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Entrained-Flow Gasification of Biomass-based Slurry

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Challenges

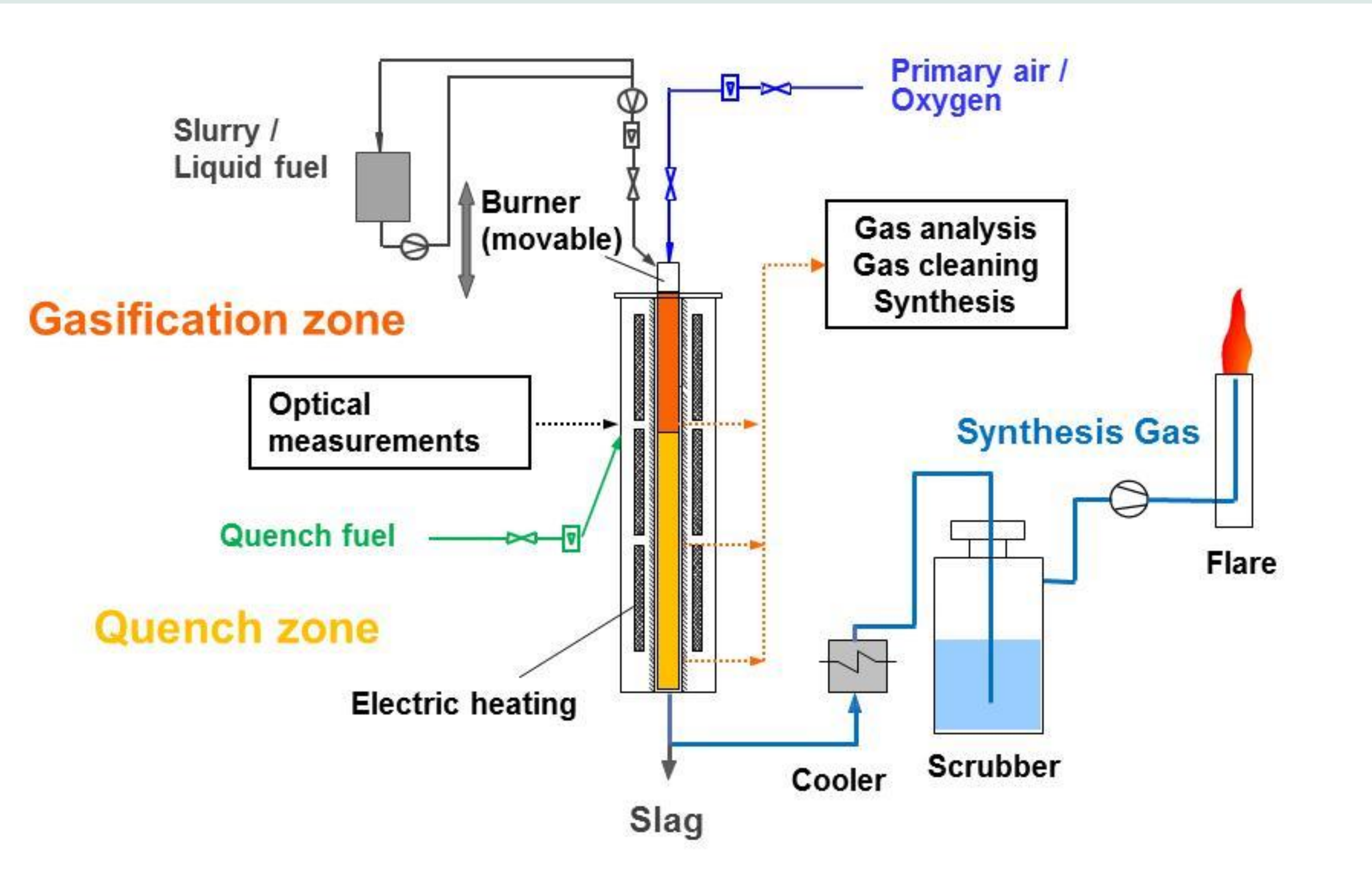
- Entrained flow gasification (EFG) of biogenic and fossil low rank fuels
- Slurry – liquid and solid fuel
- High temperature multi phase system
- Fuel conversion (liquid and solid)
- Processes in burner near region
- Syngas quality / process efficiency
- Process simulation / control

