

Optimisation of multi-fuel operation in fluidized bed boilers

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VTT Processes

Content:

- Background
- Biomass fuel properties for power availability, methods for fuel characterisation
- R&D needs
- Conclusion

Fluidized Bed Combustion: R&D Fields

Fluidized Bed Processes

Know-how and understanding of CFB combustion process

Fuel combustion profile and behaviour

Fuel reactivity

Material behaviour

Technical support

Maintenance and construction of pilot plants

Field measurements and pilot tests

Multifuel operation

Optimization of multi-fuel operation

Emissions: performance, directives, etc.

Plant availability

Ash chemistry, deposits, corrosion

Power plant operation economy

Future challenges at deregulated energy markets

- Plant performance
 - Investment costs, operation (operational and fuel) and maintenance costs
- Fuel flexibility
- Fuel saving (plant efficiency)
- Environmental performance
 - Emissions, CO, NO_x, SO_x and particularly CO₂ emissions

Background for multifuel operation

- (1) Common in industrial boilers
- (2) uses various with different fuel properties
- (3) each fuel has slightly own combustion behaviour
- (4) optimization of multifuel operation is needed



Puru ja puujäte



REF

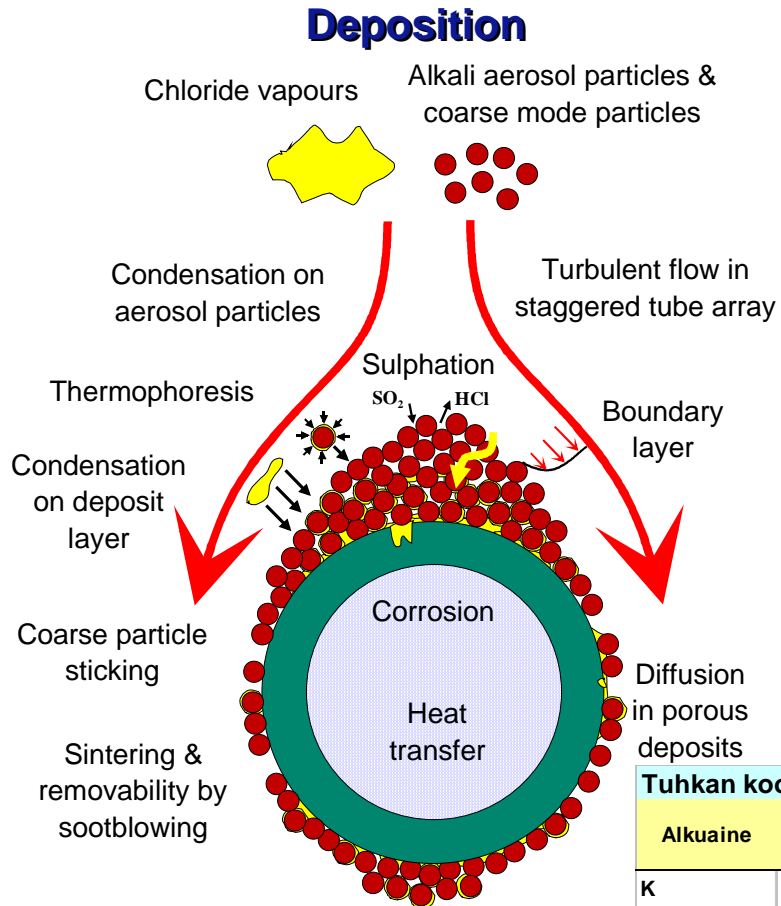
Fuel characteristics for plant availability: Ash properties

Ash elements in fuel ashes Ashed 550 °C				
Element	Peat	Bark	Logging residue bales	Coal
Si	24.0	8.79	9.86	27.3
Al	5.98	2.62	0.98	12.1
Fe	9.79	4.44	0.529	2.97
Mn	0.124	0.937	1.53	0.024
Mg	1.21	2.68	2.94	1.13
Ca	5.35	21.4	21.9	3.14
Na	1.72	1.14	0.430	1.13
K	1.77	5.36	8.80	2.15
P	1.31	2.17	2.66	0.374
S	1.78	2.13	0.893	1.50
Cl	0.165	0.15	0.131	0.004

