

# Evaluation of technology - combustion tests in residential burners

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## Four pellets + reference

	<b>Wood</b>	<b>Bark</b>	<b>Oilseed straw</b>	<b>RCG</b>	<b>Barley Straw</b>
Ash (% of dm)	0.3	3.4	4.7	7.9	6.6
Sulphur (% of dm)	<0.01	0.03	0.13	0.11	0.13
Nitrogen (% of dm)	0.1	0.4	0.5	0.9	0.7
Chlorine (% of dm)	<0.01	0.01	0.18	0.04	0.71
Ash melting IT	1550	1250	1590	1350	<980
Si (% of dm)	0.01	0.37	0.30	2.77	0.86
Ca (% of dm)	0.07	0.85	1.18	0.22	0.30
K (% of dm)	0.03	0.20	0.51	0.24	0.73
P (% of dm)	0.005	0.05	0.07	0.01	0.11



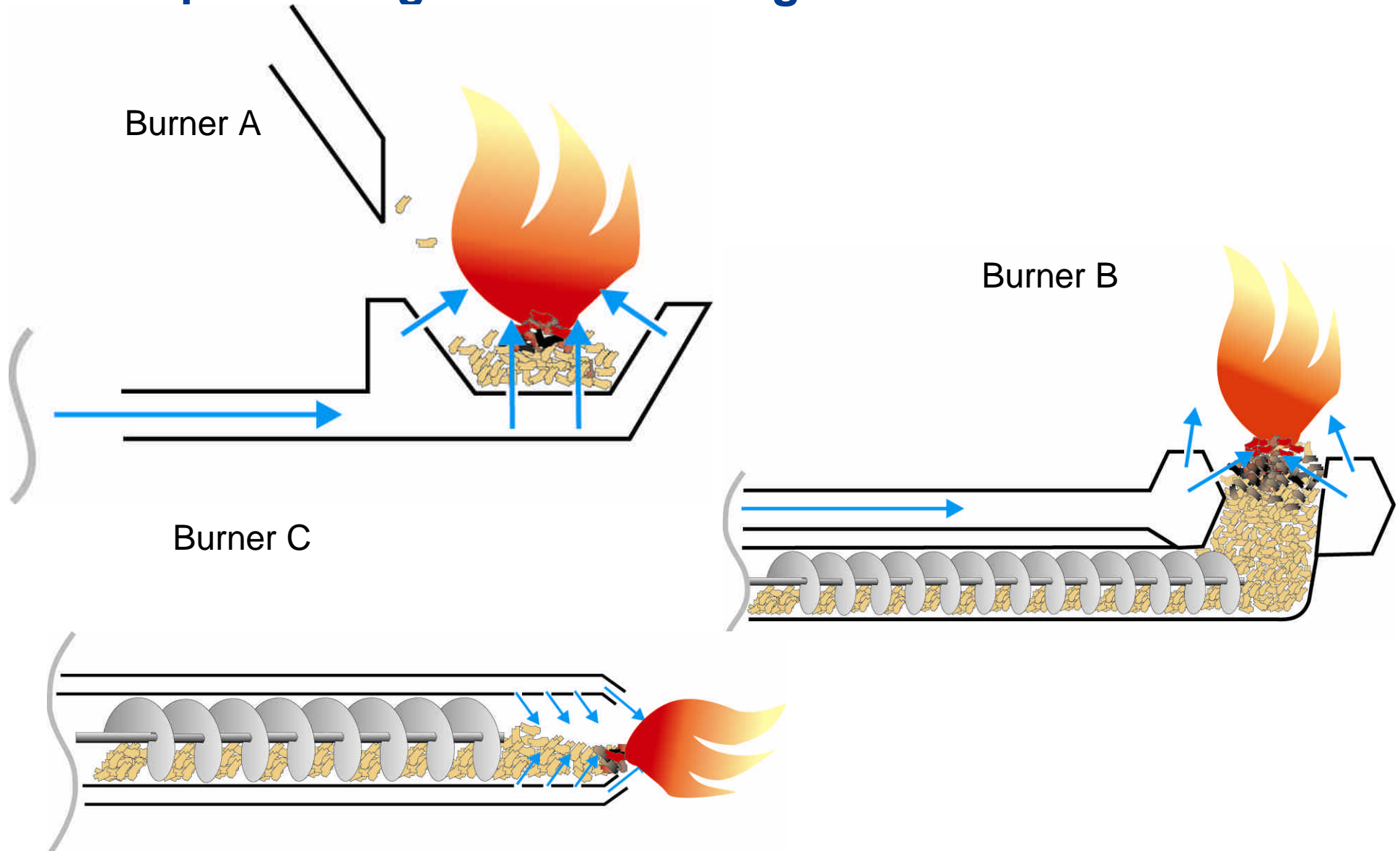
# Scientific and technical objectives of SP