Objectives

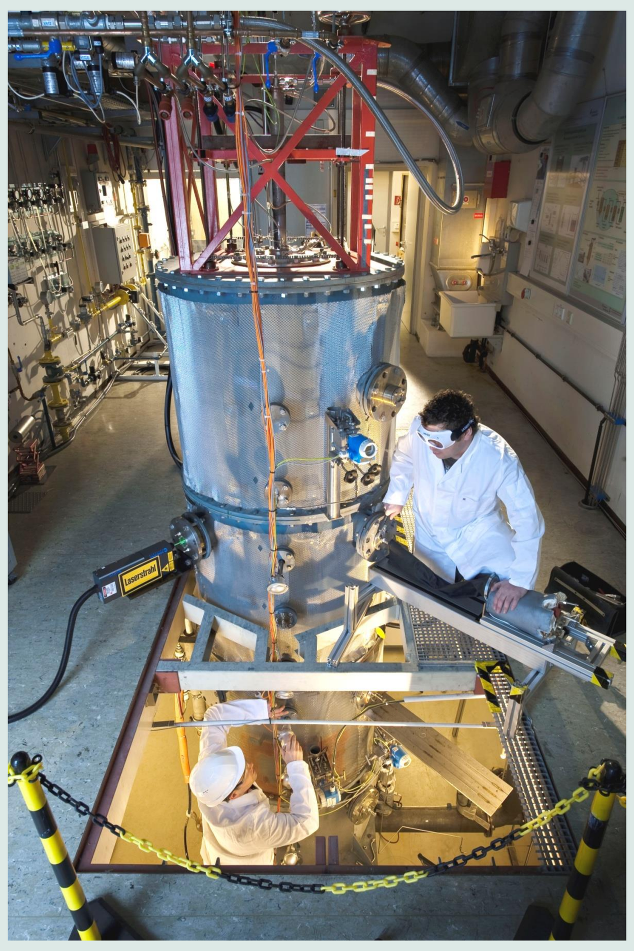
- Thermo-chemical processes during EFG of slurry:
  → Droplet evaporation
  → By-products (production, degradation)
  → Interaction of solid and liquid fuel components
  → Conversion of solid fuel components
- Model for slurry gasification under entrained-flow conditions
  → Data for validation of numerical simulation
  → Flow field, distribution of temperature and gas composition
  → Model fuel and technical fuel
- Measurement techniques newly developed and adapted for EFG (IAI, DLR, PSI)

