Karlsruhe Institute of Technology

HELMHOLTZ
RESEARCH FOR GRAND CHALLENGES

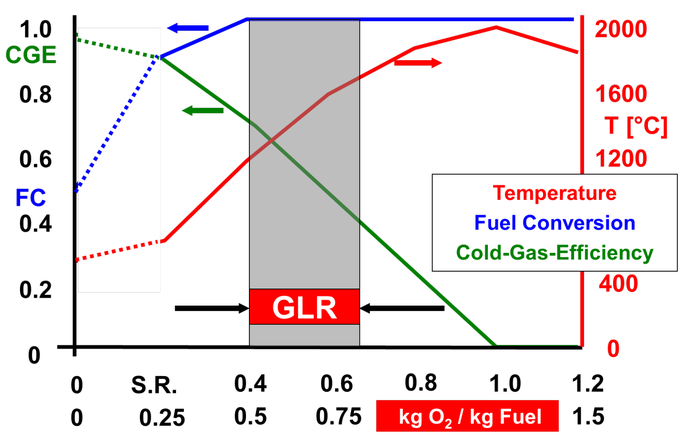
EMR / RU4 Feedstocks and Processes of the Future Carbon Cycle
Gasification

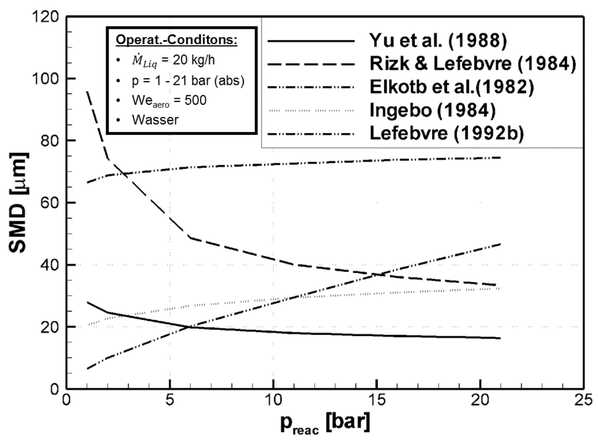
Spray Investigation for Entrained Flow Gasification

Atmospheric Spray Test Rig - ATMO

T. Jakobs, S. Wachter, A. Sänger, T. Kolb

Overview Diagramms

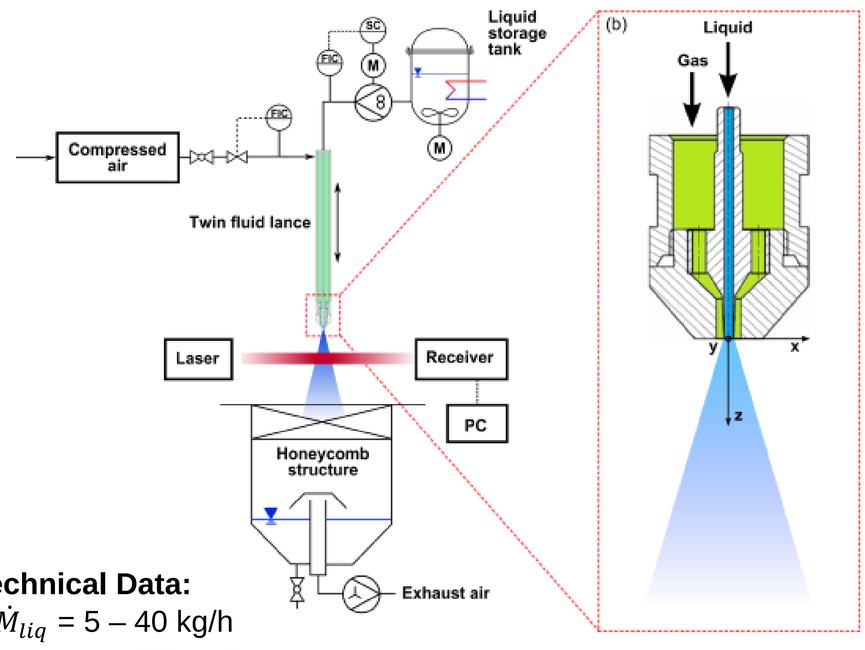




$$GLR = \frac{\dot{M}_{gas}}{\dot{M}_{liq}} = \frac{\dot{M}_{Oxidizer}}{\dot{M}_{Fuel}} \propto S.R.$$

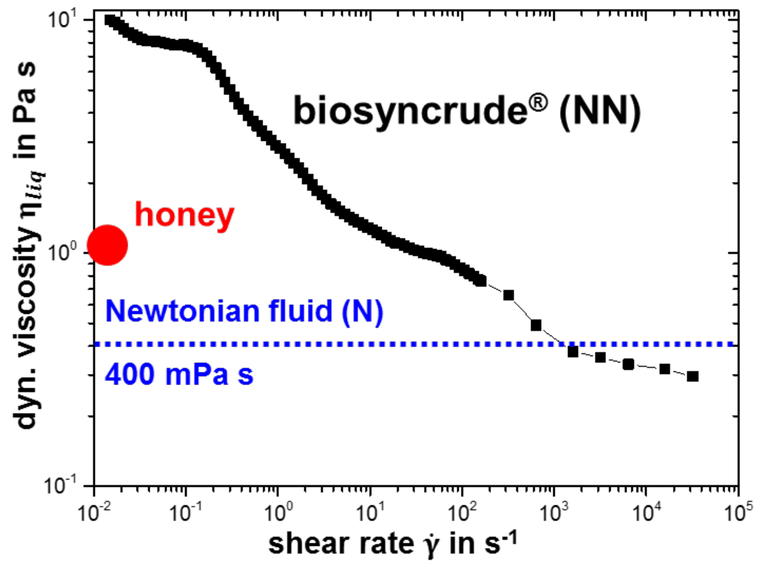
➔ ***Inconsistent dependency of SMD on pressure described in literature***
➔ ***Clarification mandatory!***