Combustion tests in domestic-scale burner (< 50 kW) using fuels produced by SLU

- Tests performed according to EN 303-5 (CO, CO<sub>2</sub>, O<sub>2</sub>, OGC and total dust) complementary evaluations:
  - demands of high ash content and ash properties (sintering, fouling, ash removal)
  - Performance (bulk density, fines)
  - Corrosion risks
  - NO<sub>x</sub>
  - SO<sub>2</sub>
  - HCl
  - Particle mass- and number distribution
  - Chemical characteristics of fly ash



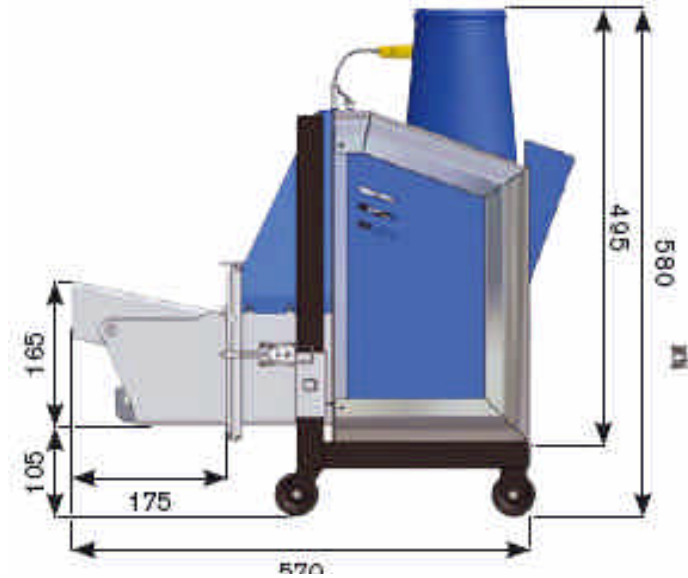
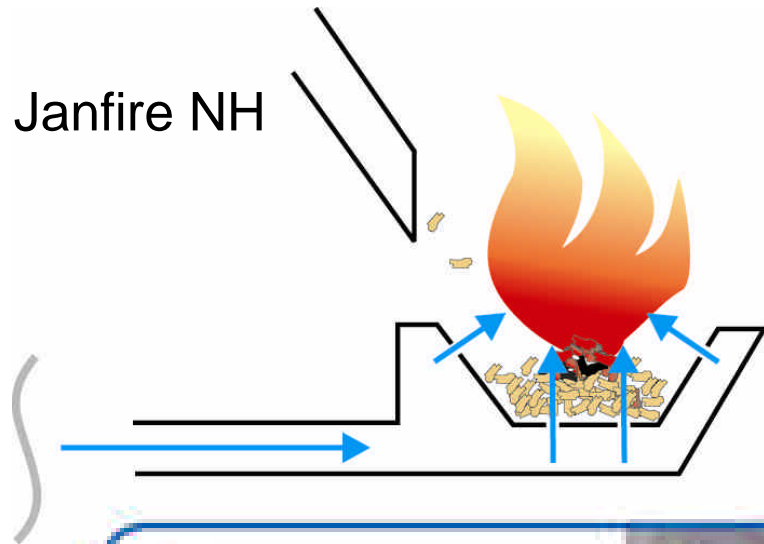
# Three commercial residential burners representing three technologies



