SUCCESS STORY

BEST / BE2020_2.0/BIO-LOOP

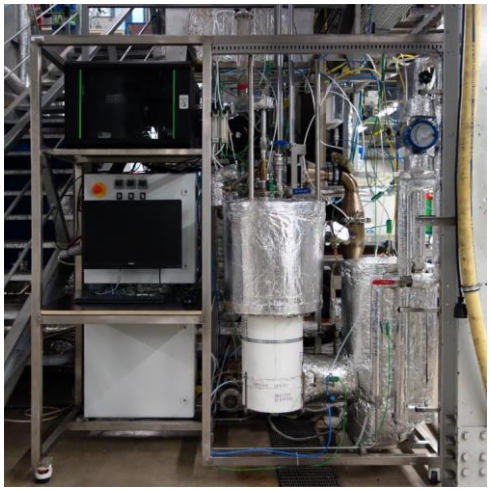
BEST – Bioenergy and Sustainable Technologies GmbH / BIOENERGY 2020 / Chemical Looping for efficient biomass utilisation

Programme: COMET – Competence Centers for Excellent Technologies

Programme line: COMET-Modul

Type of project: BIO-LOOP, 04/2020-03/2024, multi-firm

BIO-LOOP



MODELS FOR THE FUTURE

IN THE BIO-LOOP PROJECT, BIOMASS AS WELL AS OXYGEN CARRIER PARTICLES ARE UTILISED DURING CHEMICAL LOOPING PROCESSES. THEREFORE, MODELING THEIR CONVERSION PLAYS A CENTRAL ROLE FOR SIMULATING REAL-WORLD APPLICATIONS IN FIXED BED AND FLUIDIZED BED REACTORS.

With respect to the climate objectives Chemical Looping (CL) processes constitute a promising alternative to traditional thermochemical conversion routes. Through the application of solid materials, so-called oxygen carriers, instead of air as oxygen supply, CO_2 can be easily separated from the flue gas. For example, biomass can be used for hydrogen production (Chemical Looping Hydrogen, CLH) or it can be burnt without CO_2 emissions (Chemical Looping Combustion, CLC). The employed solid biomass and oxygen carrier materials consist of particulate systems which differ in size and properties depending on the application.

Multiple process scales have to be considered in order to describe the conversion of such particles. On the smallest scale, chemical reactions between gases and solids fundamentally take place. They are sufficient for modelling the conversion of very fine powders. However, in systems with larger particles (like for example pellets) gaseous reactants and heat first have to be transported to the outer surface and then into the particle. Compared to chemical reactions alone, this leads to an overall retardation of the conversion process.

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Version 01/2020

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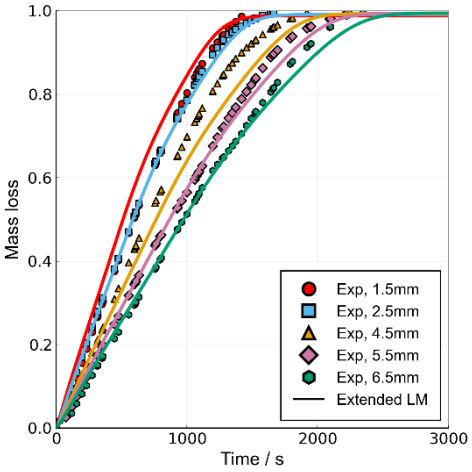
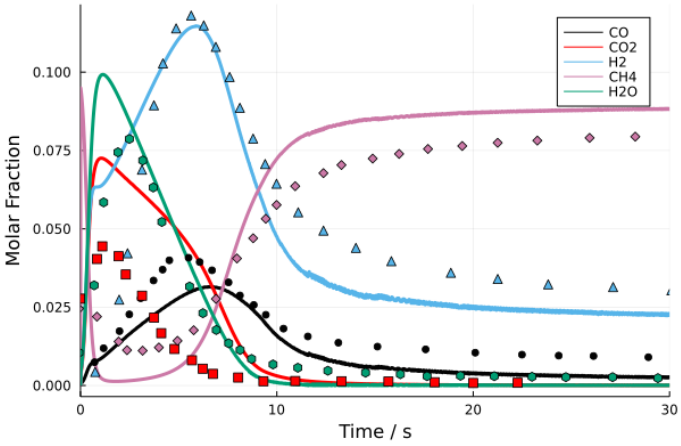
For single biomass particles the existing, so-called Layer Model has been significantly improved. The original model described biochar reactions only at the outer particle surface. However, using the example of gasification, under typical conditions reactions take place in the entirety of the biochar layer. The new model considers the influence of transport phenomena on the conversion process while maintaining comparable computational performance.



Simulated and measured mass loss of different biomass particles during gasification[1] © BEST

In real-world applications particles are used either in fixed bed or fluidized bed reactors. Additional efforts have to be made in order to describe the transport processes in the reactor as well as between reactor and particle. For this purpose, a reactor model and a particle model have to be coupled. The first simulation results show promise of a successful description of the overall processes. However, there is still a lot to be done. And after having reached the project's half-time, we kick off the "second half" in a highly motivated manner.



Early simulation results from particle-reactor-coupling for the oxygen carrier NiO_2 © BEST

Particles and Reactors

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- TU Wien
- NIC Ljubljana
- CSIC Spanien
- Chalmers University of Technology
- Aichernig Engineering GmbH
- AVL List GmbH
- Christof Industries Austria GmbH
- Rouge H2 Engineering GmbH
- SW-Energie Technik GmbH
- TG Mess-, Steuer- und Regeltechnik GmbH
- Rohkraft- Ing. Karl Pfiehl GmbH

This success story was provided by the consortium leader and the mentioned project partners for the purpose of being published on the FFG website. The BIO-LOOP COMET Module receives funding from BMK, BMDW and the regional governmen Programme. The COMET Programme is managed by FFG. Further information on

[1]data from *Van de steene et al. (2011), Chem. Eng. Sci. 66*
[2]data from *Han et al. (2013), Chem. Eng. Sci. 104*

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