Fischer-Tropsch Synthesis Based Maritime Fuel Production with Syngas containing O_2

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Abstract

New emission regulations lead to a demand for renewable fuel sources. In particular, the shipping sector needs clean and pollution-free alternatives with regard to sulfur oxide emission. As battery-powered solutions are inapplicable due to their low energy density, economic production of high-density synthetic fuels attends the focus of today's research. This work presents a new process to produce synthetic maritime fuel by Fischer-Tropsch synthesis (FTS) based on "green" syngas. Here, syngas is generated from CO_2 and H_2O using renewable energy. In this syngas production process molecular oxygen is a byproduct that can not be completely removed. Hence, the FTS is run with traces of O_2. For safety reasons the O_2-content has to be limited to a maximum of 2 vol.-%. Based on this syngas generation process by renewables a high-quality maritime fuel is obtained at low temperature Fischer-Tropsch synthesis (LTFTS) reaction conditions (10-30 bar, 180-230 °C).

At LTFTS conditions, gravimetric measurements with 5x5 mm $Co/Pt/Al_2O_3$ catalyst-particles in a magnetic suspension balance indicate that the catalyst stays active as long as H_2 is present in the system. Oxygen is converted to H_2O and CO_2 in varying proportions, based on composition and reduction degree of the catalyst. The water produced adsorbs reversibly on the catalyst surface at the reaction conditions.

Furthermore, under LTFTS conditions experiments performed in a technical tube reactor with $Co/Pt/Al_2O_3$ catalyst particles show no influence on the product distribution of C_{2+} products. Moreover, methane selectivity decreases because of the adsorbed water on the catalyst surface.

The experimental data indicate that reaction temperature and O_2 content in the gas phase have no effect on the product distribution. On the other hand, higher total pressure and CO concentration yield higher CO_2 selectivity. Finally, the variation of the H_2 concentration shows no influence on the reaction outcome. These described effects allow the conclusion that the CO surface coverage on the catalyst - that is based on the CO gas concentration - is the main factor for product distribution of the products resulting from the reaction with oxygen.

Optimizing the reaction conditions promises a 65 wt.-% yield of high quality maritime fuel.