## Combustion tests – burner B and C tried for Barley straw pellet

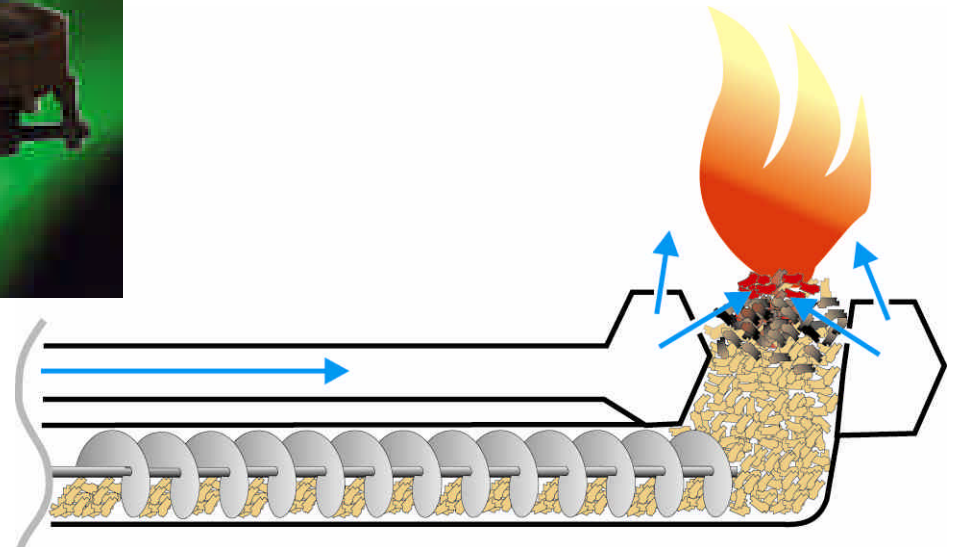


# Combustion tests – Burner A (1)



# Combustion tests – burner B

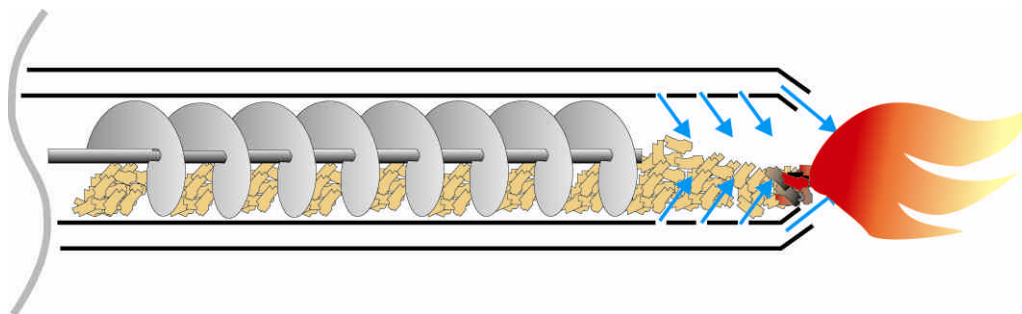
Ecotec



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# Combustion tests – burner C

