Nya karaktäriseringsmetoder för fasta bränslen - Malbarhet, tändvillighet och sintring

Panndagarna 2011

9-10 februari

S:t Gertrud Konferens Malmö

Johan Wadenbäck

Chemistry & Materials

VATTENFALL

Outline

1. Background
2. Scope of the EXAS project
3. Grindability
4. Ignitability
5. Sintering

1. Background

The demand of an extensive CO_2 reduction indicates, that many qualities of biomass will be utilized in power plant boilers in the future

- The biomass will be used alone or together with coals as co-firing
- The grindability properties for biomass (or biomass/coal blends) are not characterized by the current ”standard – classic” methods
- The combustion processes for biomass or biomass/coal blends are not characterized by the current ”standard – classic” methods
- Fly-ash deposits at ”low” temperatures (Sintering) can cause trouble with biomass firing

2. Scope of the EXAS project (1)

- Purchase of three lab-scale apparatus developed by Prof. Żelkowski, Berg, Wadenbäck *et al.* for the determination of grindability-, sintring- and ignitiability properties of solid fuels
  - Installation in the fuel laboratory at the Amager Power Plant in Copenhagen

- Initial evaluation of the hardware with a three solid fuels; coal, straw- and wood pellets
  - The results are compared with full-scale experiences in Vattenfall

- Further evaluation of solid fuels and solid fuel blends used within Vattenfall such as torrified- or steam exploded biomass etc.

continues…

2. Scope of the EXAS project (2)

continues…

- The novel methods are intended to be incorporated into the “routine analysis toolbox” of solid fuels
- Different parts of Vattenfall will gain experience from the project through reference group attendance as well as seminars/workshops/reports
  - In addition: The possibility to test additional solid fuels and solid fuel blends relevant for different parts of Vattenfall
- The novel methods are applied prior to introduction of new and unfamiliar solid fuels at power plants throughout Vattenfall
- Ackreditaded analyses and standardization?

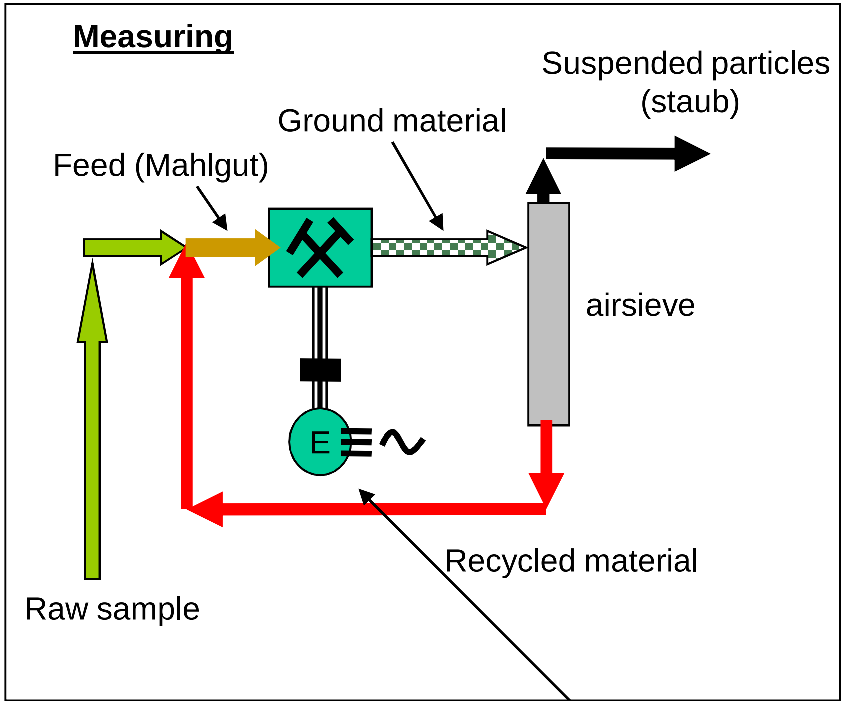
3. Grindability – Hardgrove index (HGI)

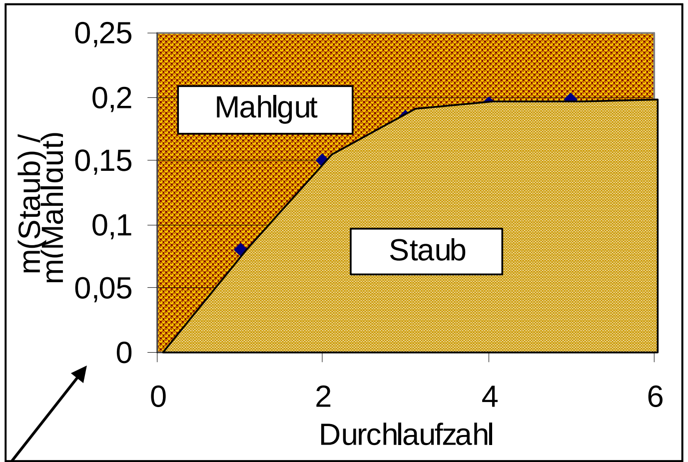
- Simple test with simple device
- 8 steel balls overroll 60 times a 50 g sample of the fraction
- 0.600-1.18 mm
- The mass M [g] of the produced material finer than 75 µm