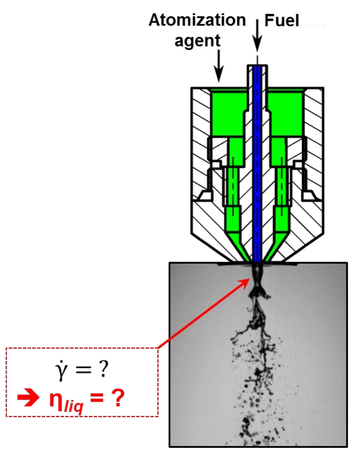
Atmospheric Spray Test Rig

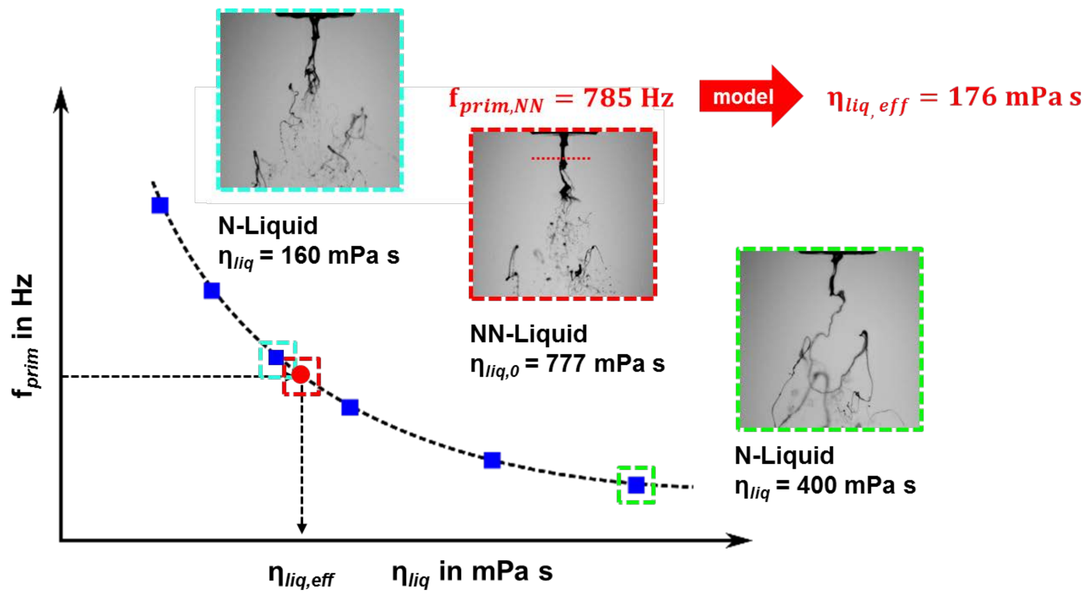


Technical Data:
- $\dot{M}_{liq}$ = 5 – 40 kg/h
- $\eta_{Liq,max}$ = 1000 mPa s
- Explosion proof exhaust
- Operated via PC

Model for determination of $\eta_{liq,eff}$ quantitatively proven for one NN-liquid







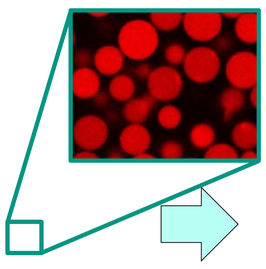
➔ ***Viscosity of NN liquids is relevant for jet breakup but not available!***

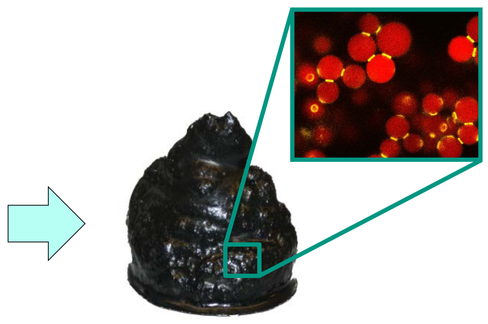
Associated Publication: A. Sänger, T. Jakobs,T. Kolb, Using primary instability analysis for determination of apparent liquid viscosity at jet breakup atomizing non-Newtonian fluids, ILASS Brighton, 2016

Successful Atomization of Stabilized Straw Coke Suspension Fuel

- Addition of a small amount of a second immiscible fluid to a suspension changes the rheological properties drastically

➔ Transition from fluid-like to gel-like behavior (NN)





0 vol.-% octanol

solid phase:
straw coke, d_{50} = 20 µm

1 vol.-% octanol

bulk phase:
water, η = 1 mPa s

2.5 vol.-% octanol

secondary phase:
octanol, η = 6 mPa s

Result
- Drastically increased storage stability (several days)
- Beneficial effect of additive on spray quality

Associated Publication: L. Jampolski, A. Sänger, T. Jakobs, G. Guthausen, T. Kolb, N. Willenbacher, Improving the processability of coke water slurries for entrained flow gasication, Fuel 2016

Ongoing Work

- **Atomization of suspensions**
- **Improved CFD-Modelling**
- **Data-based model atomization of viscous suspensions**

Future Work

- **Experimental investigation of different nozzle geometries**
- **Derive rules for burner scale up**
  ➔ **Virtual Spray Test Rig**