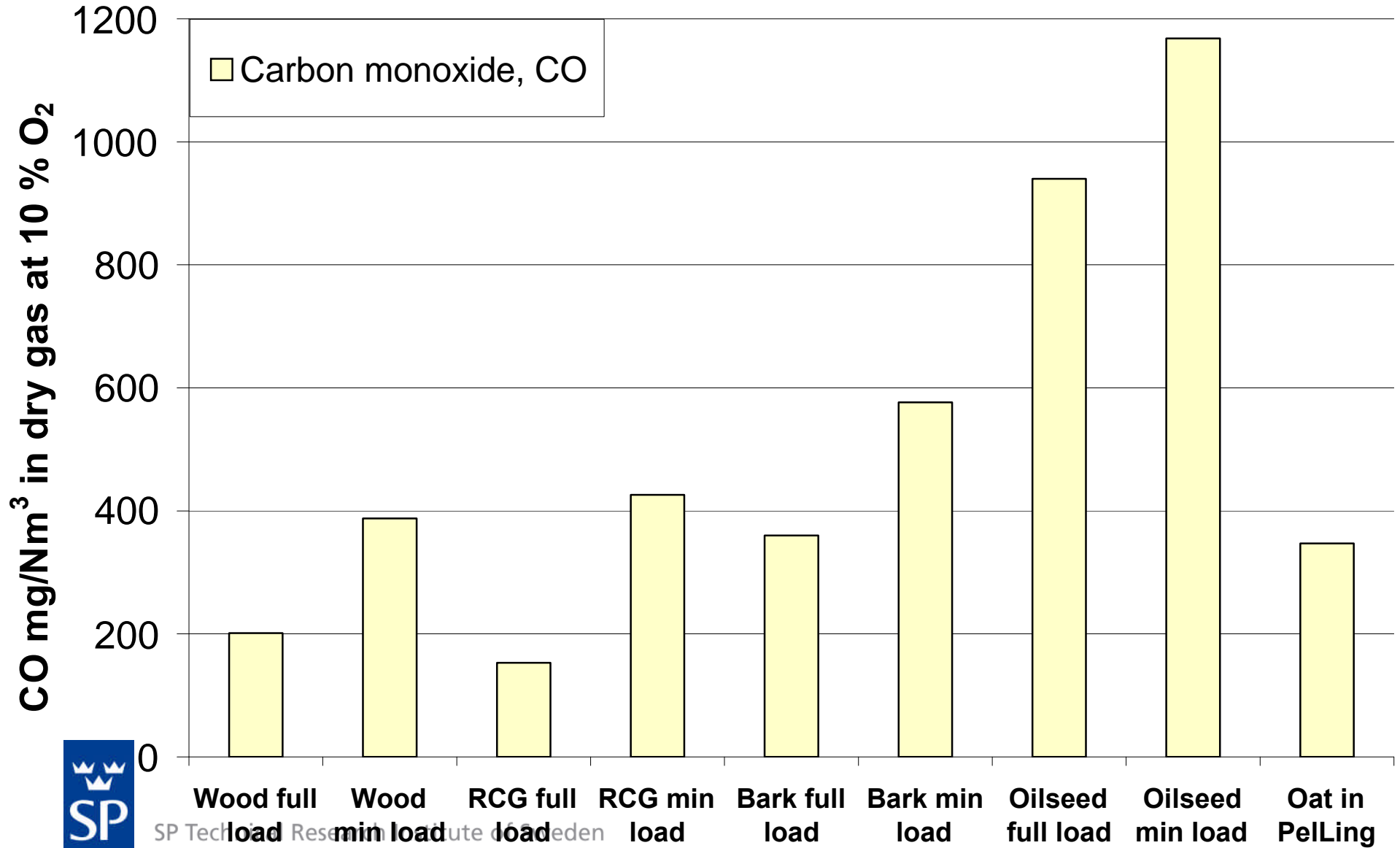
Agrotec grain burner



