

Reshaping Fischer-Tropsch: Towards Sustainable Pathways for Fuels and Chemicals

Denzil J. Moodley¹

¹Sasol Research and Technology, 1 Klasie Havenga Rd, Sasolburg, South Africa, 1947

*denzil.moodley@sasol.com

Introduction

Sasol is a world-leader in the development and application of the Fischer-Tropsch (FT) technology with more than 70 years' experience. Our own facilities and licensed technologies already produce more than 200 000 bbl/day of products. To reach our GHG emission reduction targets and decarbonize our operations we plan to leverage our proprietary catalyst and reactor technology, know-how and expertise to produce sustainable fuels and chemicals from green hydrogen and sustainable carbon sources, via Biomass/Power-to-Liquids (BPTL) processes¹

Cobalt catalysts if designed appropriately, can be used to target diesel, kerosene as well as high value base oils and waxes. We will highlight parts of the CARE-O-SENE² consortium work which is funded by the German Federal Ministry of Education and Research (BMBF) and Sasol. Here, we showcase the integrated, collaborative work to understand, develop & scale-up new cobalt catalysts that are stable at high conversion and that yield high selectivity towards desired products. The importance of selective catalysts for increased jet-fuel yield will be discussed. Further improvements and developments in sustainable catalyst preparation and process design will be required to achieve our sustainability targets, and these will be elaborated on.

Materials and Methods

Catalysts have been prepared on lab scale (100 g), pilot scale (15 kg) and semi-commercial scale (300 kg) using appropriate quantities of active metal and promoters while using Sasol's proprietary slurry phase impregnation and fluidized bed calcination and reduction steps. Testing of reduced catalyst is conducted in 1L slurry micro-reactors, 2" slurry bubble and 34" demonstration reactor at realistic FT conditions. Detailed characterization has been conducted using an *in-situ* magnetometer, which enabled determination of crystallite size distributions (CSD) and dynamic responses in catalyst phases (carburization, oxidation and sintering) under various process conditions. Operando XAS measurements and well as synchrotron-based surface techniques were used to elucidate details of catalyst structure.

Results and Discussion

In depth analysis of the technical catalysts revealed details of cobalt promoter interactions and stability of the catalyst against simulated high conversions. The learnings from the work have culminated in the scaling-up (Figure 1) of a new step out cobalt power-to-liquids (PtL) catalyst, using a risk mitigated approach³. The robustness of this catalyst towards water induced deactivation was studied with an *in-situ* magnetometer which allowed real time

monitoring as a function of process conditions. Performance data of this catalyst, in pilot scale and demonstration scale slurry reactors will be shown, and this will be benchmarked against various in-house and state-of the art competitor systems, in terms of propensity for jet fuel yield.

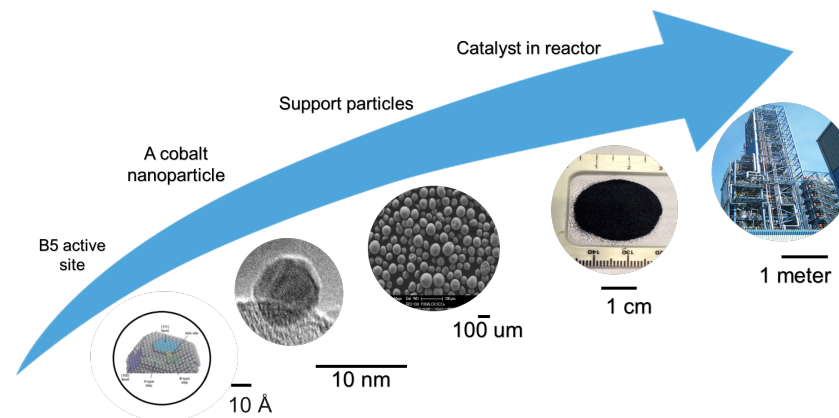


Figure 1. Integration of information across scales is essential for successful catalyst development and scale-up

Significance

This work indicates the applicability and flexibility of using FT technology to assist in decarbonizing the fuels and chemical sectors. The scale-up of the PtL catalyst, under the ambit of CARE-O-SENE, amongst the best in its class, is seen as an enabler for high yields of kerosene for the SAF market. The work also highlights the power of industry-academia collaboration to advance FT technology.

Acknowledgments

Part of this work was supported by the German Federal Ministry of Education and Research (BMBF) within the CARE-O-SENE project (03SF0673A).

References

1. Moodley, D., Botha, T., Crous, R., Potgieter, J., Visagie, J., Walmsley, R., & Dwyer, C. (2024). Catalysis for Sustainable Aviation Fuels: Focus on Fischer-Tropsch Catalysis. Catalysis for a Sustainable Environment: Reactions, Processes and Applied Technologies, Wiley.
2. <https://care-o-sene.com/en/> (accessed 20 February 2024)
3. Potgieter, J.H., Moodley, D., Botha, T., Visagie, J., Manong, T., Frank, M., Claeys, M., van Steen, E., Böltken, T. and Pfeifer, P., 2024. Catalysis Today, p.114554.