- **Fossil fuel ash;** SiO₂, Al₂O₃, CaO and Fe₂O₃. Alkalines in silicate matrix (non-soluble)
- **Biomass ash;** main ash components: CaO, K₂O, MgO ja Na₂O
 - exists as salts or in fuel organic matrix (release during combustion into gas phase)
- ➔ Ash behaviour very different compared to fossil fuel ash

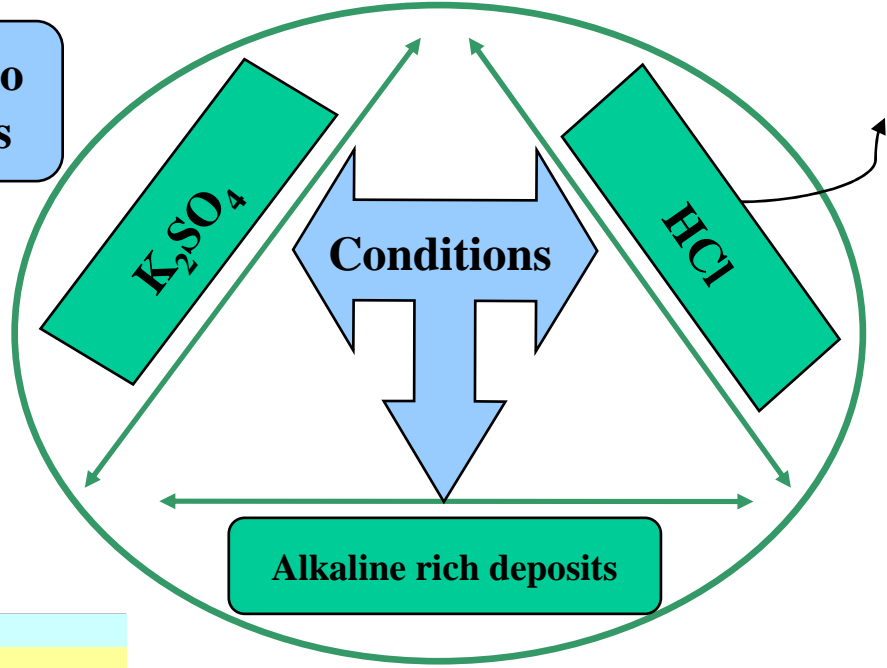
The use of more demanding biofuels - straw - short rotation biomass ash behaviour will be even more challenging

Ash behaviour in biomass combustion



Cocombustion of biomass with fossil fuels or peat

S / Cl ratio increases



Wood-based fuels → KCl-salt (deposits)

