Selective Carbon Chain Building from Synthesis Gas

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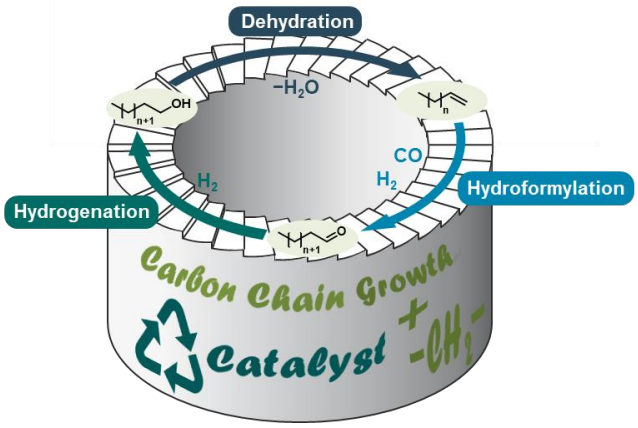
Abstract

Most carbon chain building reactions are currently based on fossil ethylene for example in the Shell Higher Olefin Process. To decarbonise carbon chain building reactions, synthesis gas can be used as a suitable alternative to ethylene as it can be sourced renewably for example from biomass or CO_2. It can be converted to hydrocarbons for fuel and blend applications in the Fischer-Tropsch reaction, but the process is less suitable for specific chemical products as the product mixture is always a distribution according to Anderson, Schulz and Florey and contains various functional groups.[1–3]

In this work, we present a single chain length and functionality selective synthesis route from synthesis gas to hydrocarbons. By a combination of hydroformylation, hydrogenation and dehydration reactions, carbon chains can be elongated to specific value products, similar to the heptene homologation developed by Sasol.[4] The cycle can be ended at one of the desired products: olefins, aldehydes or alcohols. This cycle can be based entirely on renewable resources if bio-ethanol, bio-butanol or bio-hexanol are used as starting compounds for the cycle.[5] A key focus in the development of this system is the catalyst recycling in each of the three steps, making the process more sustainable and reducing waste to a minimum.

A dehydration based on a phosphoric acid catalyst was developed to convert alcohols to the corresponding olefins while recycling the acid catalyst.[6] To convert the resulting mixture of internal olefins, Rh/Biphephos has been applied in the isomerization hydroformylation reaction.[7] The catalyst is recycled via a distillation and the aldehydes are converted in a hydrogenation over a heterogeneous Ru/carbon catalyst. 4 cycles of these reactions from hexene to decene provided a 27% yield of decenes.



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