Reliability of TGA data for characterization of alternative biomass feedstocks

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  – TGA test
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Introduction – BRISK 2

• 15 European partners
• Development of methods and research infrastructure
  – thermochemical and biochemical conversion
  – enhanced measurement techniques
  – new biorefining approaches
  – simulation tools
Introduction – TGA round robin

Potential for future
- Biomass can play a more relevant role in the production of power, liquid fuels or chemicals
  → Thermo-chemical processes using ligno-cellulosic biomass

Biomass characterisation
- mass loss behaviour is commonly determined by TGA
- TGA results in literature have strong deviations
  - mainly attributed to biomass inhomogeneity
  - impact of institution, operator, equipment, … not known
Introduction – TGA round robin

- Variation of data in literature
Scope – TGA round robin

- Investigate the reproducibility of TGA biomass pyrolysis
- 7 European partners
- Eliminate influence of biomass inhomogeneity via homogenized feedstock
- Eliminate error from data evaluation → all results evaluated by one partner
Methodology – TGA round robin

- **Fuels**
  - Avicel® PH-101 cellulose
  - Beech wood
- **low initial mass sample**
  (ideally of 3 mg)
- **Pyrolysis from 150 – 500 °C**
- **Detailed handling protocols**
Methodology – TGA

• Scheme of TGA

Source: Quelle: Netzsch-Gerätebau GmbH
Cellulose pyrolysis – Conversion $\alpha$

- shape of the curves almost similar for all cases
- max reaction rate at $328.3 \pm 9.2 \degree C$; literature$^1$: $327 \pm 5 \degree C$

$^1$ Gronli et al. A round-robin study of cellulose pyrolysis kinetics by thermogravimetry. 1999
Cellulose pyrolysis – Modelling (single reaction)

- averaged error in the fitting: 2.9 ± 1.2 % → low error
- Error: mainly at temperatures around 350°C due to the tail of the DTG curve → especially pronounced in case #3
Beech wood pyrolysis
Conversion $\alpha$

- Beech wood: 1 peak, 1 shoulder ➔ results from hemicellulose
- obtained deviations between participants are of a similar order as for cellulose
Beech wood pyrolysis
Comparison of activation energies

• Activation energy $E_a$ calculated by Isoconversional KAS method
• Standard deviations 20 – 25 kJ/mol - within acceptable range
• One case significantly lower
Beech is modelled simulating 3 components:
- hemi-cellulose, cellulose, lignin

Fluctuations in signals of some partners (e.g. #7)
Summary and Outlook

• TGA is widely used, but mass loss kinetics for biomass pyrolysis is still a non resolved topic.

• Round robin of TGA pyrolysis experiments with 7 partners
  – Pure Cellulose: satisfactory reproduction of pyrolysis experiments from literature (Gronli et al. 1999)
  – Beech Wood: deviations with different devices are of a similar order as for cellulose
  – BUT certain deviations are obtained in DTG curves for all cases
  – Detailed documentation of protocols necessary
  – Evaluation of protocols for elucidation of remaining variation
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Thank you for your attention!

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