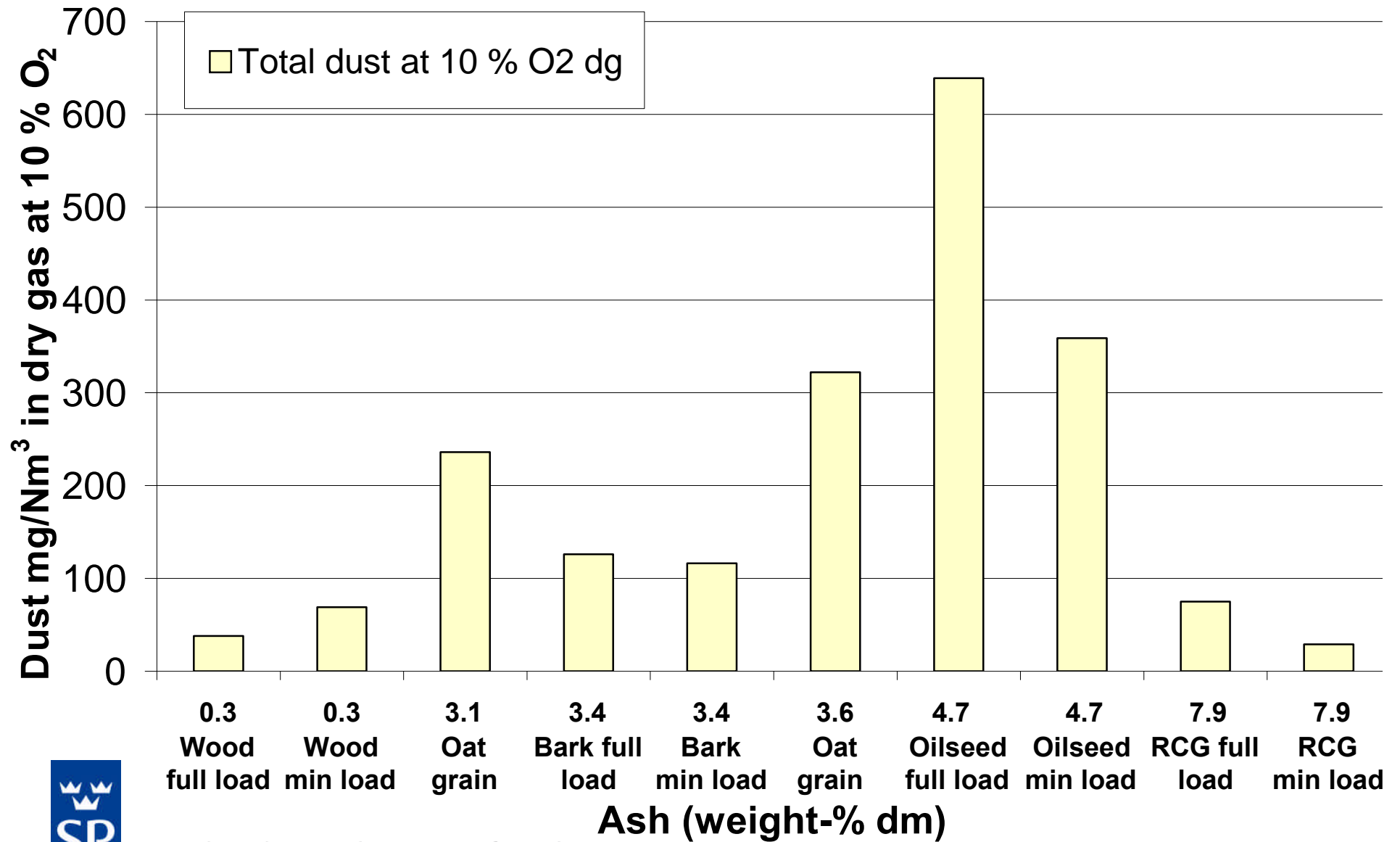
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