Karlsruhe Institute of Technology

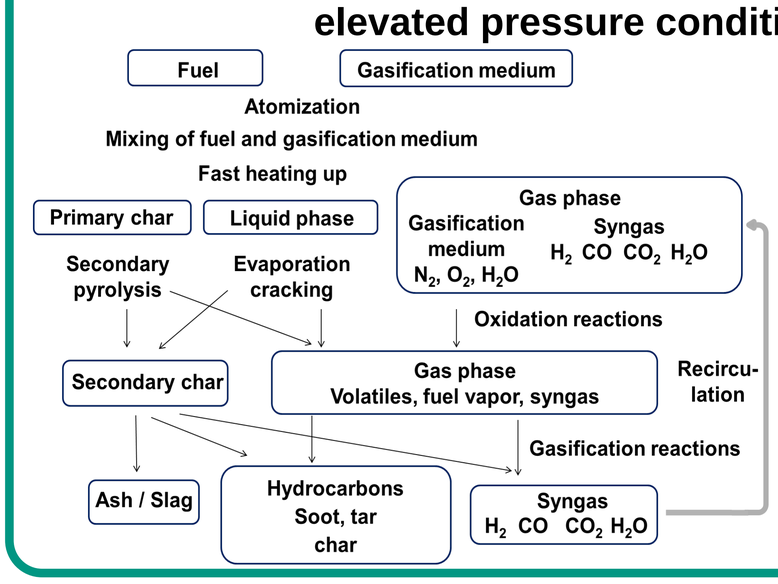
EBI-ceb, Engler Bunte Institute - Fuel Technology
ITC, Institute for Technical Chemistry
Prof. Dr.-Ing. T. Kolb, Prof. Dr.-Ing. D. Stapf

Investigation of Burner Near Processes in Entrained Flow Gasification

Manuel Haas, Sabine Fleck, Christian Hotz, Thomas Kolb

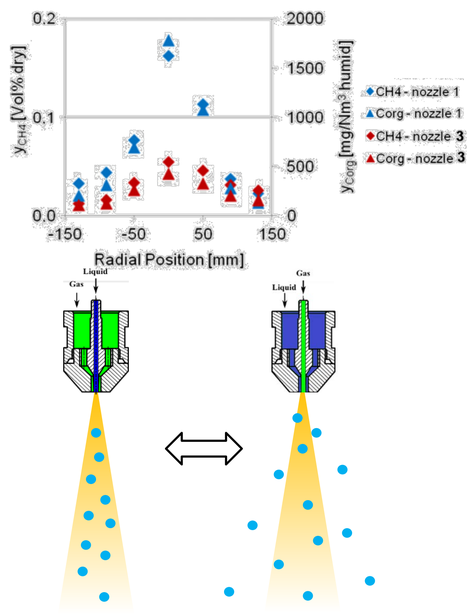
Motivation

Entrained Flow Gasification of Suspension Fuels under elevated pressure conditions



- Descriptions of sub-processes
- Development of **numerical models**
- Validation of numerical results by **detailed experimental data**

Challenges and Objectives



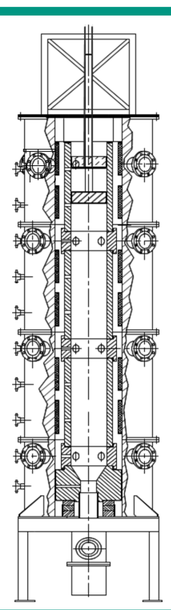
- Incomplete carbon conversion
- Hydrocarbon Formation
- Influence of flow field, fuel spray distribution and reactand mixing on syngas quality is barely understood
- **No detailed experimental data available from suspension EFG**

→ Investigate influence of atomization (droplet velocity and size distribution) and flow field

→ Validation of sub-process models

→ **Understand burner near processes**

Experimental Methods

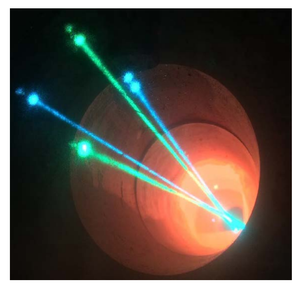


Research Entrained Flow Gasifier (REGA)

- Pilot Scale Entrained Flow Gasifier
- Atmospheric pressure (p = 1 bar)
- Thermal Power 60 kW
- **Optically accessible**
- Movable burner
- **Single component model fuels, model slurries, technical fuels**

