Capturing water to make the renewable fuels of the future

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A successful outcome for the energy transition is very much dependent on the development of alternative fuel solutions that are ultra-clean, renewable, and low in carbon emissions. Fuels that must be replaced

include liquefied petroleum gas (LPG) and diesel, which are fuels frequently used in vehicles and in heating. A promising replacement fuel is dimethyl ether (DME). Unlike current fossil fuels, DME leads to low emissions and it can be produced renewably. However, current DME production processes are limited when it comes to producing renewable DME from biomass or CO_2, particularly due to problems handling steam in the process. For his Ph.D. research, Jasper van Kampen developed a new process for producing DME, and he defends his thesis on June 4th at the department of Chemical Engineering and Chemistry.

Central to the energy transition is the provision of clean, renewable, and low-carbons fuels. One candidate fuel is dimethyl ether (DME), a colorless gas that is easy to liquefy and transport. Although DME is traditionally made from natural gas, it can be renewably produced from CO_2 and H2. Crucially, it's similar in properties to liquefied petroleum gas (LPG), which means that DME could be used in existing LPG infrastructure. As a fuel, it could be used to replace diesel in compression ignition engines or used in a blend with LPG in spark ignition engines.

Renewable issues

Normally, DME is made from synthesis gas (a mixture of CO and H2), which is obtained from natural gas, with CO_2 being the main by-product. Using a renewable source such as previously emitted CO_2 or CO_2-rich biobased materials seems like a better approach, but current processes only make small amounts of DME. In addition, H2 for the production of DME can be made from steam, but there are issues with the efficient handling of steam.

For his Ph.D. research, Jasper van Kampen explored how to improve the production of renewable DME through the capturing of steam using zeolitic material, which is a mineral that can trap certain molecules. He

implemented this in an approach known as sorption enhanced DME synthesis (SEDMES). Critically, he investigated and validated the technology under test conditions relevant for industry.

Removing steam with a sponge

Fundamentally, SEDMES is a novel way of making DME. It is based on the removal of water by a solid adsorbent that acts as a sponge to take up water. Removing water in this way ensures that no CO_2 is produced as it would be in conventional DME production methods. Instead, previously-emitted CO_2 along with the captured water can then be converted into renewable DME.

During his work on the project, van Kampen addressed several important aspects including materials, adsorption processes, catalysis and reactor engineering, and advanced modelling. His research has led to a dynamic reactor model that allows for upscaling of the SEDMES technology and predictions for large-scale DME synthesis. Importantly, the significant advancements made with the technology in this research can play an important role in the energy transition, where fossil-based fuels and chemicals have to be replaced by products from renewable feedstocks.

More information: Efficient carbon utilization to dimethyl ether by steam adsorption enhancement. research.tue.nl/nl/publication … r-by-steam-adsorptio

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