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Review

Joule-Heated Catalytic Reactors toward Decarbonization and Process Intensification: A Review

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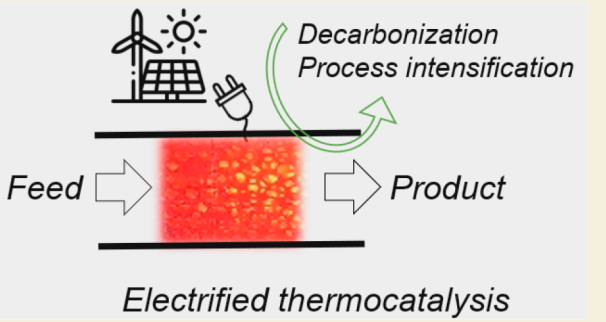
ABSTRACT: The supply of the heat required for chemical processes via renewable electricity, i.e., process electrification, provides an alternative strategy for replacing conventional fossil fuel combustion. This approach enables fast, selective, and uniform heating, offers great potential for utilizing the excess renewable electric energy, and brings about an important chance for mitigating CO_2 emissions. In this work, we provide an overview of the state-of-the-art electricity-to-heat driven catalytic processes. The principle and fundamentals of Joule heating are provided and briefly compared to induction and microwave heating in view of electrifying catalytic processes. By this comparison, we assess that Joule heating can be regarded as the most promising method for process electrification, and its applications to methane reforming, cracking reactions, CO_2 valorization, and transient process operation are then reviewed. Advantages and disadvantages are critically addressed in terms of efficiency, potential for scale-up and possibility of retrofitting. The current challenges in the development of advanced electrified processes as well as the opportunities of next generation electrification techniques are discussed.



KEYWORDS: *electrification, Joule heating, decarbonization, process intensification, methane reforming, cracking reactions, CO_2 valorization, transient operation*

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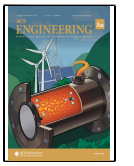

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