Diagnostic Tools

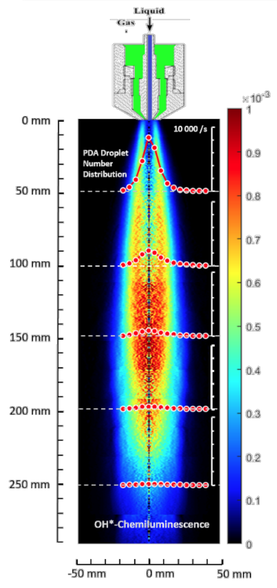
- **High speed camera** (spray characteristics)
- **OH*-Chemiluminescence** (flame structure)
- **OH-LIF** (flame structure)
- **Fuel-Tracer-LIF** (fuel conversion)
- **LDA/PDA** (droplet size and velocity)
- **Shadowgraphy** (droplet imaging)
- **DP-thermocouples** Locally resolved temperature
- **FID/GC/FTIR** Online gas analytics



Reaction Zone Characterization

Flame Structure Analysis

Instantaneous



Average, abel-transformed

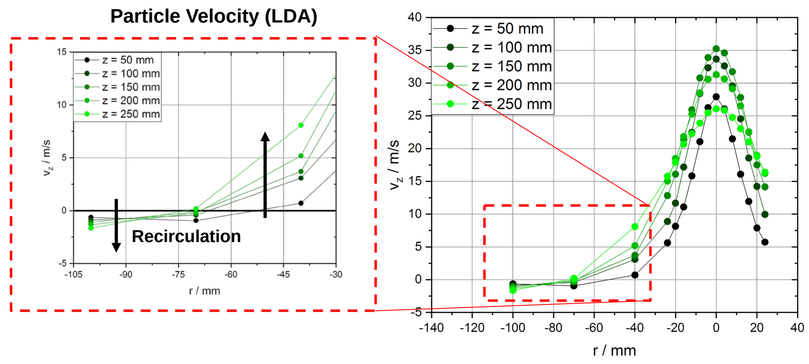
- Oxygen from Gasification medium reacts with hot syngas
- Flame is stabilized at nozzle exit
- Flame envelope around fuel spray
- **Structure of main reaction zone can be explained by free-jet-theory**

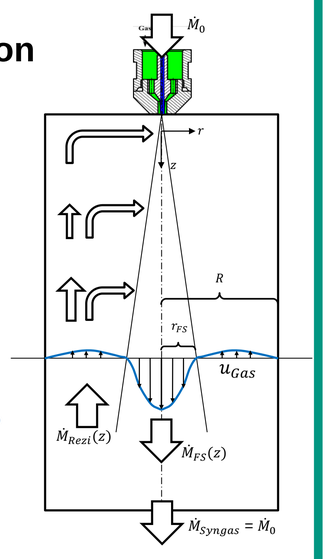
Future work:

→ OH- and CH_2O-LIF to gain **detailed insight into reaction zones**

Flow Field Analysis

- **Detailed mapping** of flow field inside gasifier for model-based description of free jet and recirculation zone
- Investigate **influence of flow field on fuel conversion**

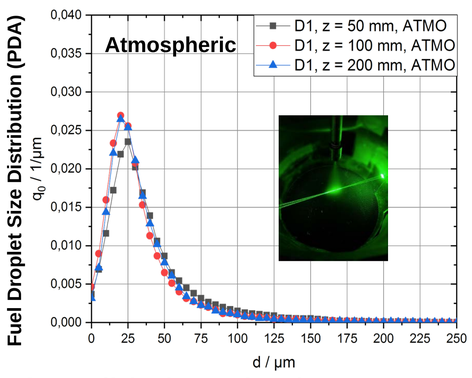


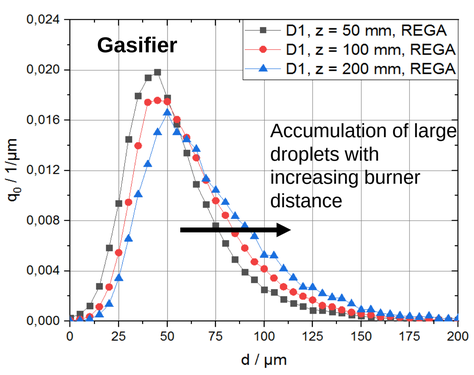


- **Enclosed free-jet** with recirculation zone
- High centerline velocity due to thermal expansion

Fuel Conversion Analysis

- Comparison of cold-flow and gasification experiments
- Droplet size distribution (PDA) and fuel concentration (LIF)

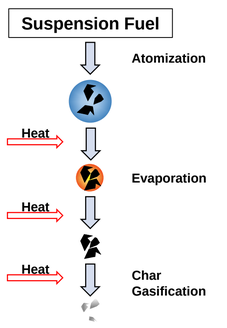


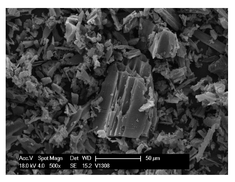


→ Validation of sub process models for evaporation

→ Determine **influence of flame structure on fuel conversion**

Modeling of Suspension Fuel Conversion





Wood char particles extracted from REGA gasifier

- Gasification experiments of model slurries with variable solid content and particle size
- Detailed in-situ data from shadowgraph
- Particle extraction to determine solid fuel conversion
- **Model based description of suspension fuel gasification**