Karlsruhe Institute of Technology

HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

EMR / RU4 Feedstocks and Processes of the Future Carbon Cycle

Atmospheric Gasification of Suspension Fuels

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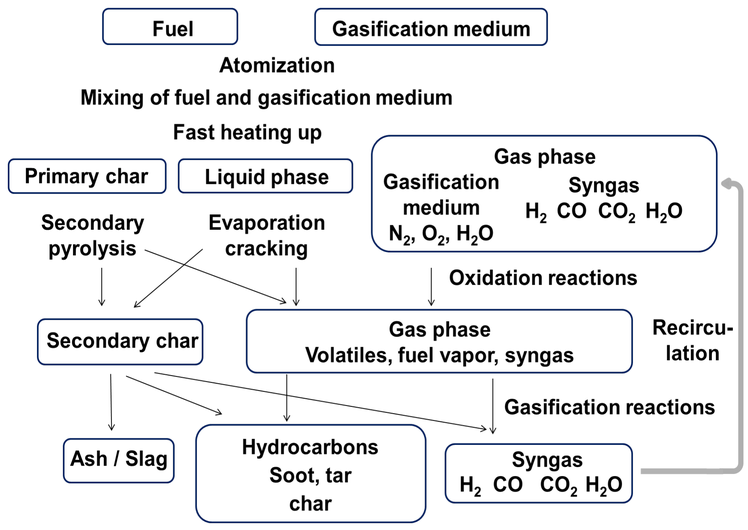
Challenge + Objectives

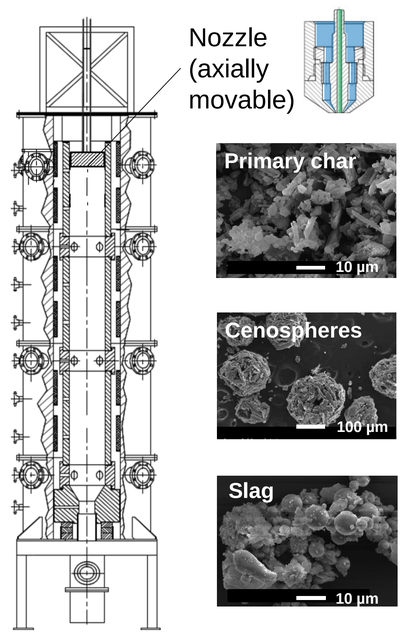
Entrained Flow Gasification of Suspension Fuel

multi-phase reacting system at high temperature



- Understand and describe sub-processes
- Develop models for numerical simulation tool
- Validate simulation tool by detailed experimental data