determines the HGI

$$HGI = A + B \cdot M \approx 13 + 6.93M$$

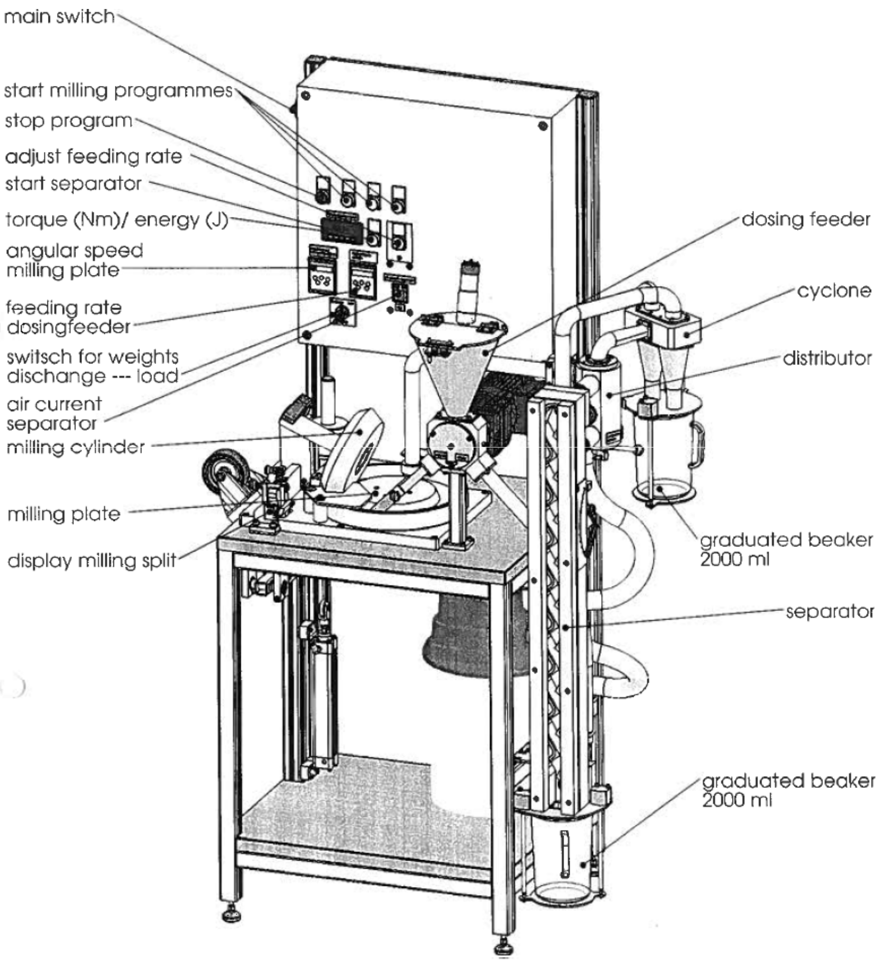
3. Grindability – CMT-mill principle

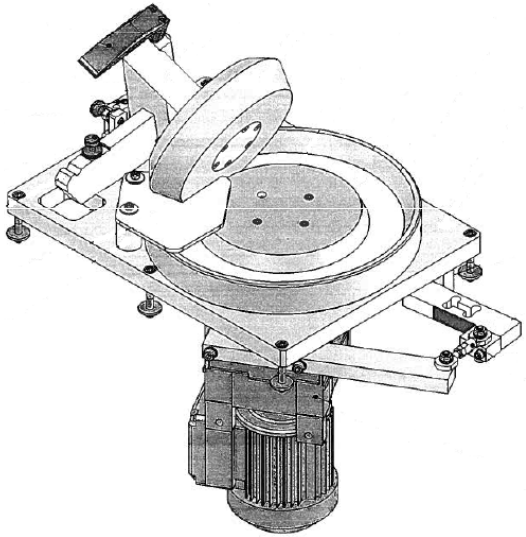




Modeling of the recycling in a large mill

3. Grindability - The EXAS CMT-mill





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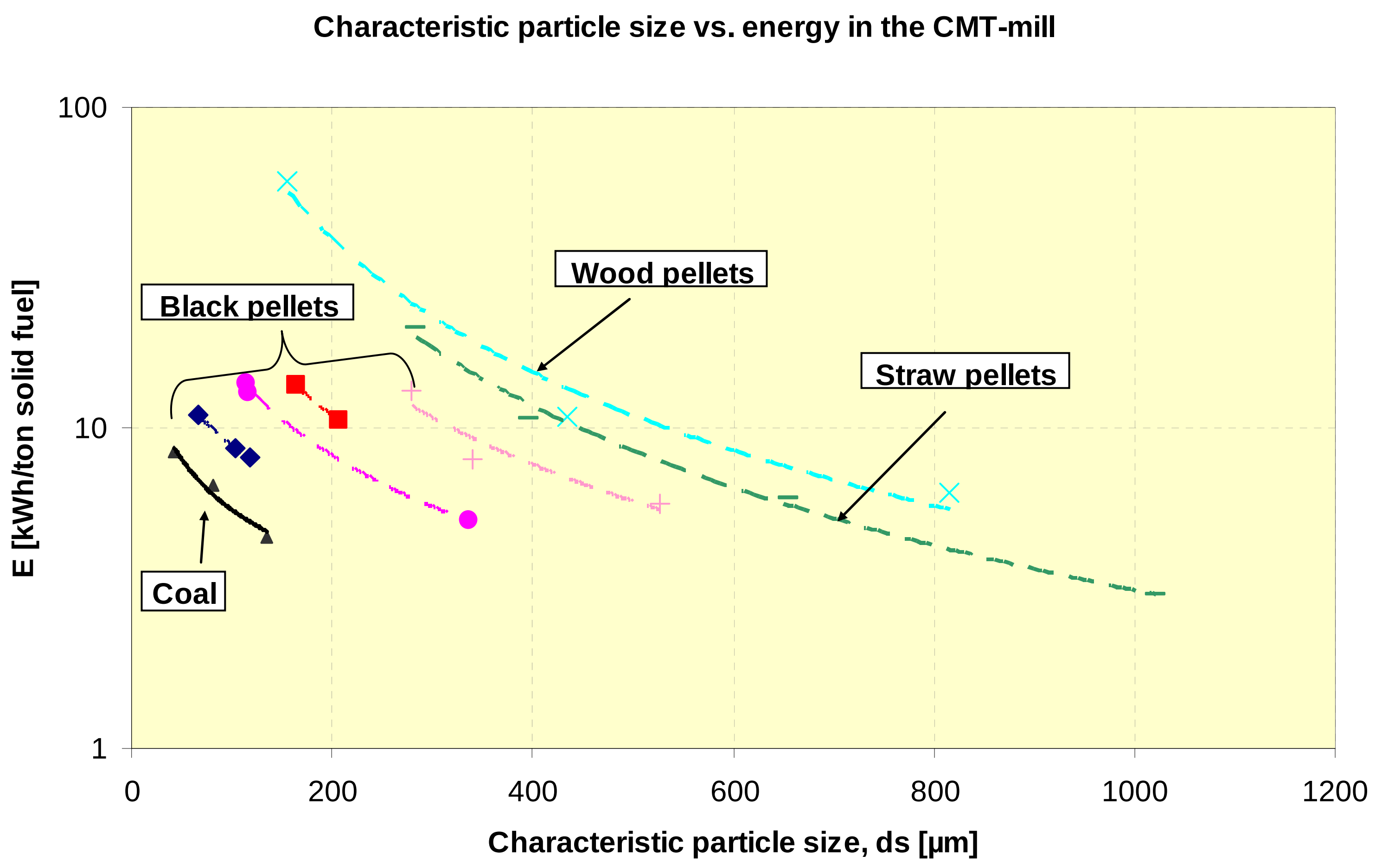
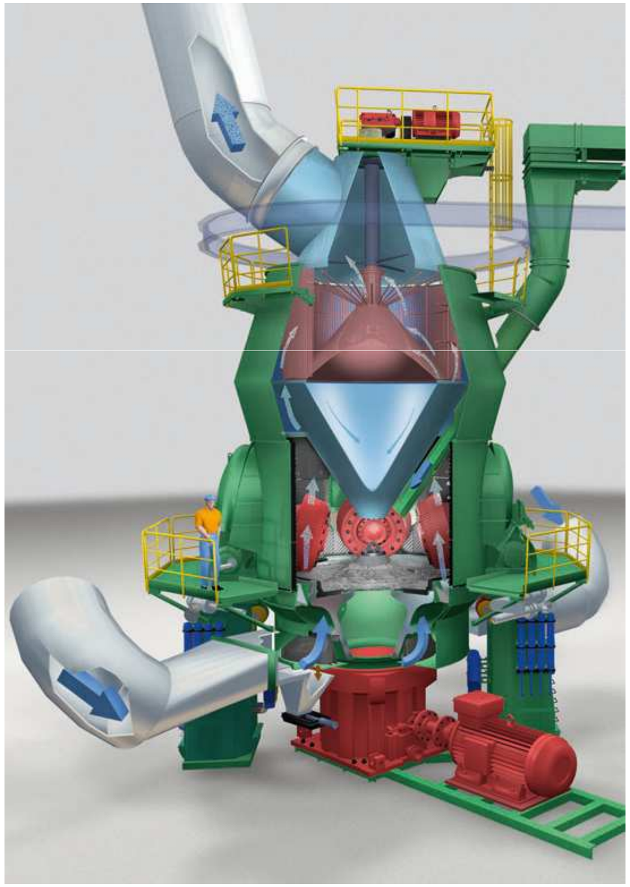
3. Grindability – Solid fuels tested so far…