Research Entrained-flow GAsifier – REGA

Flow Chart



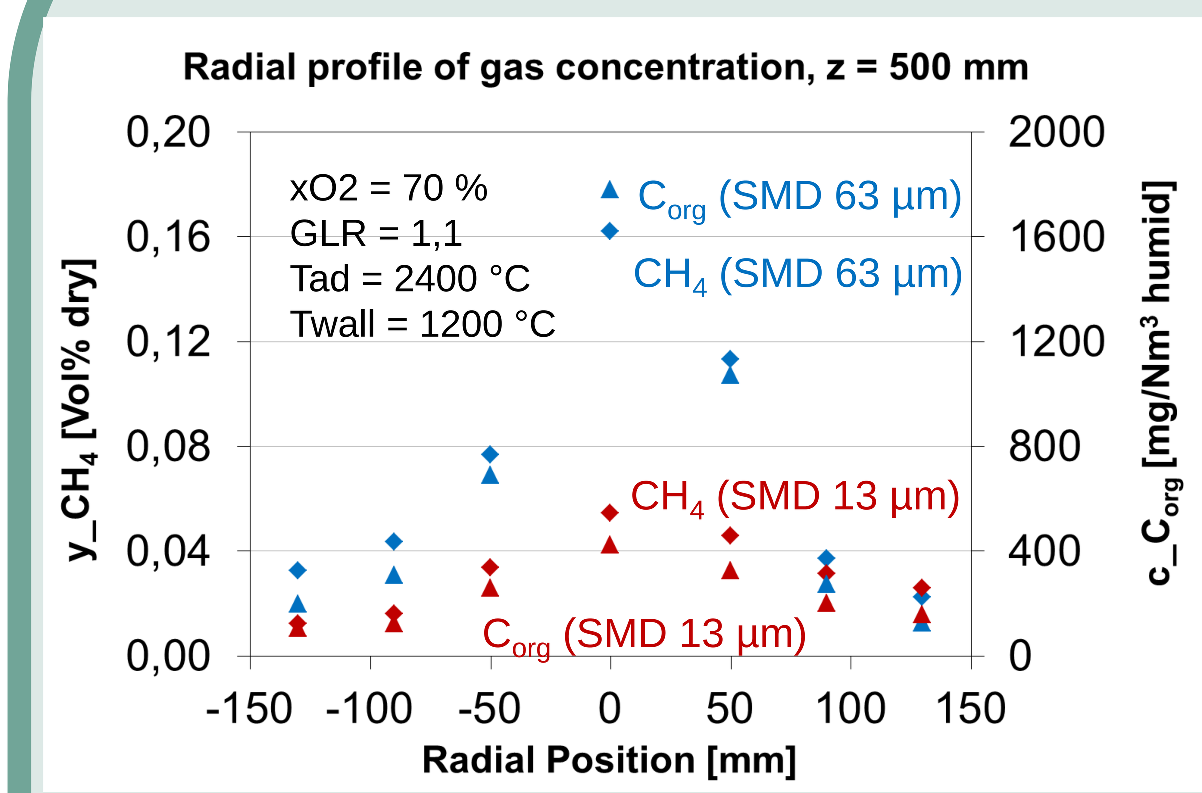
Reactor

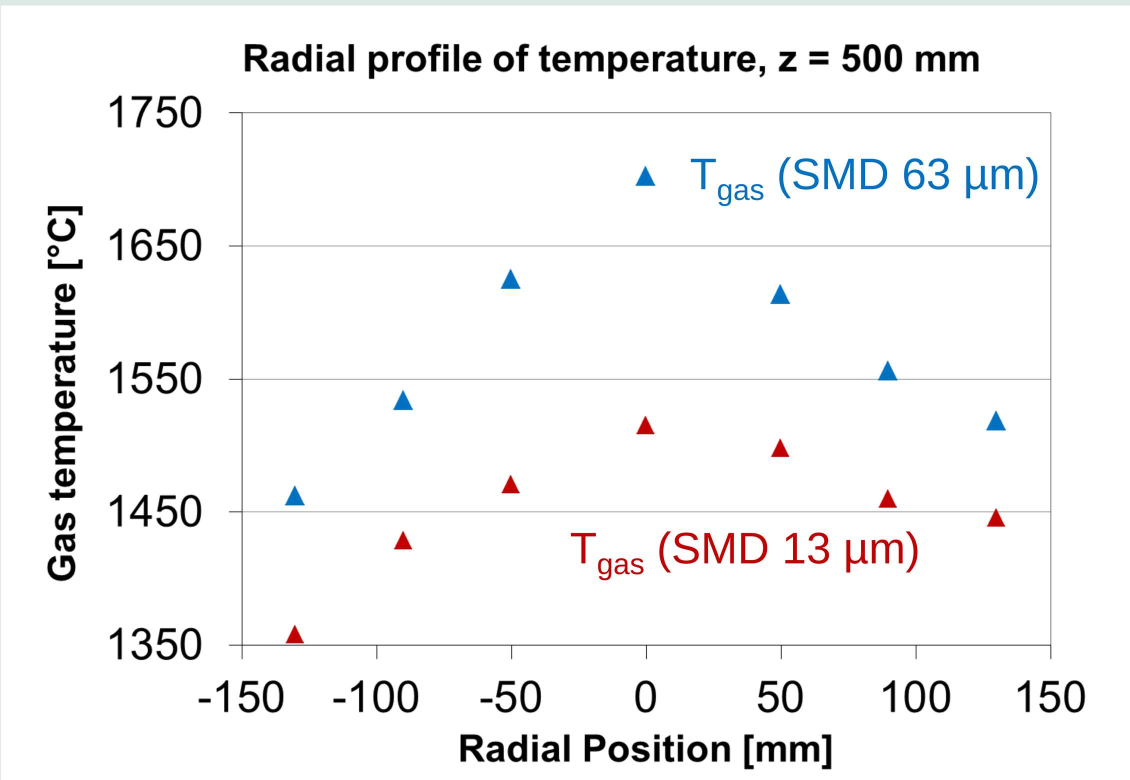


Technical Data

- Inner diameter: 0.28 m
- Reactor length: 3.0 m
- Max. temperature = 1600 °C
- Max. thermal load: 60 kW
- Max. gas flow rate: 100 Nm³/h
- Pressure: atmospheric
- Burner axially movable
- Flanges for online analytics and optical measurements

