

Popular science summary of the PhD thesis

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| PhD student | René Kofler |
| Title of the PhD thesis | Marine transport fuels from residual biomass and renewable electricity – Pathways for DME Production from wheat straw gasification and water electrolysis |
| PhD school/Department | Department of Civil and Mechanical Engineering |

Science summary

A rapid transition towards an energy system with net zero greenhouse gas emissions is required to limit global warming to stay below 1.5 °C. The maritime transport sector is one of the hard-to-abate sectors, due to its reliance on high energy density liquid fuels. Dimethyl ether (DME) has been identified as a promising alternative fuel for the shipping sector. DME (CH_3OCH_3) is a synthetic fuel produced from syngas (H_2 , CO and/or CO_2). The syngas can be produced from biomass gasification, and with the use of residual biomass, like wheat straw, the sustainability of the produced fuel can be ensured. Combining the production of DME via biomass gasification with electrolytic hydrogen from renewable electricity increases the fuel yield, carbon efficiency and energy efficiency of DME production plants.

This PhD thesis investigated the production of DME from wheat straw using the low-temperature circulating fluidized bed (LT-CFB) gasifier integrated with electrolytic hydrogen production. 20 different fuel production plants were designed, and thermodynamic models of the plants were built, with the aim of assessing and improving the performance of wheat straw based DME production. The main focus was on maximizing carbon efficiency, considering also the production of by-products like biochar, bio-oil, process heat and district heating. The production cost of wheat straw based DME was compared to DME produced from woody biomass, which is easier to convert than wheat straw. Additionally, the operation of wheat straw based DME production systems in an off-grid scenario, connected to wind and solar electricity production units was investigated.

The results showed that efficient DME production from wheat straw gasification and water electrolysis is possible, with carbon efficiencies up to 98 %. The production costs were found to be equal or slightly higher than for woody biomass, depending on the used cost scenarios. Off-grid operation of DME production plants is possible, but variable operation of the plants is necessary to follow the fluctuations in the electricity production.

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