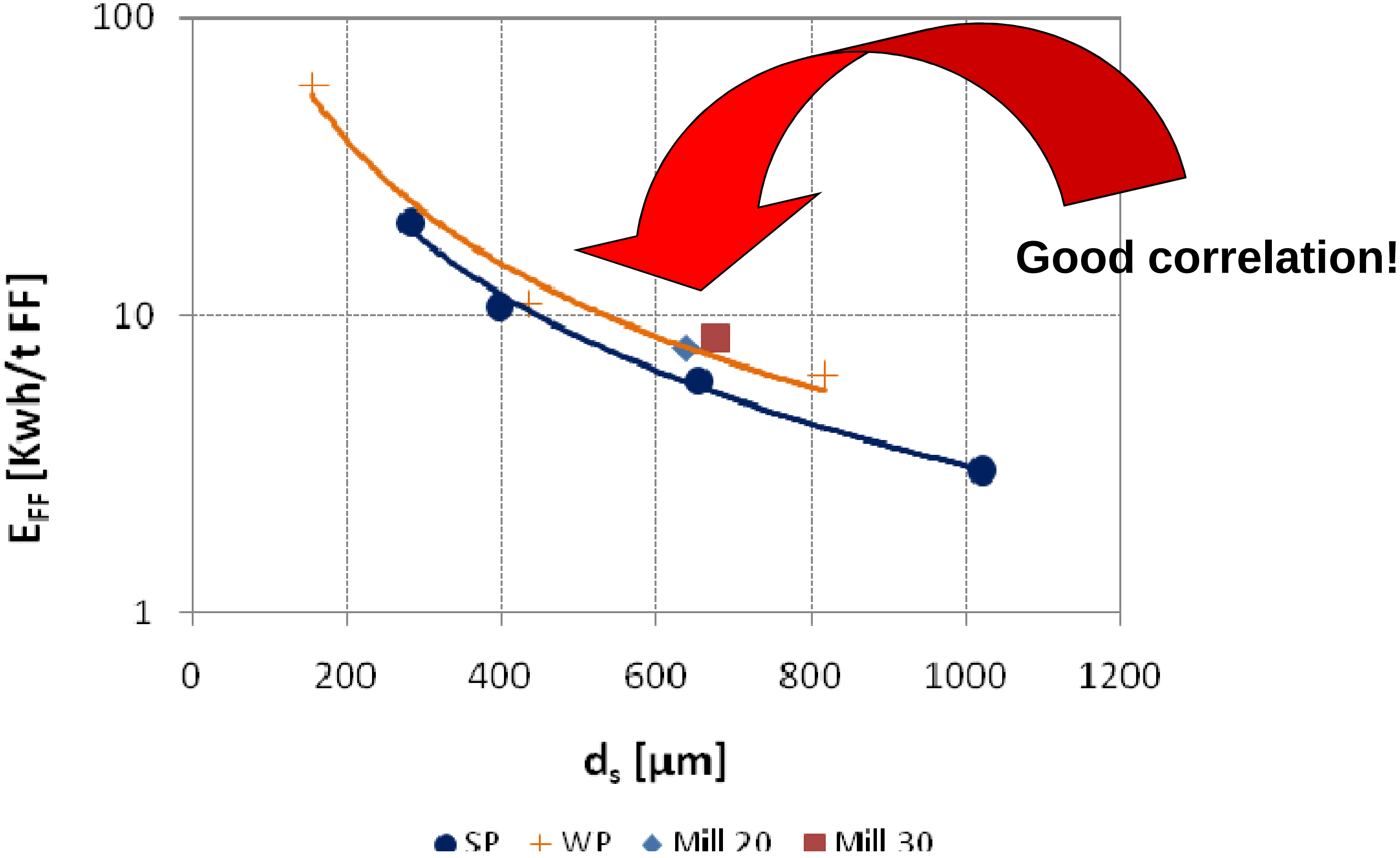


3. Grindability – Correlation with full scale (1)

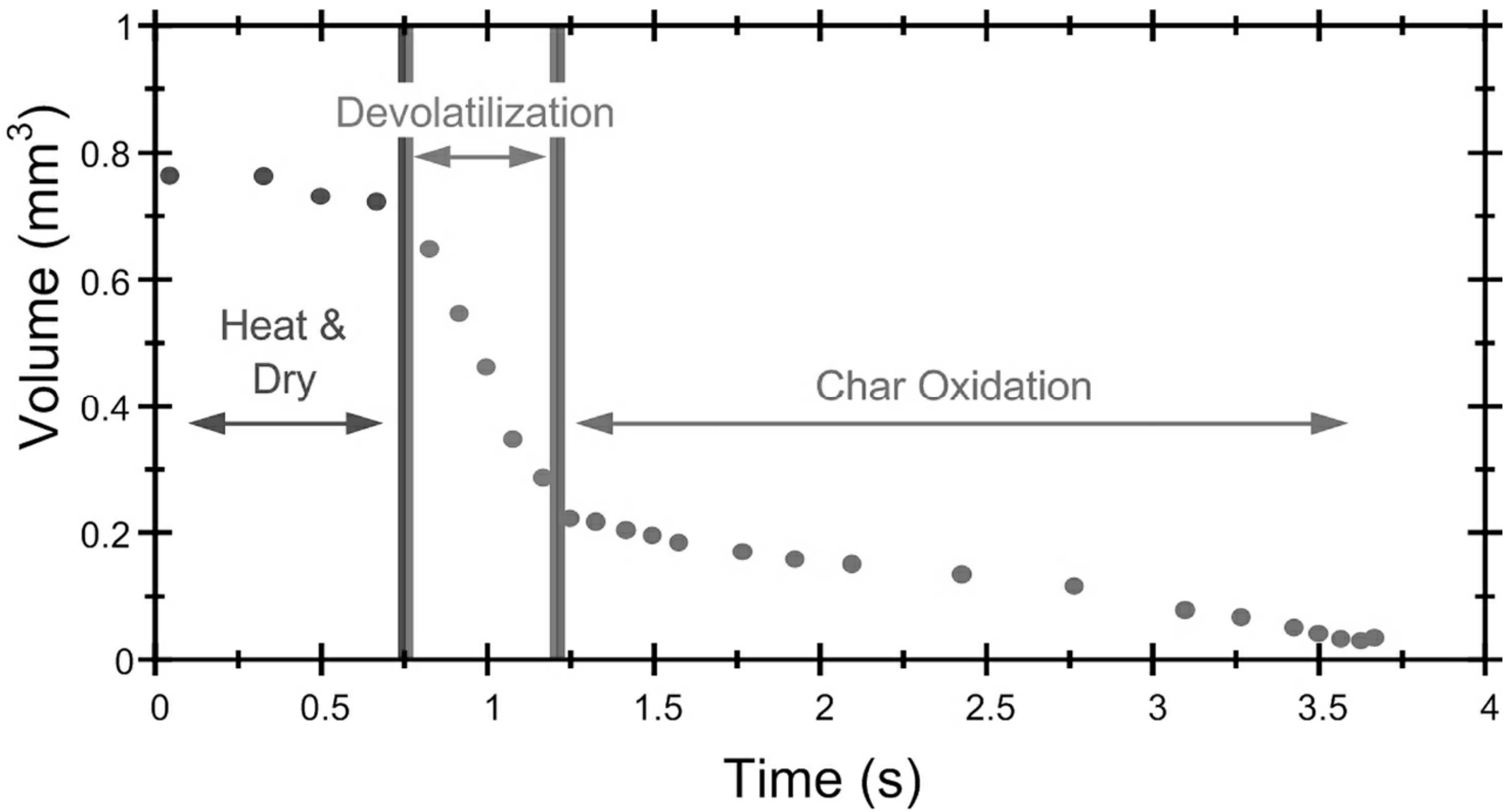


- Loesche mill
- 3 installed in Unit 1 on Amager CHP
- Samples can be taken before and after the mill
- The grinding energy and capacity can be recorded

3. Grindability – Correlation with full scale (2)



4. Ignitability – Combustion principles

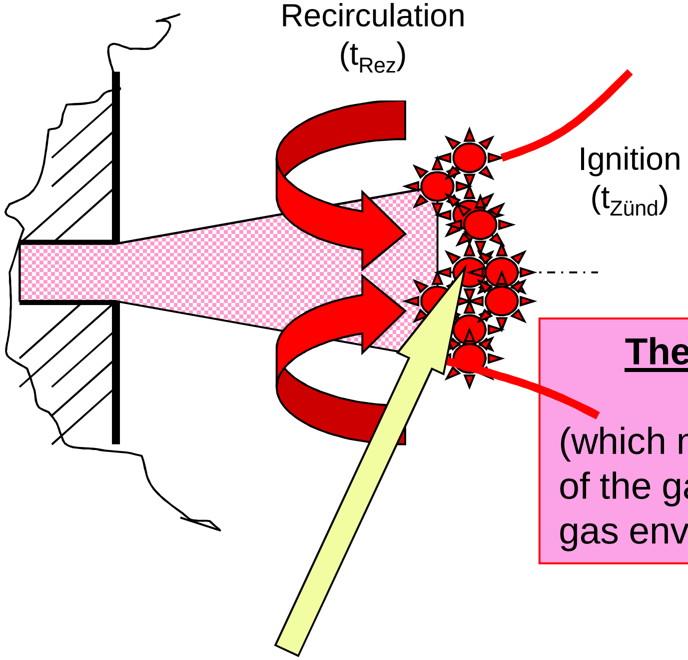


Loo and Koppejan 2008

4. Ignitability – Ignitability Index

At the moment: No standardized methods

