

## **Enhancement of Fischer-Tropsch-Synthesis due to Periodical Draining of Wax-filled Catalyst Pores by Hydrogenolysis**

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### **Abstract**

Fischer-Tropsch-Synthesis is one option for long term chemical storage of energy from renewable sources like wind and solar power. It produces a variety of products from synthesis gas, but mostly linear alkanes ranging from methane to long chain waxes. In industrial operation a high chain growth probability is favourable producing mostly waxes, which are cracked or isomerised to the desired product downstream. The mayor problem of this process is accumulation of long chain waxes in catalyst pores, which cannot evaporate at process temperature, resulting in reduced reaction rate and high methane selectivity due to diffusion limitation at steady state. This projects aim is to identify parameters (e.g. temperature, reaction time, partial pressures) to enhance Fischer-Tropsch-Synthesis by regularly removing wax from the catalyst by hydrogenolysis.

Whilst accumulating of long chain hydrocarbons a higher diffusion resistance becomes more present causing decreasing effective activity. Different diffusion velocities of hydrogen and carbon monoxide in wax lead to a high hydrogen to carbon monoxide ratio towards the catalyst's core, resulting in an increased selectivity to methane. This unfavourable side effect becomes most prominent when most of the transport pores are blocked, at a pore filling degree of around 80 %. During hydrogenolysis single bonds of hydrocarbons are split in presence of hydrogen. The reaction is inversely dependent on hydrogen pressure. Chain length can also influence reactivity, but especially hydrogenolysis of long-chain hydrocarbons is not yet very well understood.

Therefore, a non-stationary process where wax gets periodically drained from the pores of the catalyst can be viable. The Fischer –Tropsch-Synthesis runs as long as the porous system of the catalyst is not yet fully filled with wax, then the hydrocarbon deposit is cracked during hydrogenolysis leading to evaporation of the smaller alkane products and ultimately to a clean and active catalyst again. Process parameters ought to be selected in a way that activity and selectivity of the periodical drainage are more favourable than in steady state operation. In this project temperatures of FT-Synthesis and hydrogenolysis are tested in an industrial relevant range between 210°C and 240°C. Partial pressure of hydrogen for hydrogenolysis are employed from 0.5 bar to 4 bar. All variations of these tested parameters delivered better results regarding selectivity and activity than steady state operation. The overall carbon monoxide consumption rate increased by up to 65 % and methane selectivity was at best 30% lower than for steady state Fischer-Tropsch-Synthesis at the same temperature.