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One-Stage Syngas-to-Fuel in a Micro-Structured Reactor: Investigation of Integration Pattern and Operating Conditions on the Selectivity and Productivity of Liquid Fuels

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Highlights

- Effective promotion of fuel synthesis is achieved with hydrocracking (HC) coupling.
- Both Fischer-Tropsch synthesis (FTS) and HC profit from intimate integration.
- The FTS and HC catalysts show reasonable and comparable long-term stability.
- Simplified X-to-Liquid plants with variable syngas supply seem feasible.

Abstract

A one-stage syngas-to-fuel process was carried out by integrating Fischer-Tropsch synthesis (FTS) with hydrocracking (HC) in a micro-reactor to verify the feasibility of a related process simplification with a view to small-scale X-to-liquid (XtL) plants. Different approaches to the integration of the two process steps and the influence of the operating conditions were investigated targeting liquid fuel synthesis (C_5-C_{20}). It was proven that FTS plays the determining role in the integrated process and HC only exhibits a promoting function. Good performance was obtained in both sequential and mixed-bed systems. With an increase of temperature the liquid fuel selectivity reaches a plateau value of around 70% at 230-250 ºC, depending on the integration pattern and syngas space velocity. H_2/CO ratio and pressure only have limited influence on the fuel selectivity. FTS was enhanced in the mixed-bed configuration. Meanwhile, consistent hydrocarbon distribution was obtained for both integration patterns when reaching the plateau