The EXAS method: Ignitability index „Zündwilligkeitszahl“ (Zelkowski):



The Ignitability index can be interpreted in praxis as the ability of a fuel **to develop and maintain** a stabile "strong" flame.

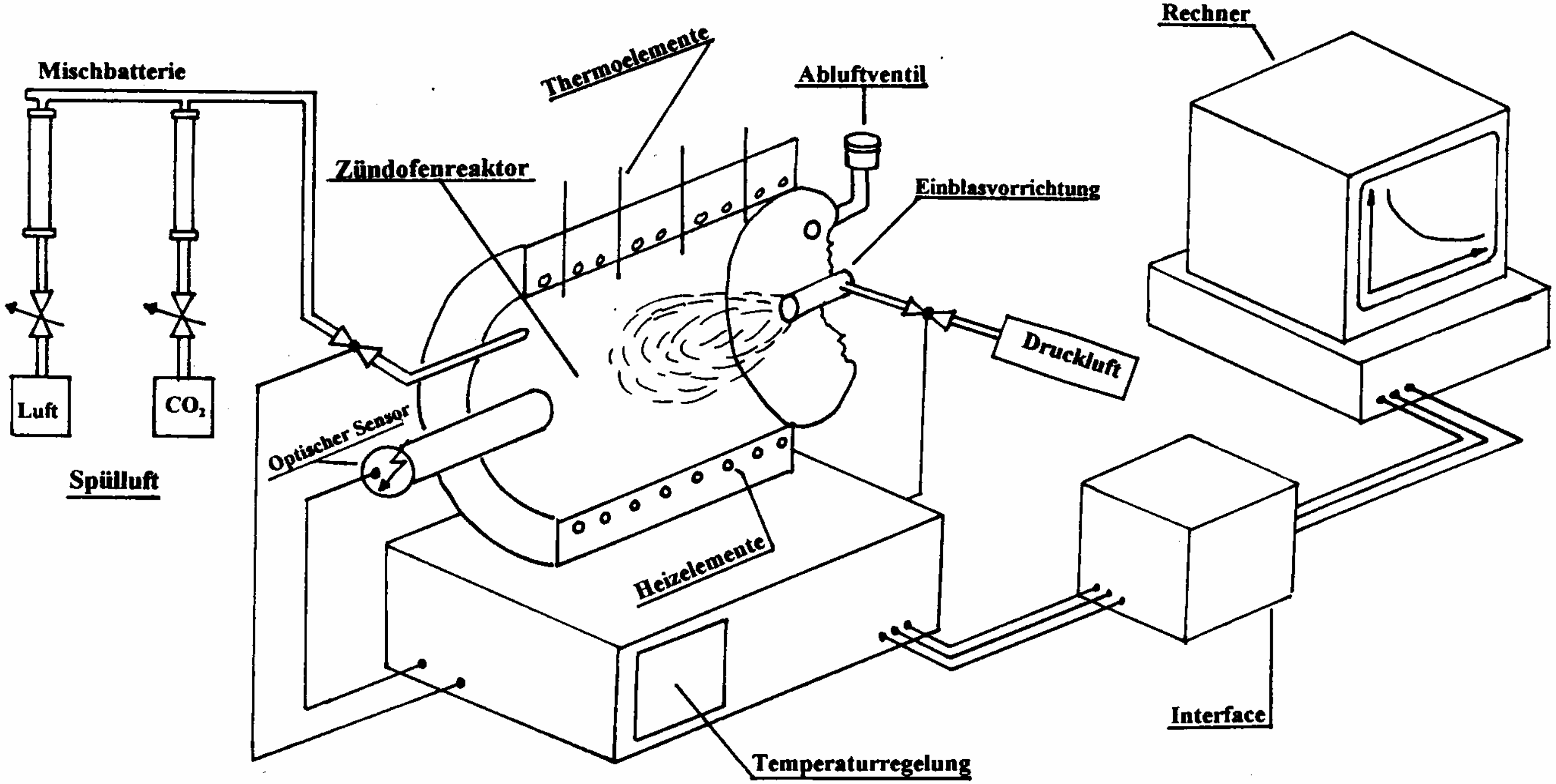
The Ignition Temperature of a cloud of suspended fuel particles (t_{Z150} in ℃)
(which models the initial stages in the combustion process), the temperature of the gases, of a defined particle size probe, which is injected in a defined gas environment and ignites after 150 msec.

