BEST
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Influence of ash forming elements from biogenous residues on fluidized bed conversion processes

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Bed material in DFB steam gasification

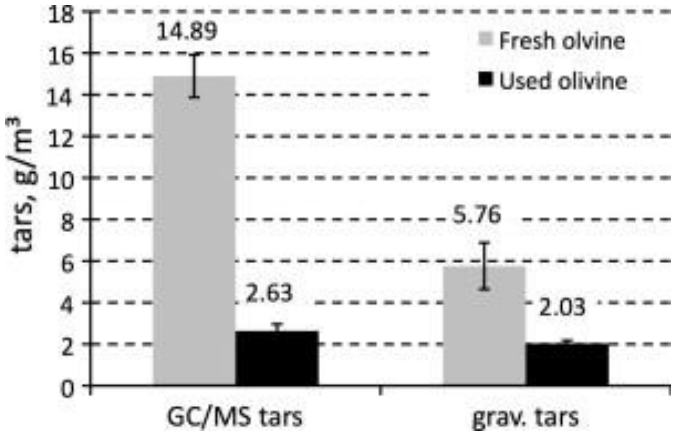
- Role:
  - Heat transfer
  - Tar reduction
  - Improved product gas composition
- Olivine is used as bed material in commercial plants
  - Catalytically active
  - Appropriate mechanical properties

  - But heavy metal content leads to necessity of deposition

→ Search for a heavy metal-free alternative bed material

Bed material – fuel ash interactions

- Agglomeration
  - Can cause defluidisation and plant shut-downs
- Layer formation
  - Positive effect on catalytic activity

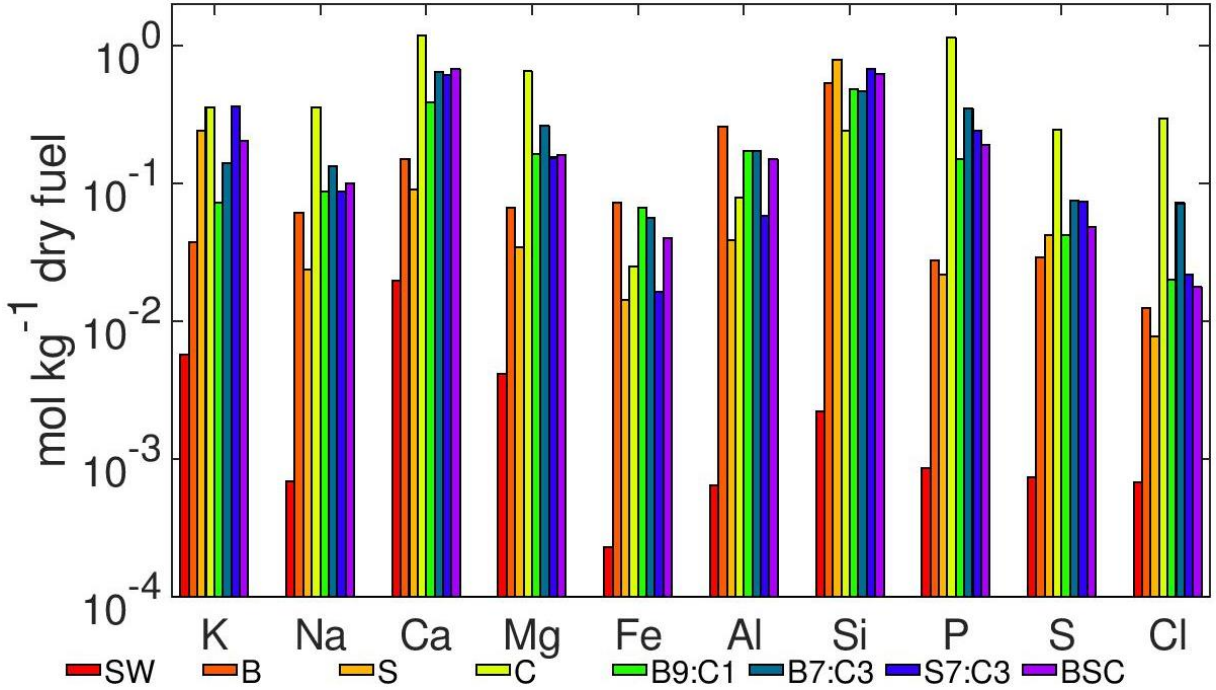


F. Kirnbauer, V. Wilk, H. Kitzler, S. Kern, and H. Hofbauer, 'The positive effects of bed material coating on tar reduction in a dual fluidized bed gasifier', *Fuel*, vol. 95, pp. 553–562, May 2012.