Variation of Droplet Size





Fuel: glycol, variation of SMD (Sauter mean diameter) by application of two different nozzles

- SMD ↓ ⇒ y_{CH4} ↓, c_C_{org} ↓, T_{gas} ↓
- Effect of evaporation:
  SMD ↓ ⇒ $\tau_{evaporation}$ ↓ ⇒ λ_{local} ↓
  ⇒ gasification process advanced

Oxidation: $C_xH_y + O_2 \rightarrow CO_2 + H_2O$

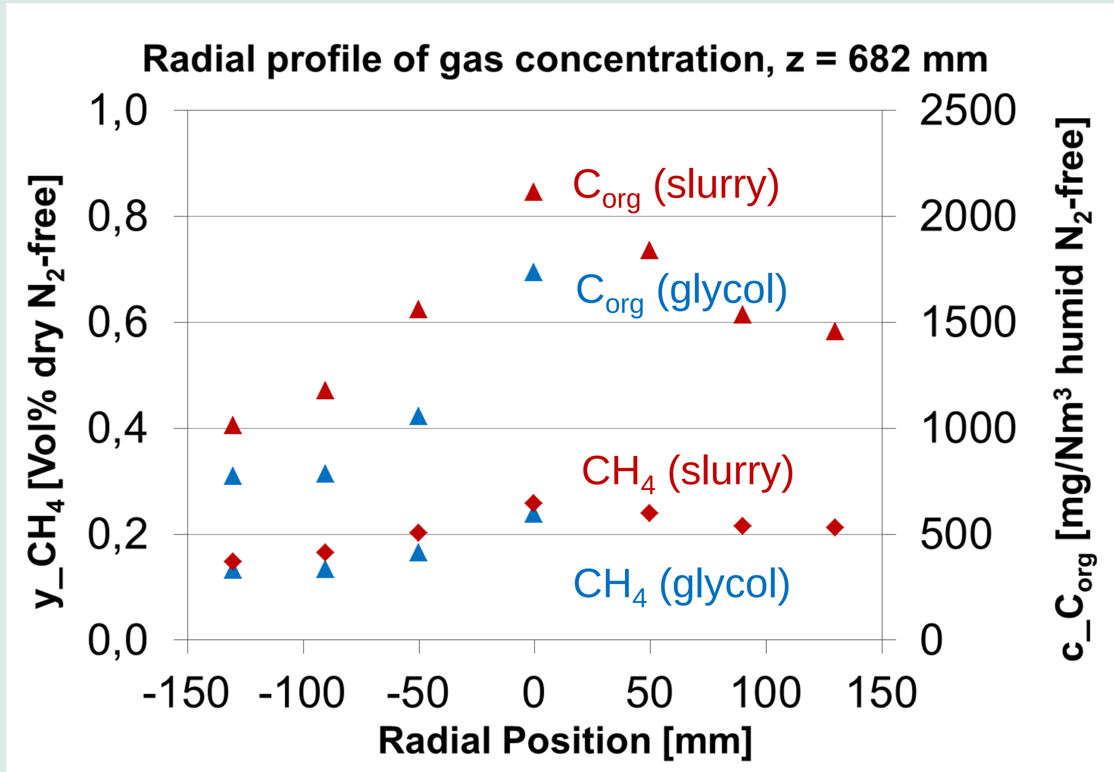
$C_xH_y + O_2 \rightarrow CO + H_2$

Gasification: $C_xH_y + CO_2 \rightarrow CO + H_2$

$C_xH_y + H_20 \rightarrow CO + H_2$

WGS eq.: $CO + H_2O \leftrightarrow CO_2 + H_2$

Variation of Fuel Composition



Fuel: glycol, glycol with 20 wt% char from beechwood
SMD: glycol = 35 µm, slurry = 57 µm

- Glycol → Slurry ⇒ y_{CH4} ↑ and c_C_{org} ↑
- Effect of SMD and heterogeneous reaction kinetics