The Ignition potential N_{Z500} (in MJ/kg solid fuel)
is the chemical energy per kg, which is released (volatile matter) from a dry solid fuel up to 500 ℃.

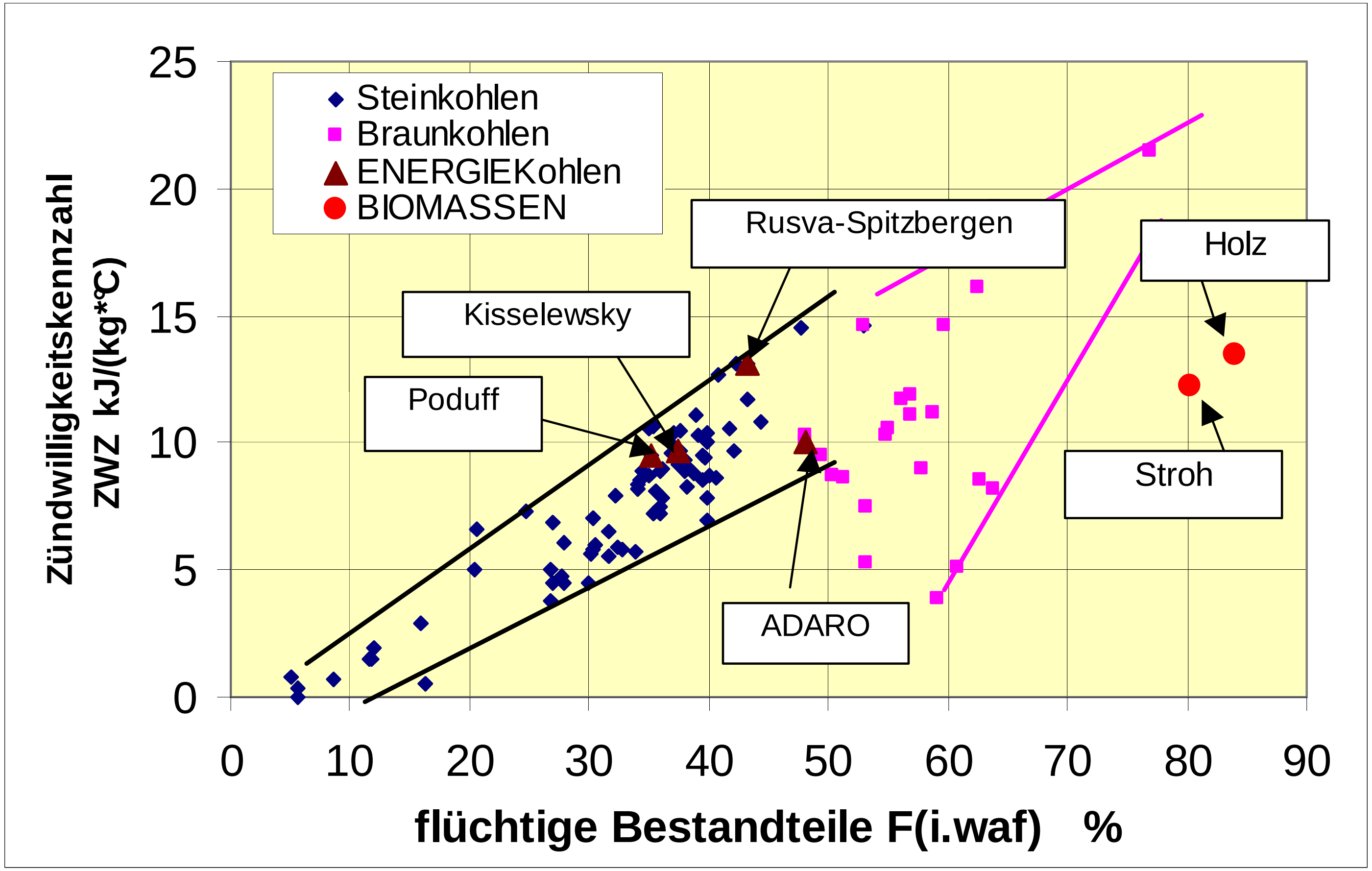
Ignitability Index

$$ZWZ = \frac{N_{Z500}}{t_{Z150}} \quad \left[\frac{MJ}{kg\ Kohle \cdot °C}\right]$$