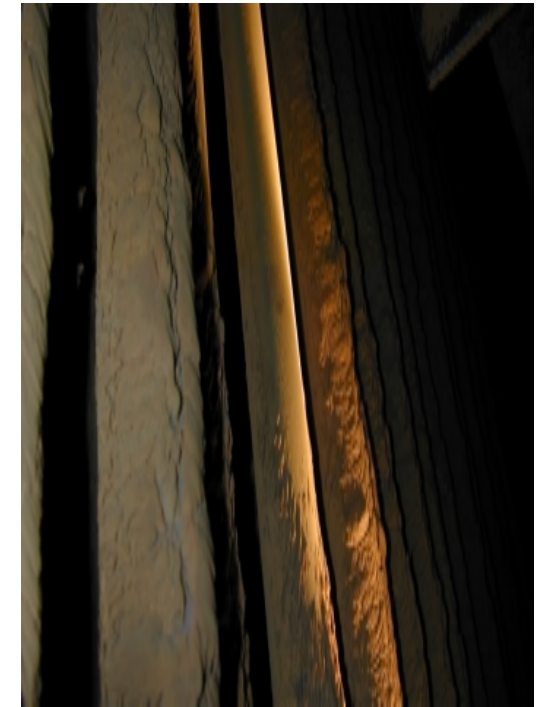
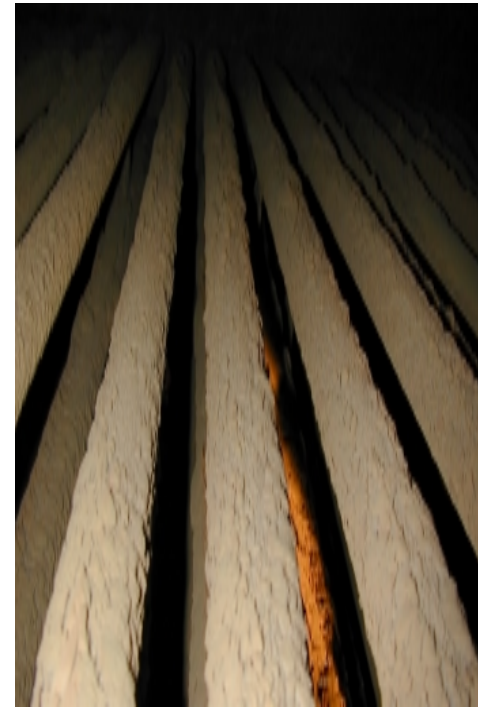
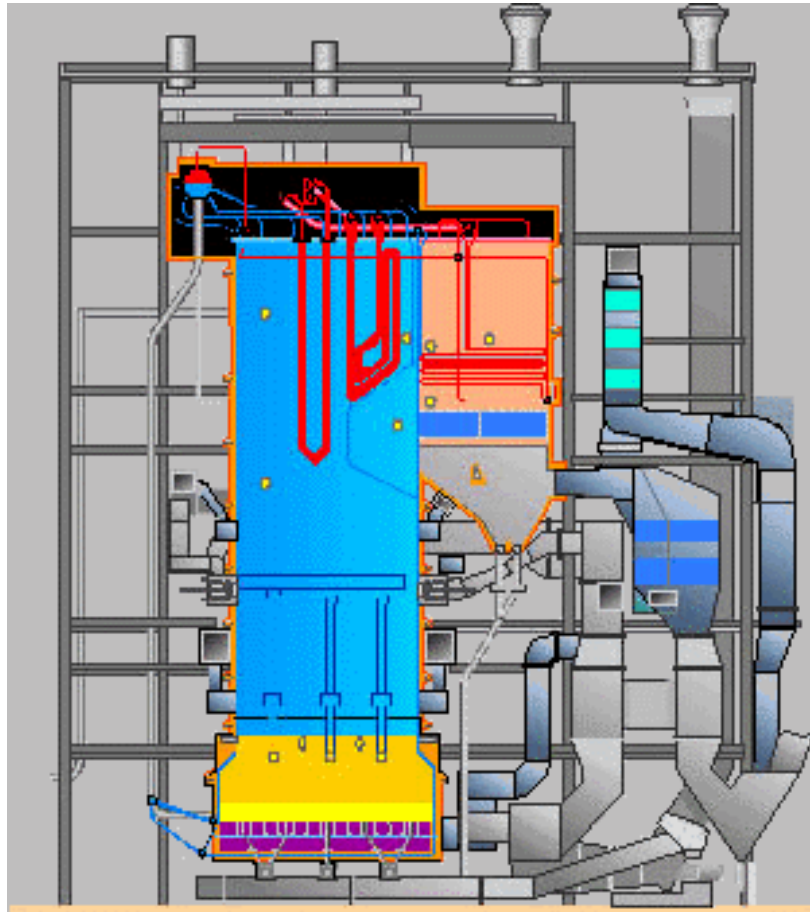
By Jouni Pyykönen /VTTPRO