Approach

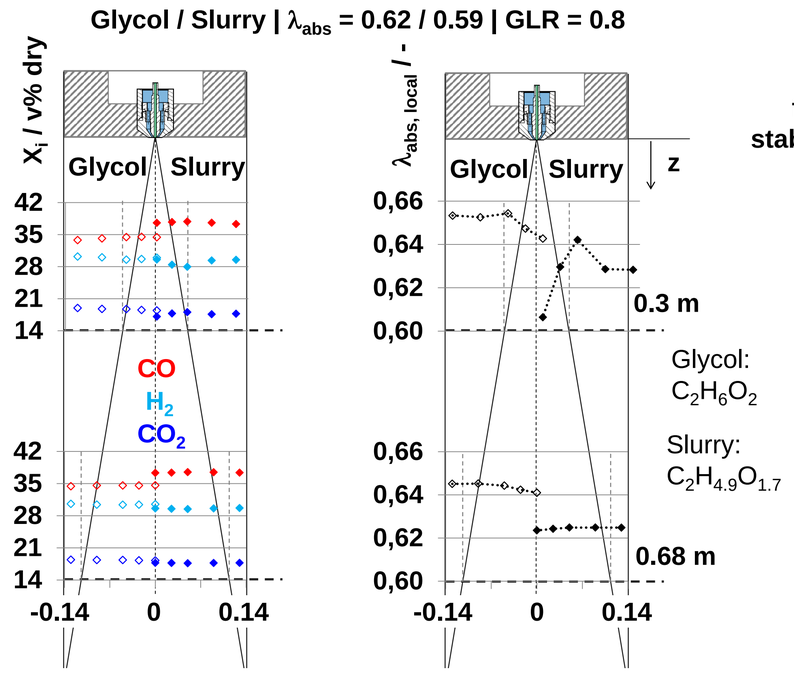


Atmospheric entrained flow gasifier REGA

- Atmospheric experiment for detailed process data
- Mapping of gasifier: local profiles of X_i, T, u
- Independent variation of operating parameters
- Free jet model for evaluation and sensitivity analysis of sub-process models
- Numerical simulation, RANS, for overall process
- Basis for pressure simulation (bioliq® EFG)

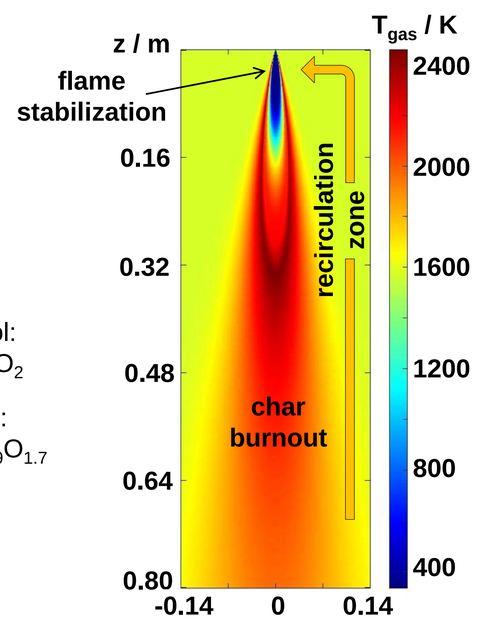
From Detailed Experiment to Validated Simulation

Main Gasification Zone

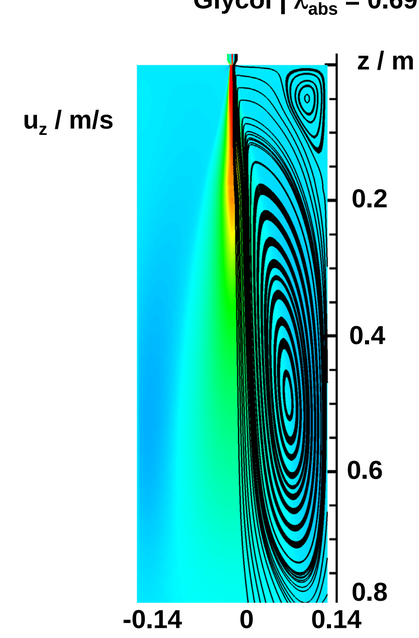


local data mapping species, temperature

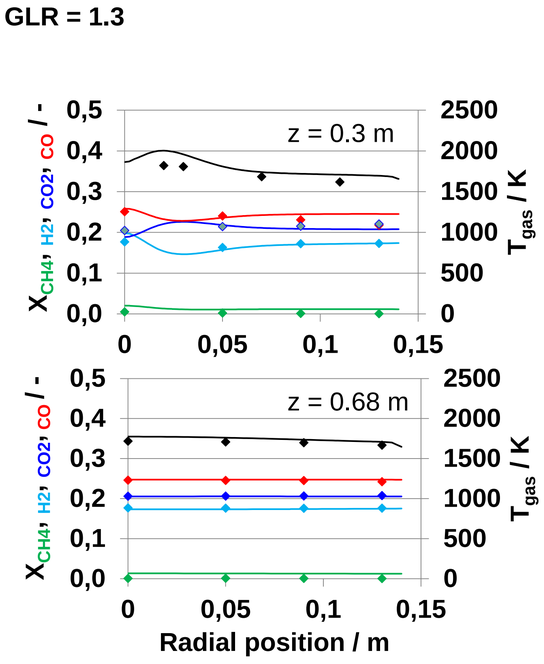
local characteristic parameters absolute stoichiometry