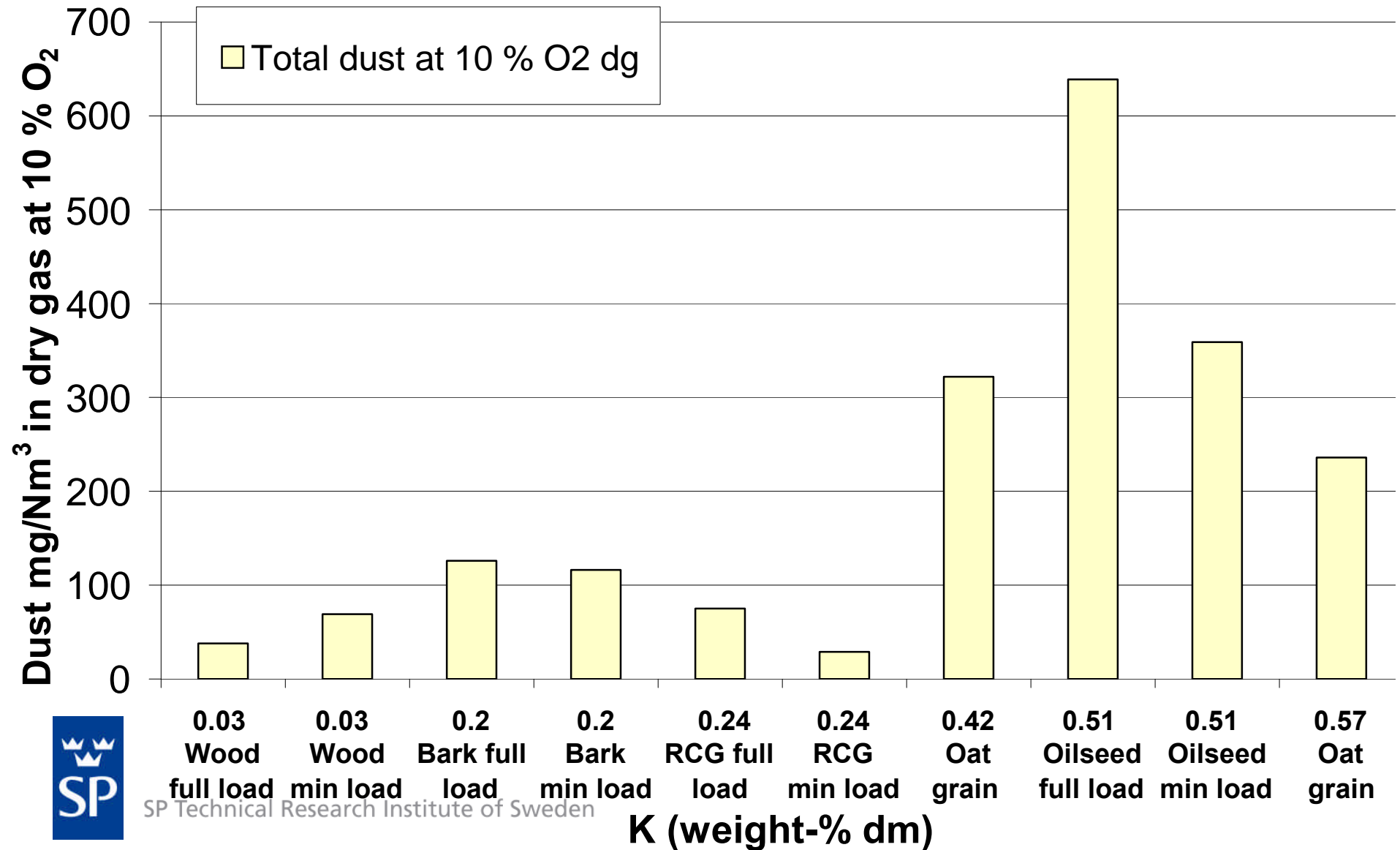
# Combustion performance



