

Conversion of Microalgae Oil to Biokerosene over WO_3/ZrO_2 Supported Metal Catalysts

L. Milakovic, Yue Liu, E.r Baráth, J. A. Lercher

Technische Universität München, Lehrstuhl für Technische Chemie II, Garching, Germany

Abstract

Microalgae is a highly abundant, fast growing, readily cultured biomass resource and is not competing with our food chain. The lipid constitutes up to 70 % of the microalgae dry mass^[1] and its transformation into hydrocarbon fuels is considered as an important alternative to petroleum-based fuels. Diesel like transportation fuel can be produced from microalgae oil (triglycerides, fatty acids) via hydrodeoxygenation^[2]. Over the past years increasing interest is also gained in the further conversion to hydrocarbons in the kerosene range for the utilization in the aviation sector. This can be implemented by an additional hydrocracking step. In our work, we study the one-step production of kerosene from stearic acid as a model compound for microalgae oil over as a model compound for microalgae oil over WO_3/ZrO_2 supported metal catalysts.

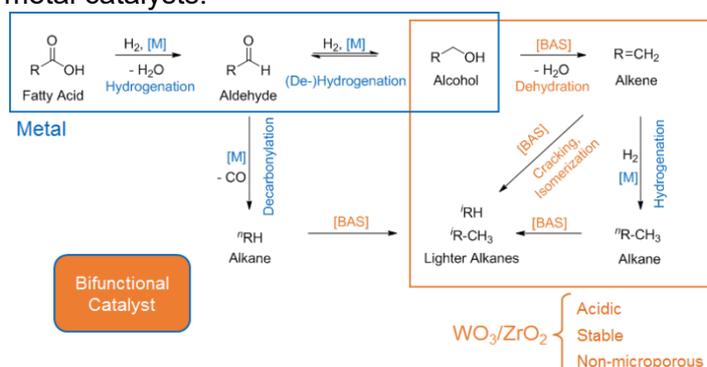


Figure 1: Reaction network of fatty acid conversion

The proposed hydrodeoxygenation and hydrocracking mechanism of a fatty acid is displayed in Figure 1. The reaction network clearly shows the role of a bifunctional catalyst in the conversion process. The metal function catalyzes the hydrogenation of the fatty acid to the aldehyde and further to the alcohol. The acid function then catalyzes the dehydration of the alcohol to an alkene, which in turn is cracked or isomerized. The acid functions of the catalyst are provided by the WO_3/ZrO_2 , while the choice of the metal is varied by rhodium, platinum and copper. The tested catalysts showed a successful hydrodeoxygenation of the stearic acid, however, only hydroisomerization but no hydrocracking of the obtained octadecene could be observed.

The synthesized WO_3/ZrO_2 supported metal catalysts were capable to catalyze the hydrodeoxygenation of the stearic acid. The rhodium catalyst showed the highest activity followed by the platinum and copper (Figure 2).

References

[1] F. B. Metting, J. Ind. Microbiol. 1996 17, 477-489.

[2] B. Peng, Y. Yao, C. Zhao, J. A. Lercher, Angew. Chem., Int. Ed. 2012, 51, 2072-2075.

The proposed hydrodeoxygenation and hydrocracking mechanism of a fatty acid is displayed in Figure 1. The reaction network clearly shows the role of a bifunctional catalyst in the conversion process. The metal function catalyzes the hydrogenation of the fatty acid to the aldehyde and further to the alcohol. The acid function then catalyzes the dehydration of the alcohol to an alkene, which in turn is cracked or isomerized. The acid functions of the catalyst are provided by the WO_3/ZrO_2 , while the choice of the metal is varied by rhodium, platinum and copper. The tested catalysts showed a successful hydrodeoxygenation of the stearic acid, however, only hydroisomerization but no hydrocracking of the obtained octadecene could be observed.

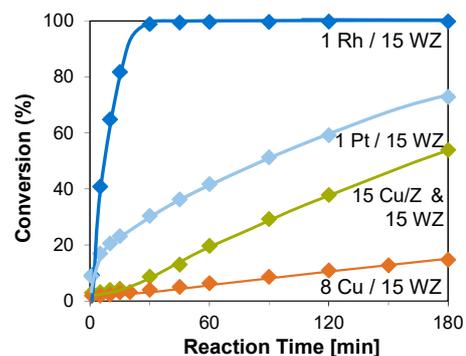


Figure 2: Stearic acid conversion on different WO_3/ZrO_2 (WZ) supported catalysts