free jet model gas temperature



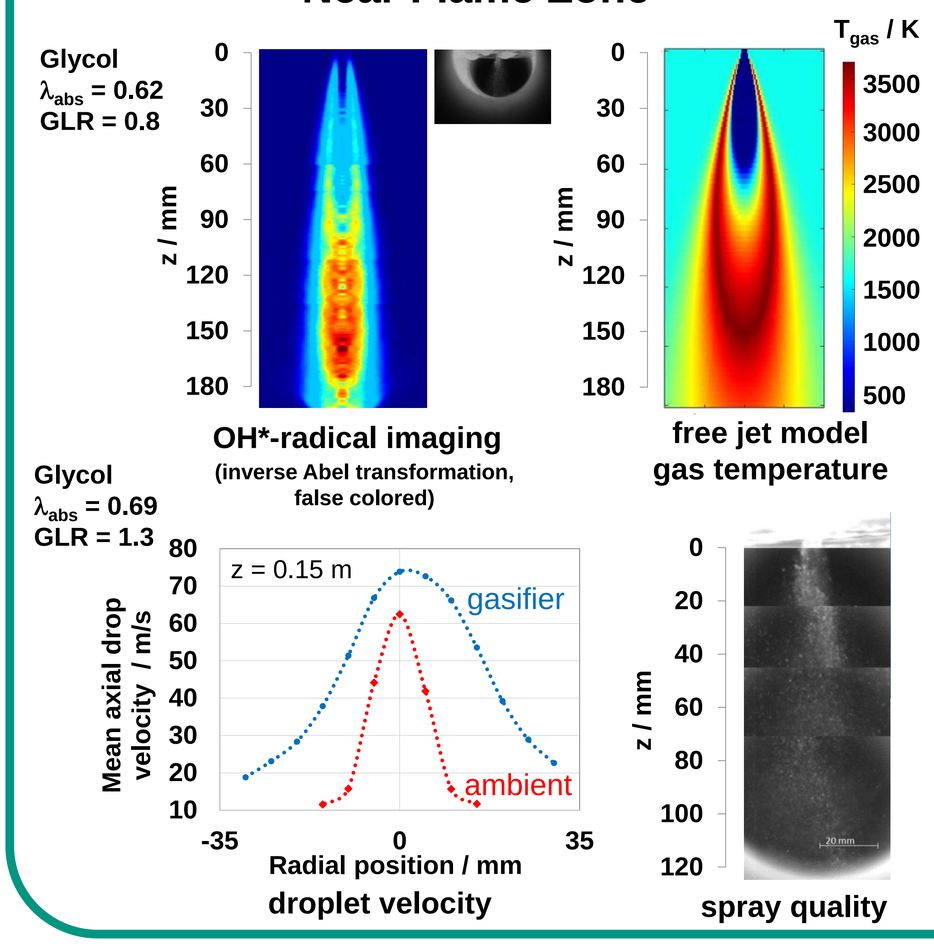
RANS simulation axial velocity, stream function



experimental data (dots) vs. RANS simulation (lines)

S. Fleck et al.; **Fuel 217 (2018) 306-319**

Near Flame Zone



OH*-radical imaging (inverse Abel transformation, false colored)

free jet model gas temperature

droplet velocity

spray quality

input atomization

input gas phase kinetics

input char kinetics

Results

- Local data describe mixing and reaction pattern
- Local characteristic parameters assess consistency of measured data and quantify reaction conditions
- Burner momentum determines spray quality and entrainment from outer recirculation zone → flame position / structure / stability
- RANS simulation is validated for glycol
- Free jet model matches OH* profile qualitatively

Future work

- Application of wider fuel specification
- Determination of catalytic effects of ash components
- Application of free jet model for sub model validation

Cooperation

Helmholtz Virtual Institute for Gasification Technology (HVI GAS TECH) · IEVB Institute for Energy Process Engineering and Fuel Technology · DLR · JÜLICH FORSCHUNGSZENTRUM · RWTH AACHEN UNIVERSITY · PAUL SCHERRER INSTITUT PSI · KTH Royal Institute of Technology · ECN Energy research Centre of the Netherlands · Luleå University of Technology