ABSTRACT:

Electrified Structured Catalytic Reactors Integrated with Pd-Based Membranes for Efficient Hydrogen Production

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The transition toward a low-carbon energy system requires innovative technologies capable of producing hydrogen with high efficiency and reduced environmental impact. Electrified catalytic reactors represent a promising solution to replace conventional fossil-fuel-based heating systems, enabling the direct use of renewable electricity for driving highly endothermic reactions [1,2].
In this work we present recent advances in the development of electrically heated structured catalytic reactors integrated with Pd-based hydrogen-selective membranes. The combination of highly conductive structured catalysts, Joule heating, and in-situ hydrogen separation enables significant process intensification, improved thermal management, and enhanced energy efficiency [3]. Particular attention will be devoted to dry reforming and reforming-based hydrogen production processes, where membrane-assisted operation allows equilibrium limitations to be overcome while simultaneously producing high-purity hydrogen. Experimental results obtained with metallic structured catalysts and Pd–Ag membranes demonstrate the possibility of achieving high hydrogen yields, excellent thermal uniformity, and energy efficiencies exceeding 90% under relatively mild operating conditions. The integration of electrification and membrane separation is shown to be a promising pathway for the development of compact, flexible, and scalable hydrogen production systems compatible with future renewable-energy-based industrial scenarios.

References

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