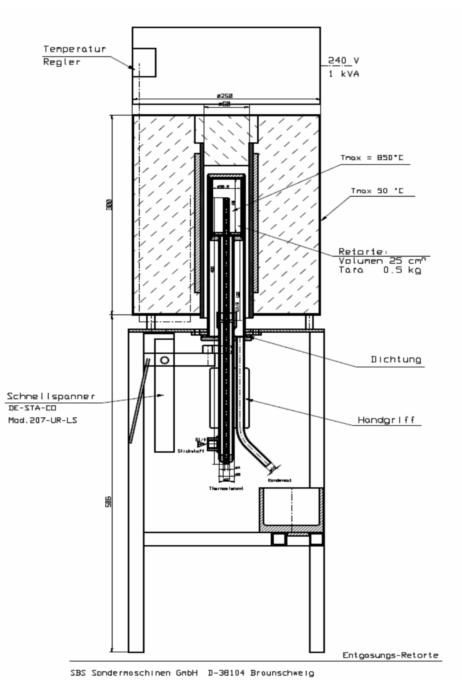
4. Ignitability – Ignitability oven



4. Ignitability – TU Clausthal / E2

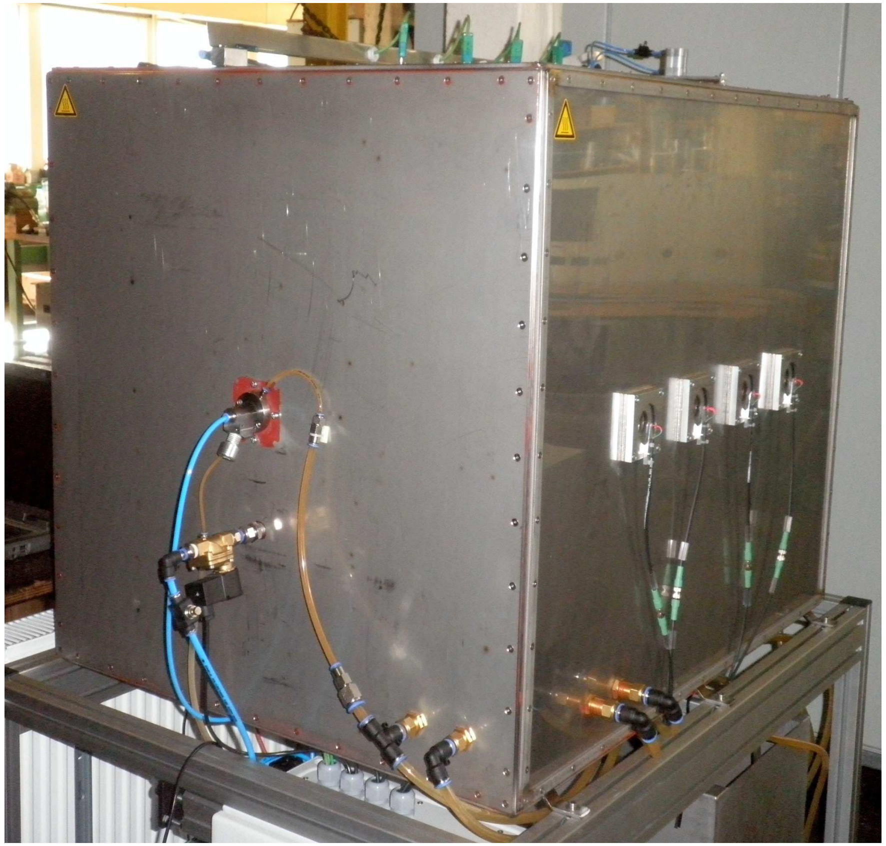


4. Ignitability – EXAS ignitability oven

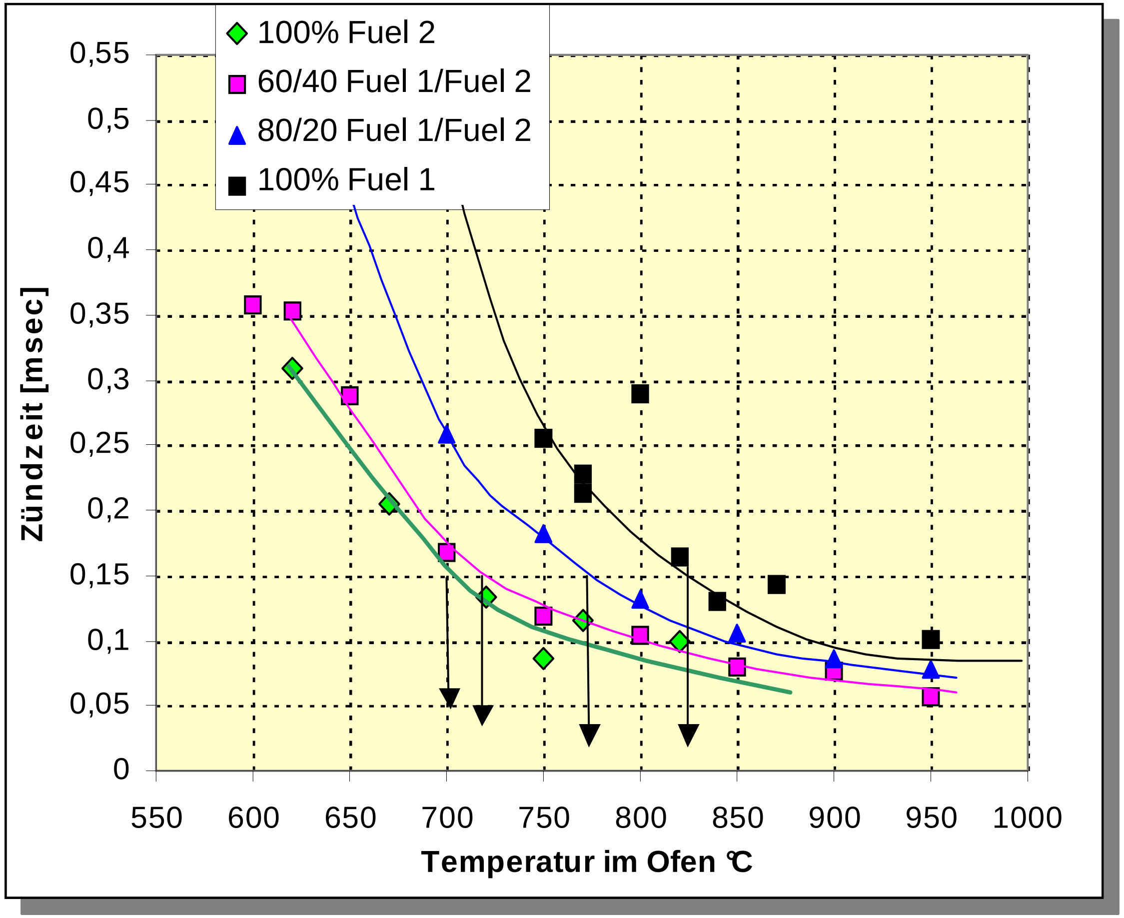


Jenkner device

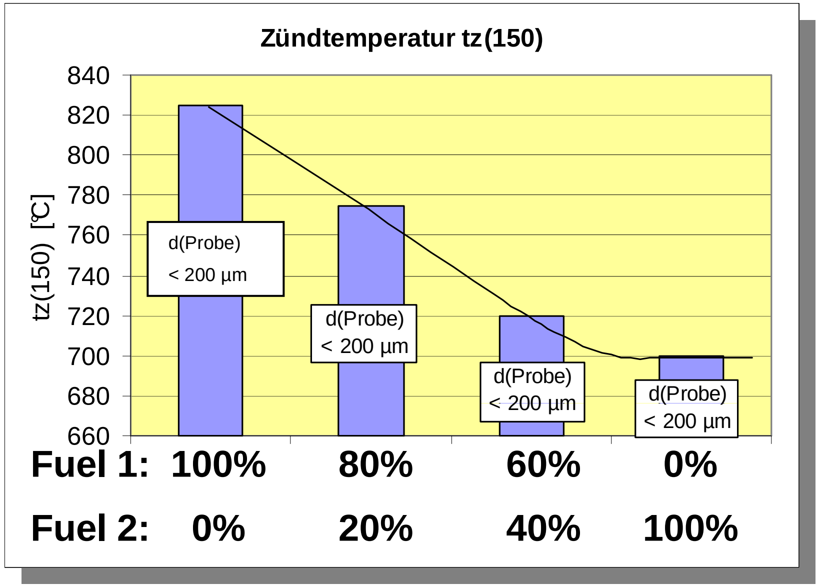
Ignitability oven

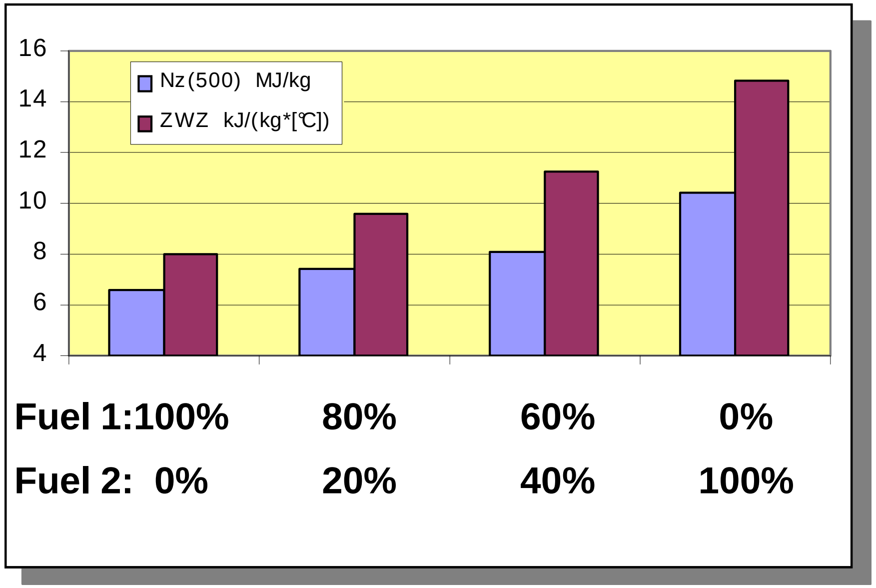


6. Ignitability – Some results…



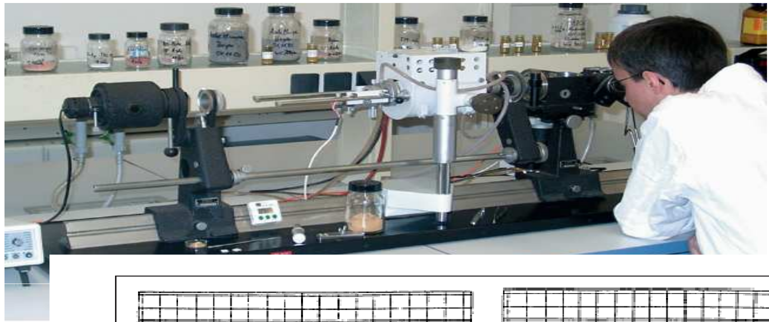
