Highly Efficient Production of Valuable Hydrocarbons from CO_2 and H_2O via an Integrated Co-Electrolysis-Based Synthesis Process

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Abstract

Energy transition and sector coupling have become frequently used terms in recent times. It is generally agreed that electrolysis will play an important role in a future energy system [1,2]. A technology with promising prospects for applications in this very context is the co-electrolysis in solid oxide electrolysis cells (SOEC) [3]. The co-electrolysis allows for the direct generation of syngas from CO_2 and H_2O. Together with the advantage of SOEC technology to use high temperature heat as energy input for the electrolysis reaction, it offers excellent properties for the development of processes consisting of an electrolysis and a synthesis step [4]. The presented modeling results show that heat integration and by-product recirculation allow for an electric efficiency of $\eta_{el} > 0.6$ for the overall process. The comparison of the proposed process design with other concepts highlights the advantages of a coupled process of co-electrolysis and Fischer-Tropsch synthesis. As an industrial application of electrolysis-based processes in the mid-term is more likely for highly valuable products, the experimental work is focused on the synthesis of higher alcohols on low-cost iron catalysts. Fixed-bed reactor tests show that optimized process conditions and the application of suitable promoters allow for a high selectivity towards alcohols with chain lengths C_{5+}. Additionally, first results on a small-scale technical demonstration of a process consisting of co-electrolysis and Fischer-Tropsch synthesis will be presented. The first-time realization of such a process proves the advantages of the concept.

Literature

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