Alternative fuels

- Often higher ash contents compared to wood
- Ash behavior more challenging compared to wood
  - Ash handling during operation
  - Ash melting
- Increased ash contents speed up the catalytic activation

Fuel ash composition



TU Wien *2nd generation* DFB gasifier

Inauguration: 2015

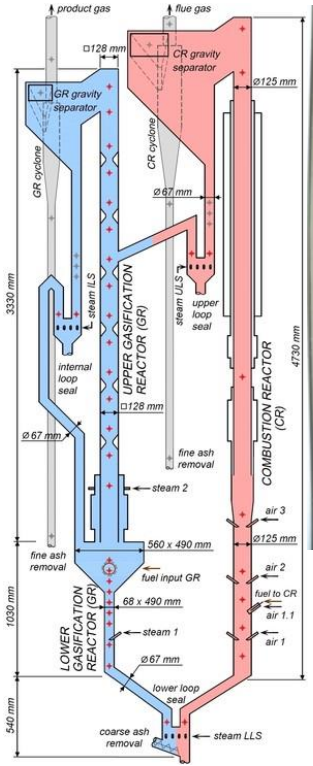
Capacity: 100 kW

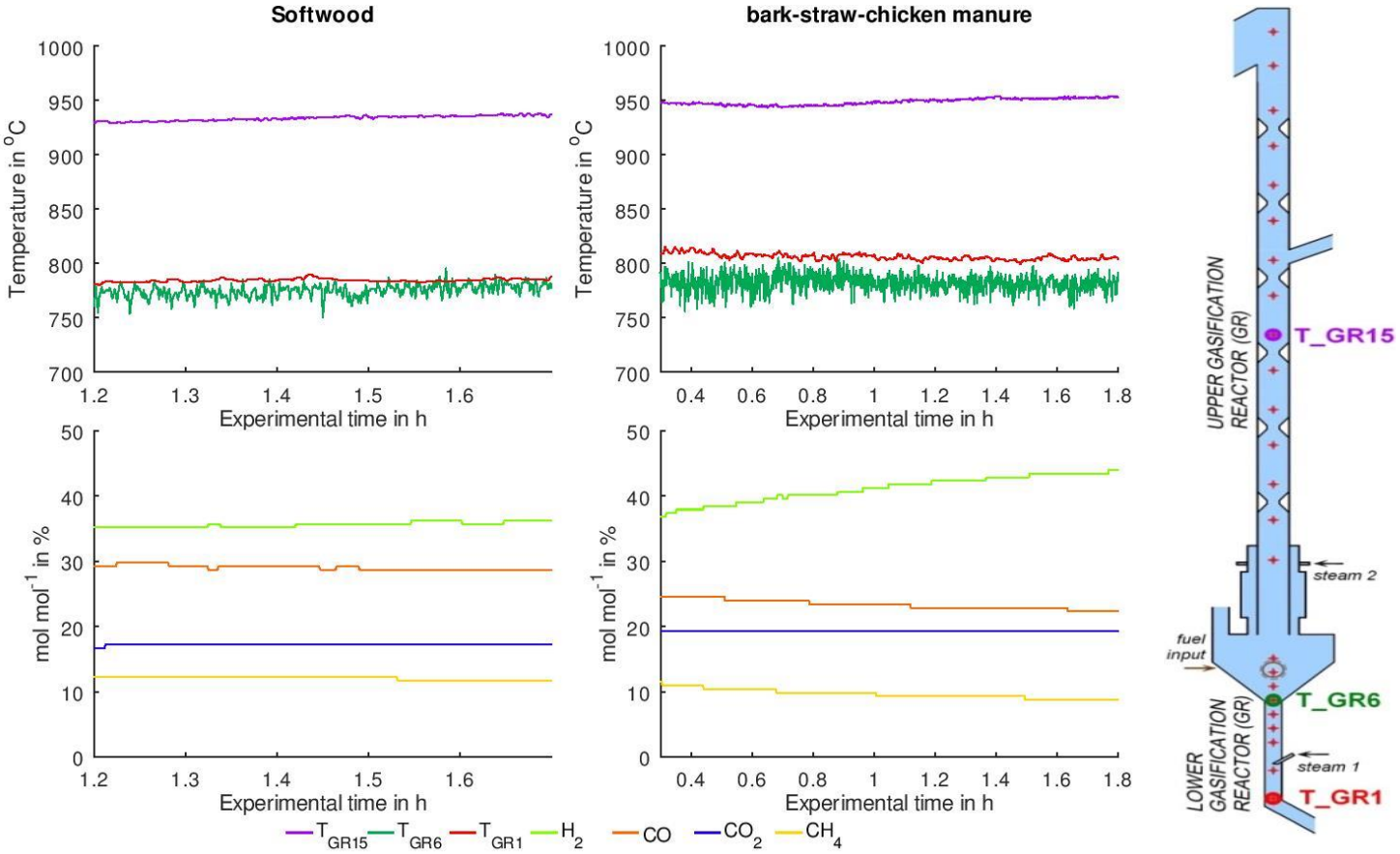
Reactor type: DFB

Gasifying agent: Steam

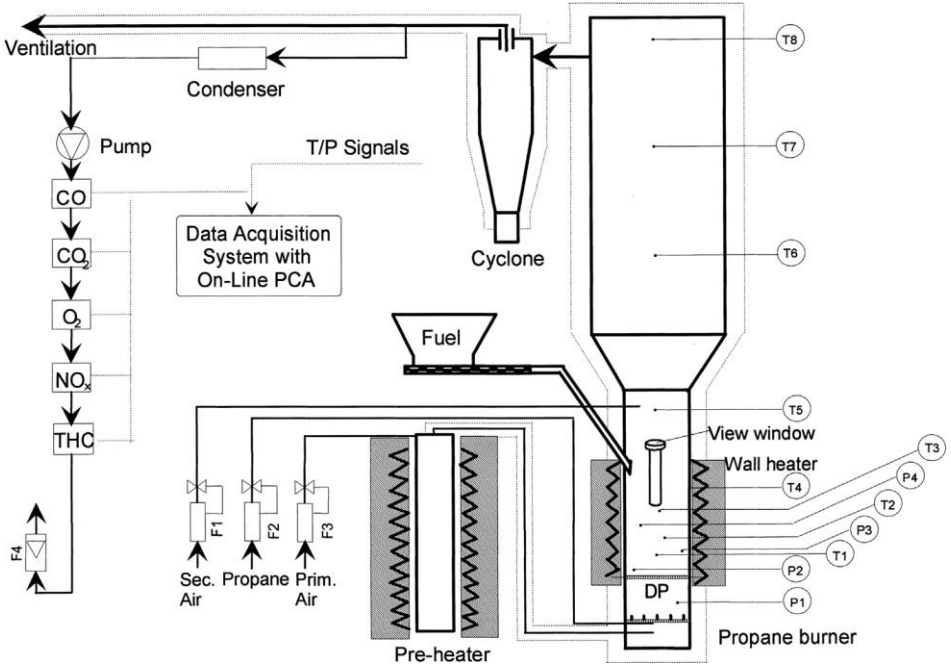
Research focus:

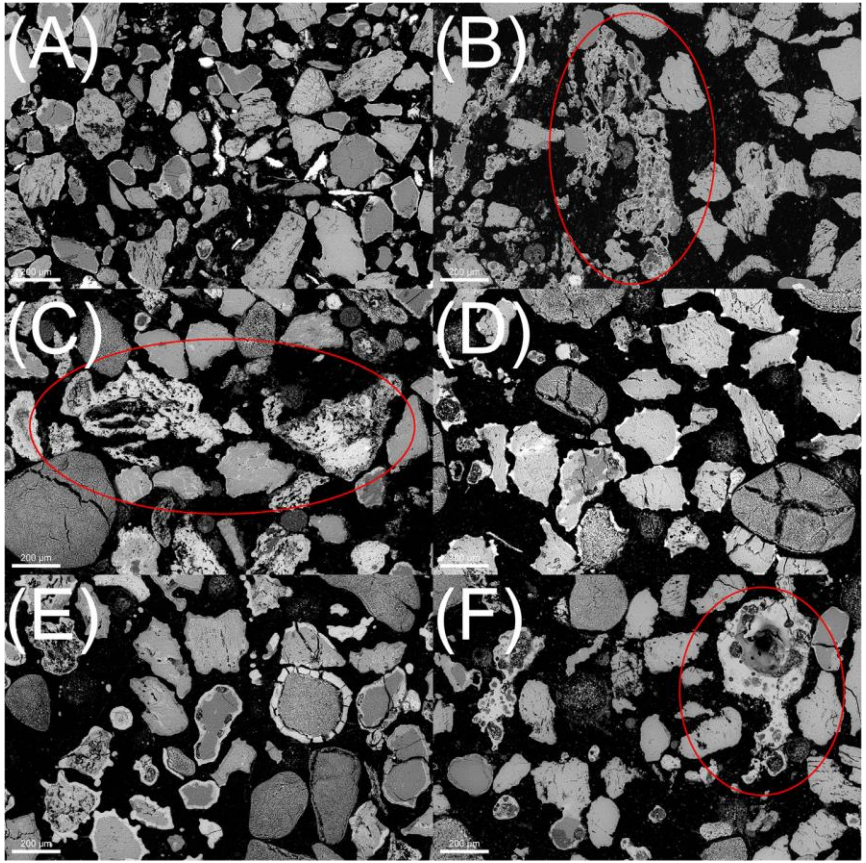
- Counter-current flow column above BFB gasifier
- Gravitational separators for softer bed materials



