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Catalytic hydrothermal conversion and upgrading of wet biomass feedstocks – Process design and optimization

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Liquid biofuels will play a major role for a more sustainable energy system of the future. Fossil fuel limitations and their environmental burden make liquid combustible biofuels necessary that can fit into the existing hydrocarbon infrastructure. Bio-oils from hydrothermal liquefaction are characterised by their high feedstock flexibility. The hydrothermal conversion process produces a sort of viscous crude oil replacement, which has an important major drawback from conventional crude oil: The oxygen content of the fuel is significantly higher, typically 5-20% in the bio-oils versus <1% in conventional crude-oil [1]. The higher oxygen content leads to a number of undesirable qualities, such as lower energy content, poor thermal stability, higher viscosity, higher corrosivity, and a tendency to polymerize [2]. To overcome these physicochemical issues, hydrodeoxygenation reaction is a possible upgrading method i.e., by partial or total elimination of oxygen and hydrogenation of chemical structures. Upgrading of complete bio-oils derived from hydrothermal conversion has not yet been extensively studied. Purpose of this work is to reduce the oxygen content of the bio-oil to improve the quality and thus increase the application areas of the bio-oil.
In this study a commercial Nickel-Molybdenum (NiMo) hydrotreating catalyst is going to be investigated for the hydrodeoxygenation of bio-oil derived from Wet Distillers Grains with Solubles (WDGS). For the experiment bio-oil from the CatLiq® process is used which has a heating value of 35 MJ/kg and a relatively low oxygen content of ~5% compared to bio-oil derived from pyrolysis. The CatLiq® process is a second generation process for the production of bio-oil from various aqueous biomass-based waste products. It is carried out at subcritical conditions (280-370oC and 25MPa) in the presence of a homogeneous alkaline and a heterogeneous Zirconia catalyst [3]. Figure 1 shows two FTIR spectra from Catliq® bio-oil [4] and commercial diesel oil. In the FT-IR spectra of bio-oil oxygen containing compounds can be detected. Wavenumbers from 3600-3300 cm -1 show an O-H group-stretch, indicating alcohols and phenols in the bio-oil. The higher absorption of bio-oil from wavenumbers 2700-3300 cm-1, 1700cm-1 and 1400cm-1 relates to a higher amount of carboxyl acid groups (COOH) in the bio-oil, compared to commercial diesel oil.

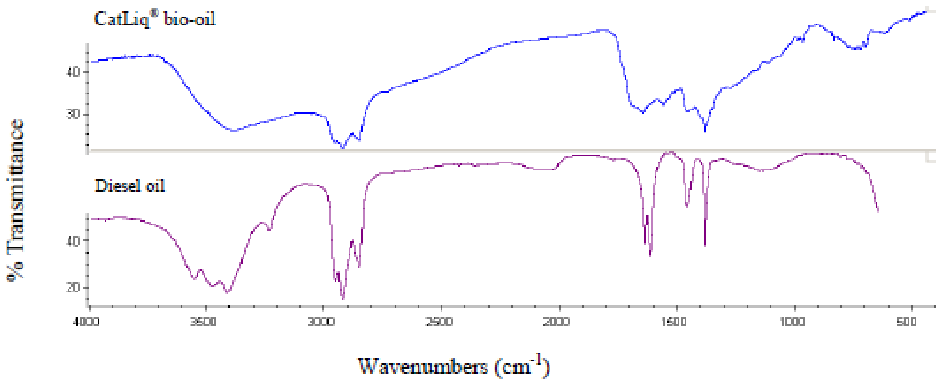

Figure 1**:** Comparison of FT-IR spectra from CatLiq® bio-oil and commercial diesel oil

The hydrodeoxygenation experiments are conducted in a 500 ml batch reactor. A temperature range from 300°C to 350°C is going to be investigated at hydrogen pressures of up to 200 bar. The reaction time will vary from 10 min to 60 min. It is expected to reduce the amount of oxygen containing compounds considerably and to improve viscosity and quality of the bio-oil.

References

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