6. Ignitability – Some more results…





5. Sintering – Classic analysis of ash melting

Often used methods:



3.6.2

Leitz-Method: Determination of the ash-melting behavior (**Influence of the temperature**: e.g. DIN 51730, CEN/TS 15370);
Change in physical form of a **relatively fast** (10 K/min) **heated** ash probe.

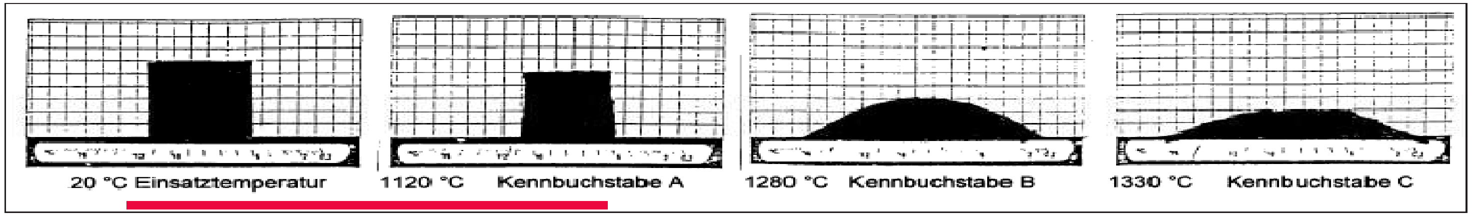
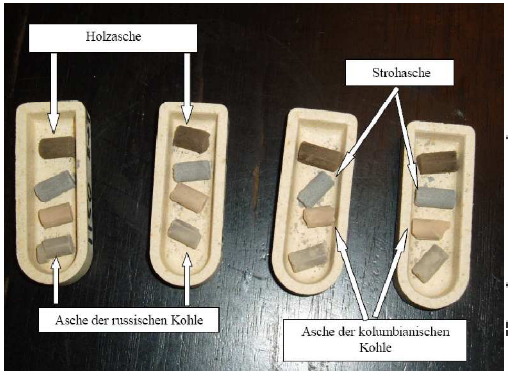