Tuhkan koostumus				
	Alkuaine	Turve	Kuori	Metsähake
K		1.77	5.36	8.80
P		1.31	2.17	2.66
S		1.78	2.13	0.893
Cl		0.165	0.15	0.131
Tyypillisiä polttoaineen pitoisuuksia				
Tuhka (850C)		4.77	2.51	2.57
S		0.2 - 0.3	~ 0.1	~ 0.05
Cl		0.04 - 0.08	0.01 - 0.03	0.01 - 0.03

Operational economy at power plants

- **substitution of fossil fuels with biomass increase plant operational costs:**
 - **Boiler fouling → increase in flue gas temperature
→ decrease in boiler efficiency**
 - **Increased need for boiler soot-blowing and cleaning**
 - **Increase in plant power own-use (increase in flue gas flow, deposition)**
 - **Use of more expensive superheater materials (high temperature risk)**
 - **Ash end-use. Due to ash quality increased costs for ash utilization**
 - **Investments for fuel storing systems**

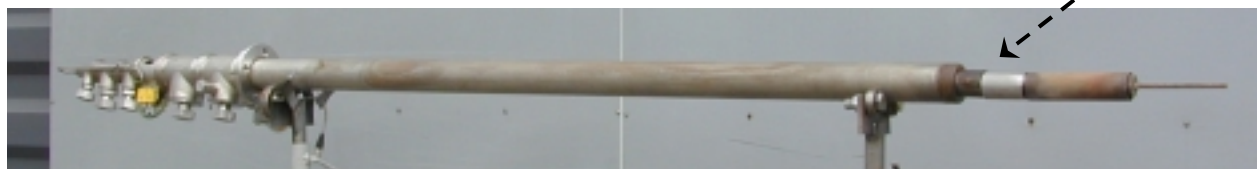
Optimization of fuel mixture: power plant monitoring



Probe for deposit / corrosion monitoring

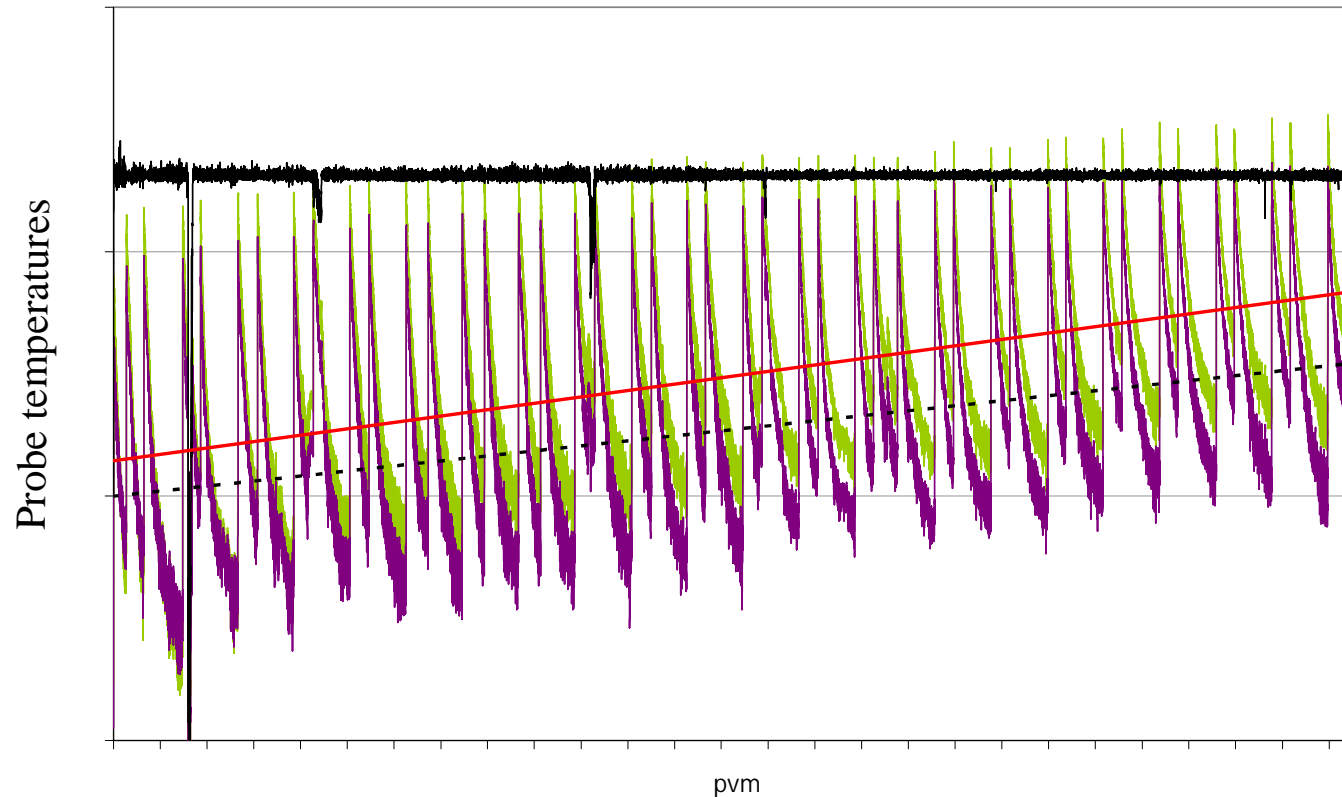
Specimens:

