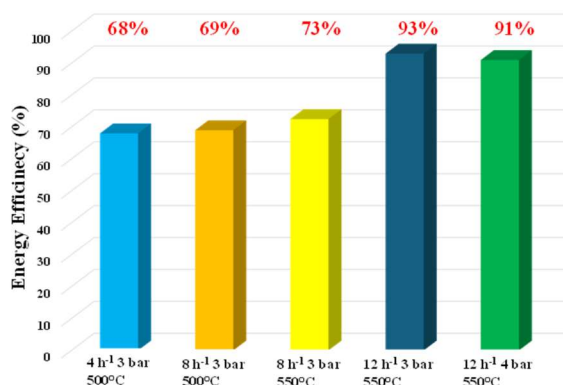


Figure 1: Energy efficiencies comparison under different operating conditions.

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