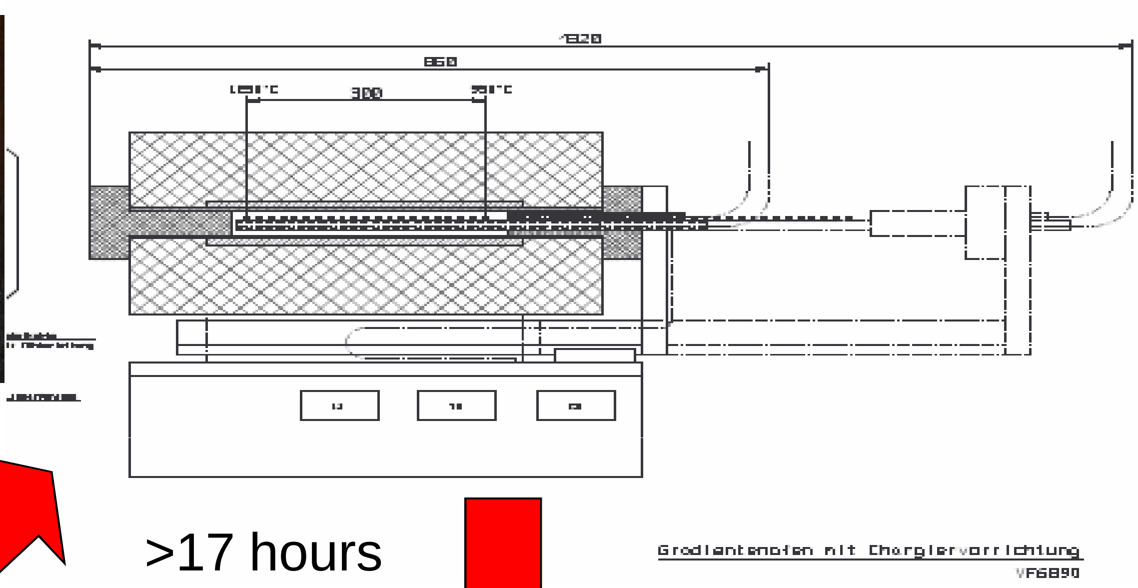
Bild 3.6.23 Aussehen des Ascheprobekörpers bei Untersuchung des Ascheschmelzverhaltens.

The EXAS Method:

Determination of ash melting properities: Influence of the temperature and time on the physical- and mechanical properties of an ash probe.

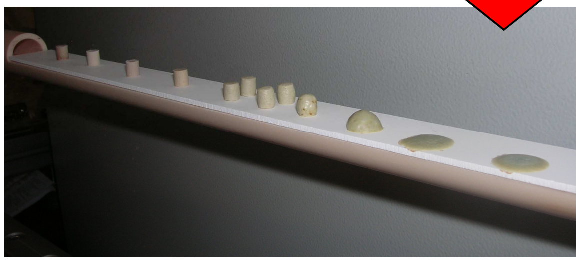
5. Sintering – EXAS sintering oven





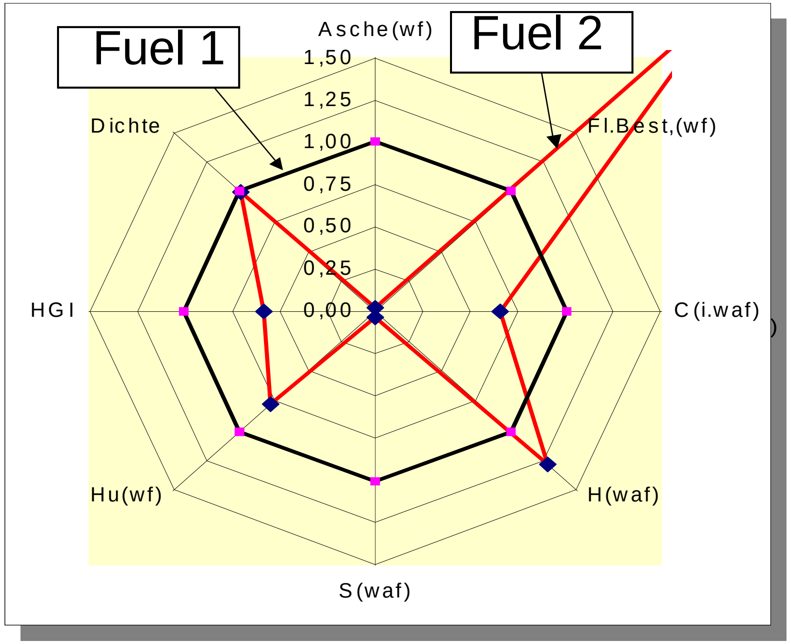
Manufacturing of ash pellets

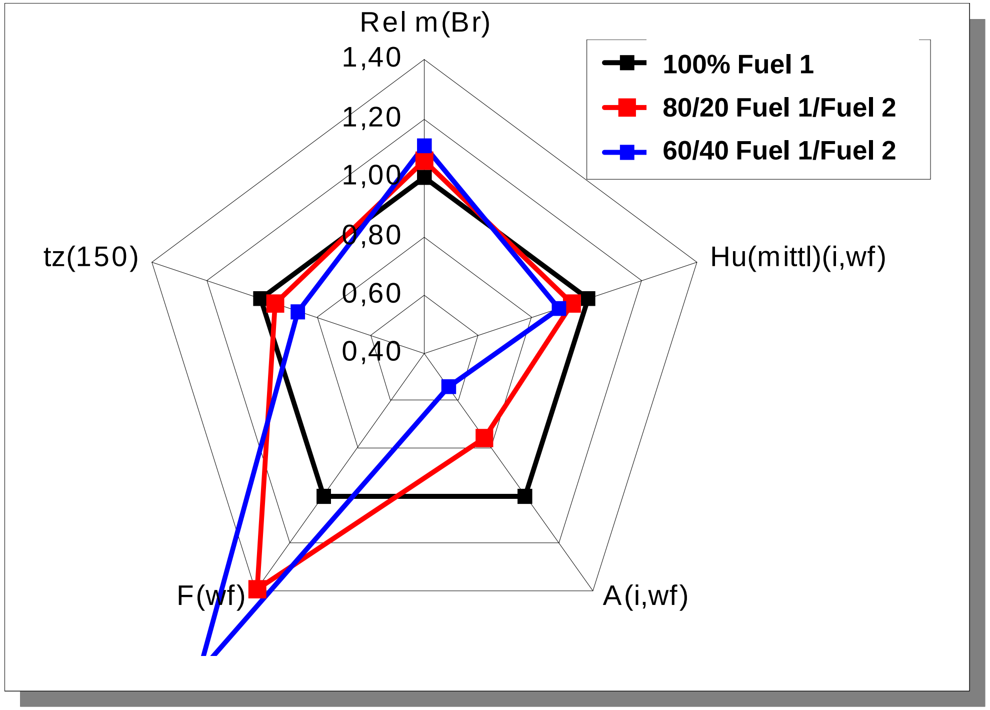
>17 hours in oven



Strength of pellets

Presentation of solid fuel results – An example





Acknowledgements

- Prof. Żelkowski, TU Clausthal
- Mogens Berg, Vattenfall
- Nader Padban, Vattenfall
- The laboratory staff at AMV
- Troels Christansen, DTU
- Mr, Schäfertöns, SBS, Braunschweig
- Etc.

And the work goes on…

Thank you for your attention!