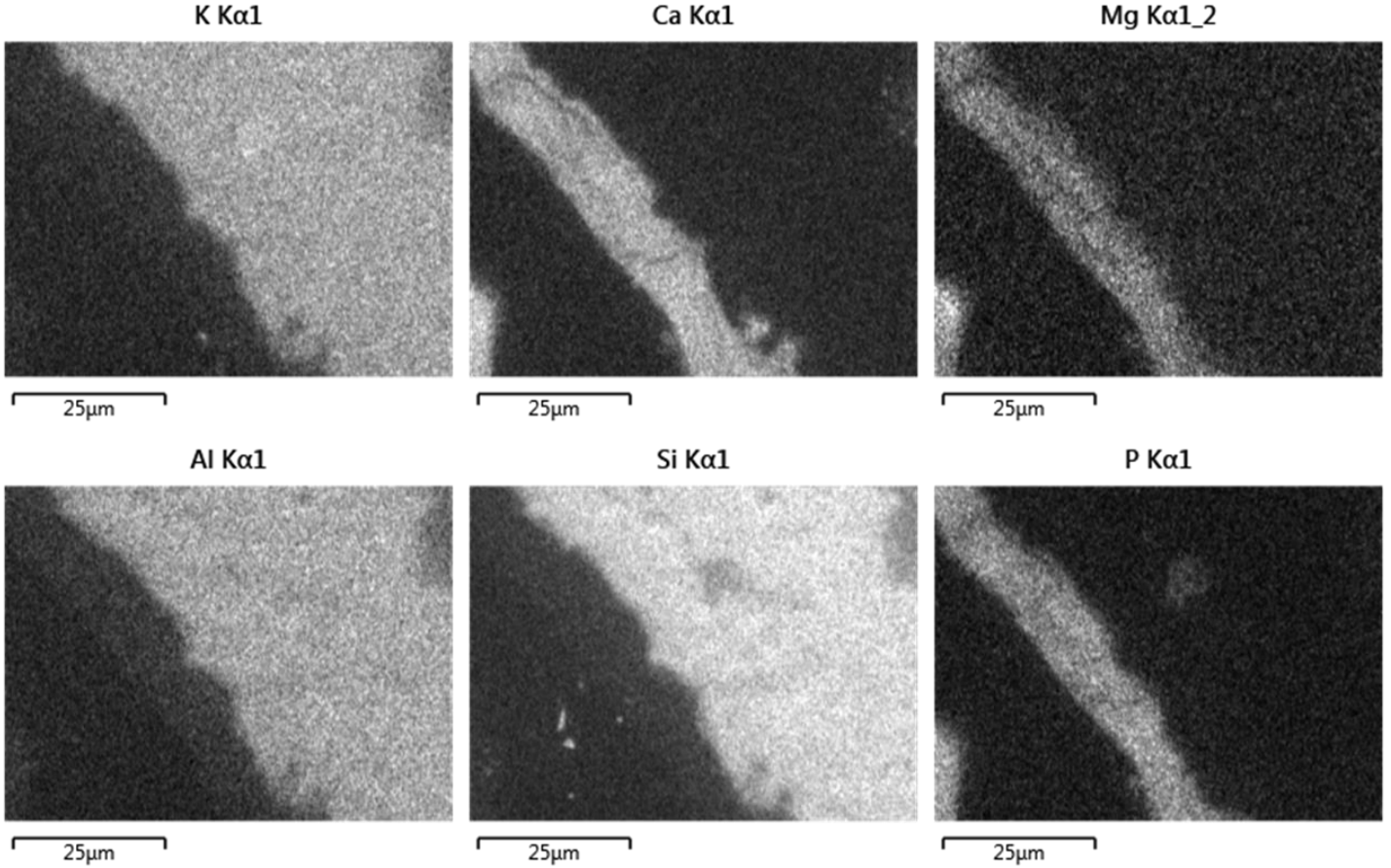

Softwood
bark-straw-chicken manure
Temperature in °C
Experimental time in h
mol mol-1 in %
T_GR15
T_GR6
T_GR1
H2
CO
CO2
CH4
UPPER GASIFICATION REACTOR (GR)
LOWER GASIFICATION REACTOR (GR)
steam 2
steam 1
fuel input