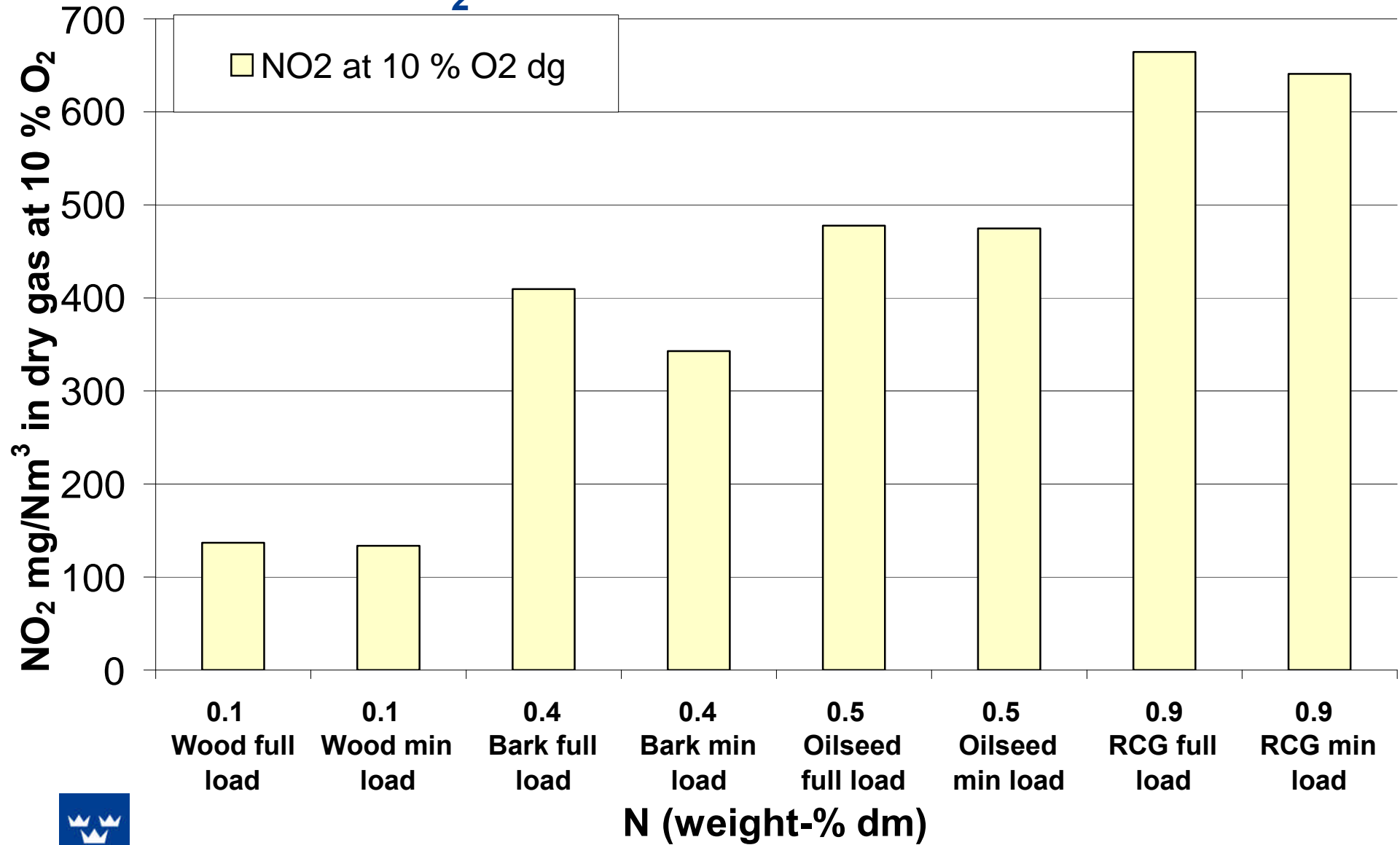
# Total dust as function of ash content



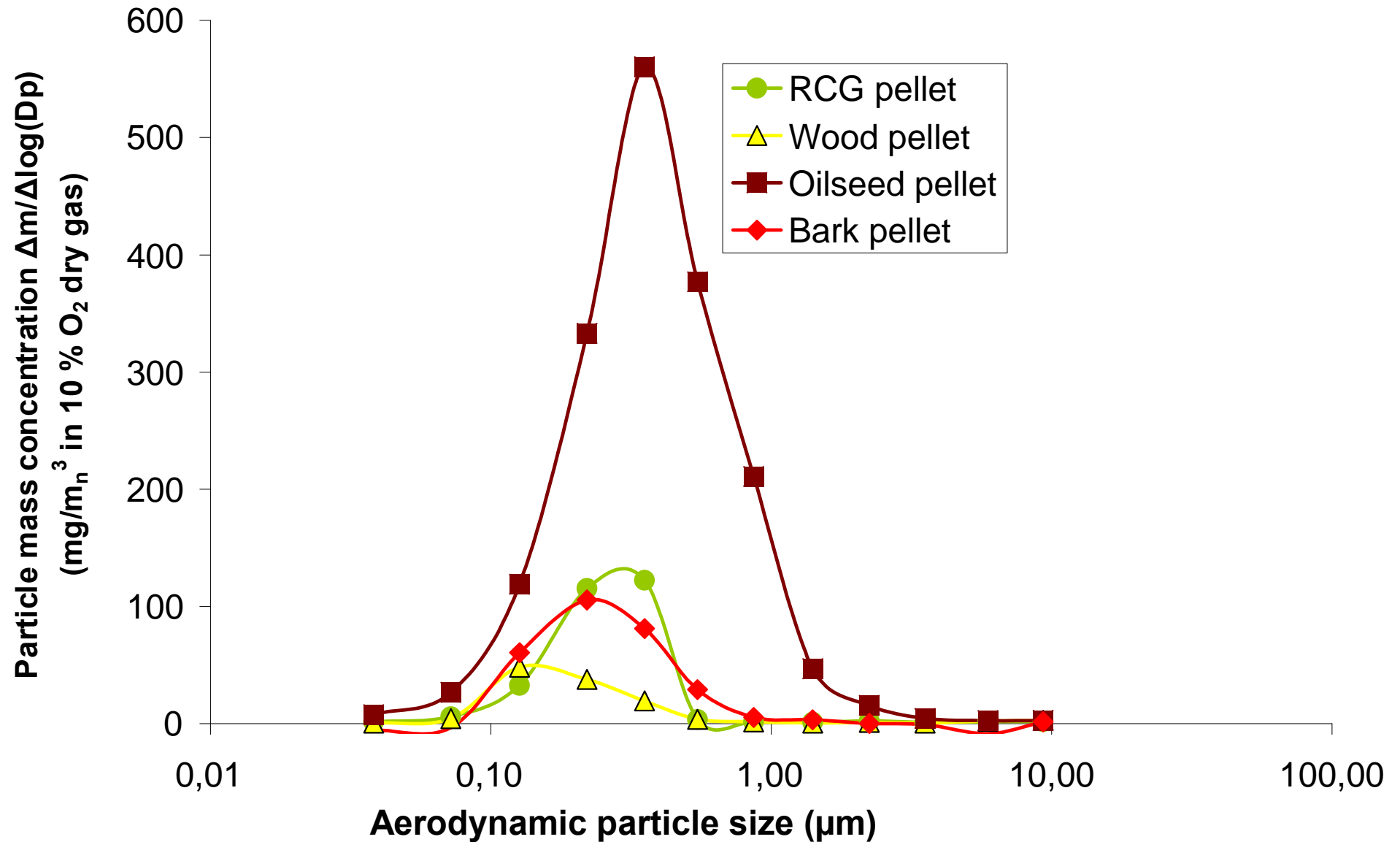
## Total dust as function of K-content



## NO<sub>2</sub> as function of N-content



## Particle mass concentration (mg/Nm<sup>3</sup> dry gas at 10 % O<sub>2</sub>)



# Char combustion models



Figure from Biofuel Combustion by Henrik Thunman

## Conclusions – Demands for good combustion of ash rich pellets in small-scale

The ash needs to be removed

Piling up of ash in the cup/on the grate

High enough temperature during char combustion

Low temperature caused by low diffusion rate and/or cold surrounding

Residence time of char must be long enough

Char combustion time may be prolonged by low diffusion rate

High temperature in gas phase combustion

To combust  $\text{CO} \rightarrow \text{CO}_2$

Mixing of combustible gases and air

Must be enough



# Conclusions

Small-scale technology has to be adapted for ash rich pellets

Important fuel parameters

- ash melting temperature
- nitrogen, sulphur and chlorine content
- fly ash forming species