- * superheater materials
- * adjusted for steam temperature by air / water cooling



Probe temperature behavior during monitoring period

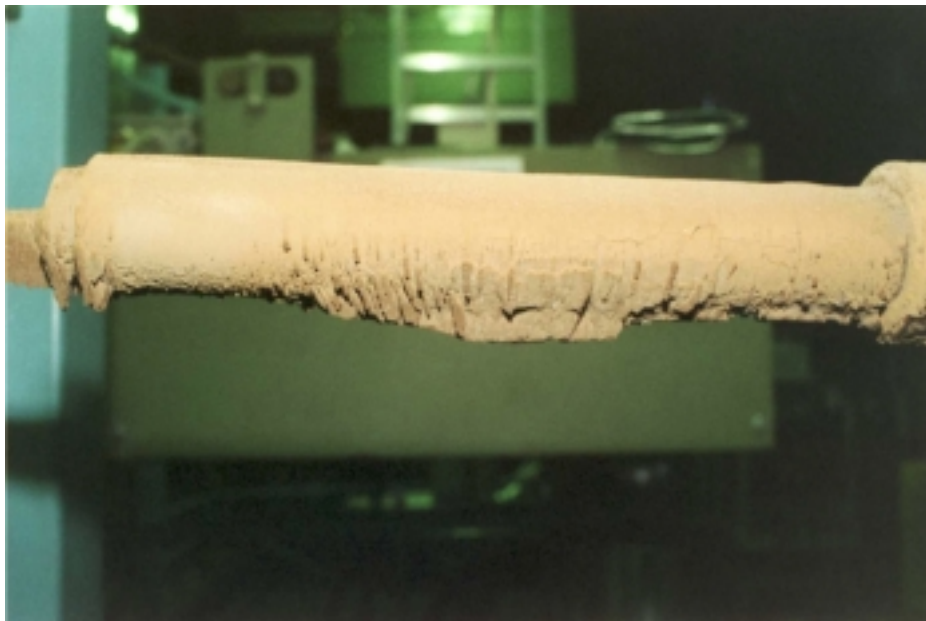
Four week monitoring at CFB boiler



Monitoring period 672 h. Strong increase in leeward and side temperatures → on-line information of deposit formation rate = deposition onto windward side of the probe



Co-combustion of recovered fuels (REF) with peat and wood based fuels. The share of REF 10 to 15 % as energy basis