5 kW BFB test plant

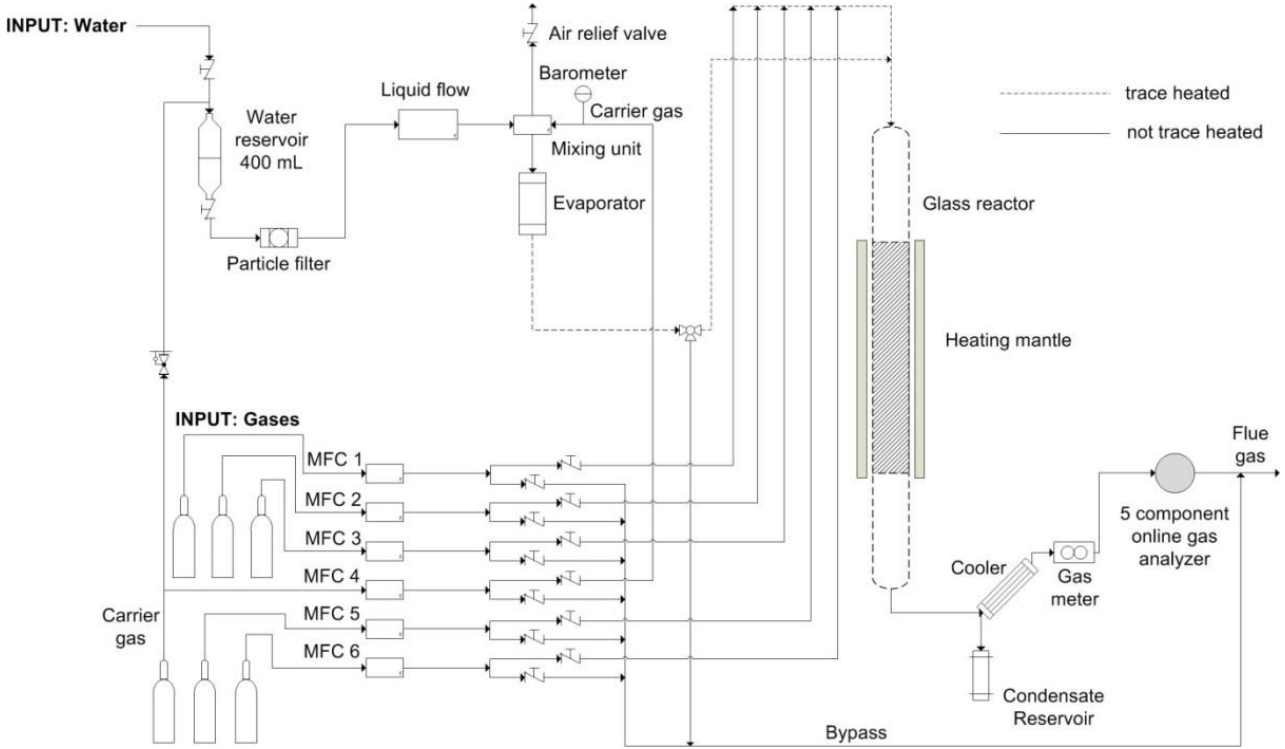




SEM: A) Bark, B) Wheat straw, C) Chicken manure, D) B9:C1, E) B7:C3, F) S7:C3

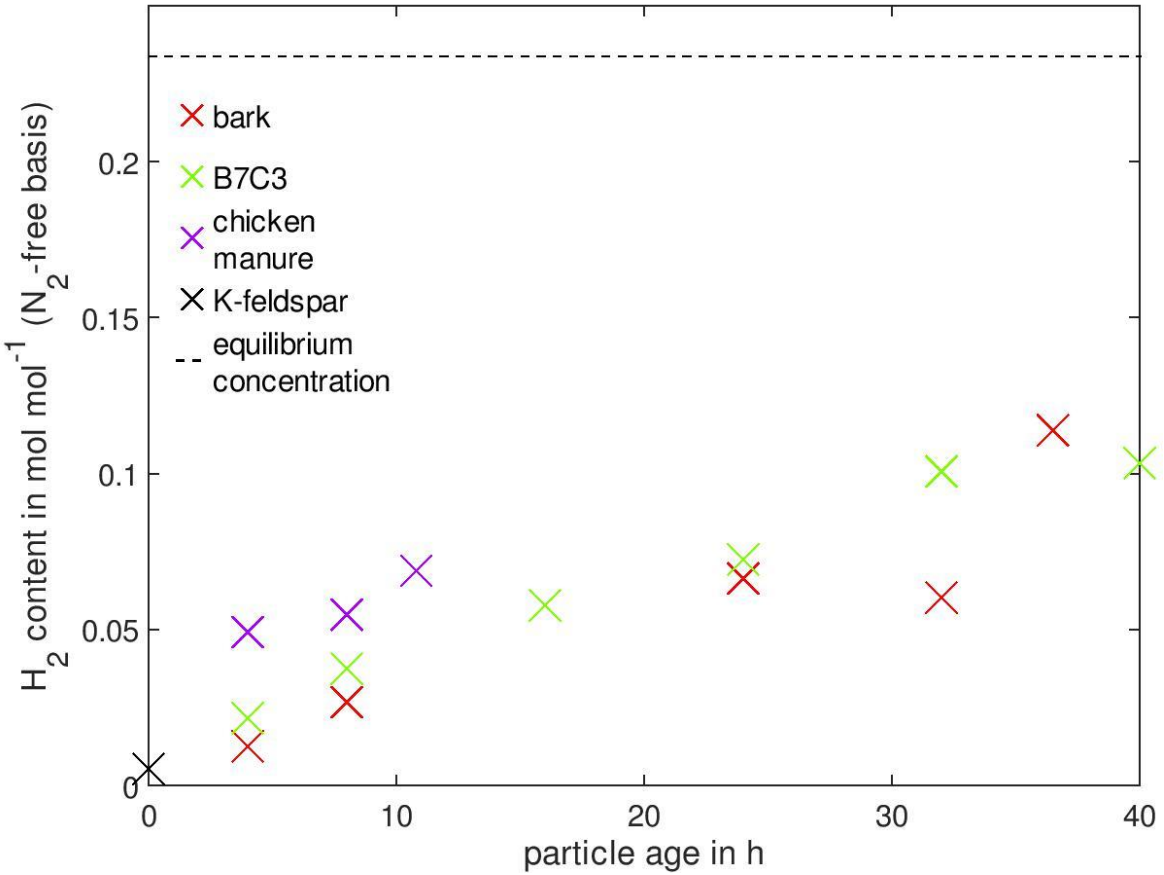

K Kα1
Ca Kα1
Mg Kα1_2
25µm
25µm
25µm
Al Kα1
Si Kα1
P Kα1
25µm
25µm
25µm

Micro-scale test-rig



Water-gas-shift reaction

- $H_2O + CO \Leftrightarrow H_2 + CO_2$
- $\Delta H = -40.9\ {}^{kJ}/_{mol}$
- One of the major reactions occuring during gasification


bark
B7C3
chicken manure
K-feldspar
equilibrium concentration
H_2 content in mol mol^{-1} (N_2-free basis)
0
0.05
0.1
0.15
0.2
0
10
20
30
40
particle age in h

Conclusion

- K-feldspar is a possible bed material for fluidized bed applications
- An activation of K-feldspar occurs during the interaction with fuel ash
- The fuel ash composition influences the ash layer composition formed on the bed material
- The BET surface area of K-feldspar increases during the interaction with fuel ash

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Thank you for your attention

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