289h In-Situ Measurement of Temperature Dynamics during Catalytic Hydrogen Production from Methane in a Reverse-Flow Reactor

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Hydrogen production via high-temperature catalytic conversion of (fossil or renewable) methane is gaining increasing attention due to wide-spread expectations of a future ‘hydrogen economy'. While large-scale processes for methane conversion based on steam reforming or autothermal reforming already exist, small-scale applications need novel and adapted technological solutions. We have previously demonstrated that catalytic partial oxidation of methane in a reverse-flow reactor is a highly efficient route towards synthesis gas or hydrogen. Here, we report results from a study of temperature dynamics during catalytic partial oxidation as well as autothermal reforming of methane over noble metal catalysts in a reverse-flow reactor. In-situ temperature profiles were measured, and the influence of the periodicity of flow-reversal, reactor throughput and catalyst deactivation were studied. A strong decoupling of kinetic effects in the catalyst zone and thermal effects in the reactor is observed for both reactions. Optimization of reaction conditions yields significantly improved methane conversions and strongly improved hydrogen-to-CO ratios in both cases. Significant reactor operating aspects will be discussed and compared between the two reactions. Overall, we will demonstrate that the use of regenerative heat-integration through dynamic reactor operation yields reactor configurations which are ideally suited in particular for small-scale and decentralized hydrogen production from methane.