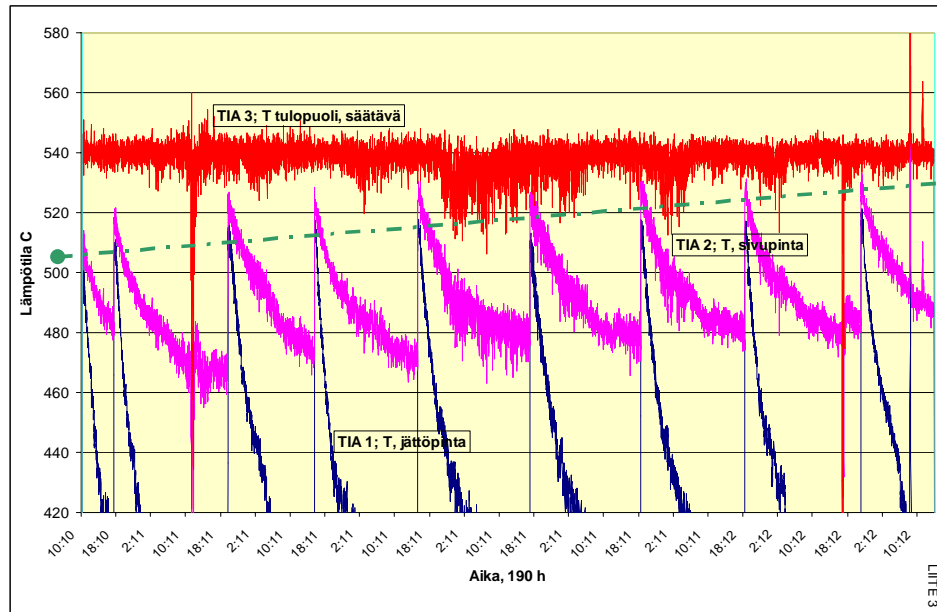


Test period I: Combustion of REF III with peat and wood based fuels:
One week probing



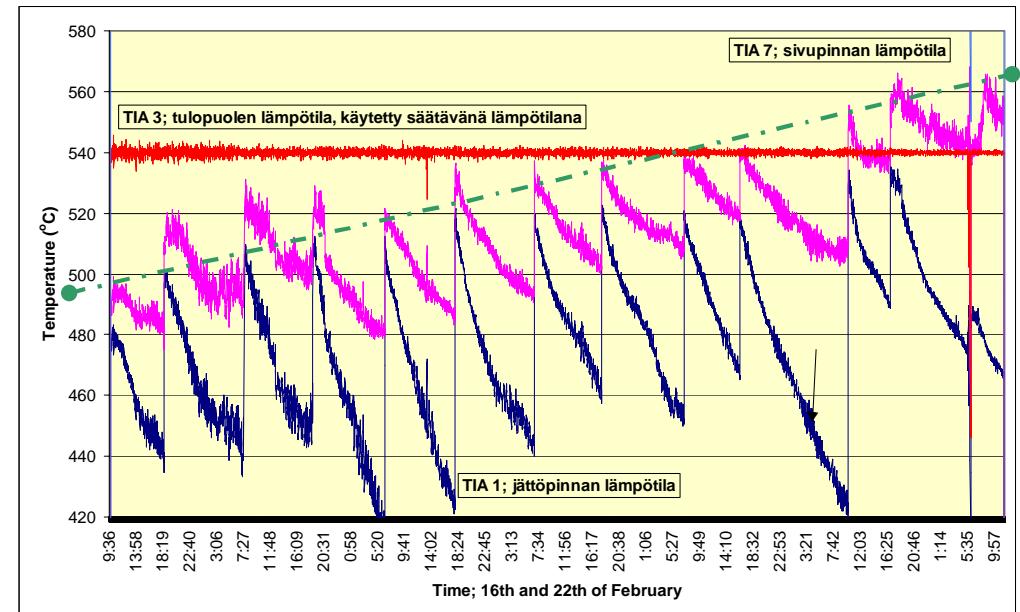
Test period II: Combustion of REF I with peat and wood based fuels:
One and half week probing

PROBE TEMPERATURE BEHAVIOUR IN COCOMBUSTION TEST OF REF WITH PEAT AND WOOD



December 2001: Exposure time c. 190 hour

Note: sootblowing interval. Longer as in the test of spring 2000

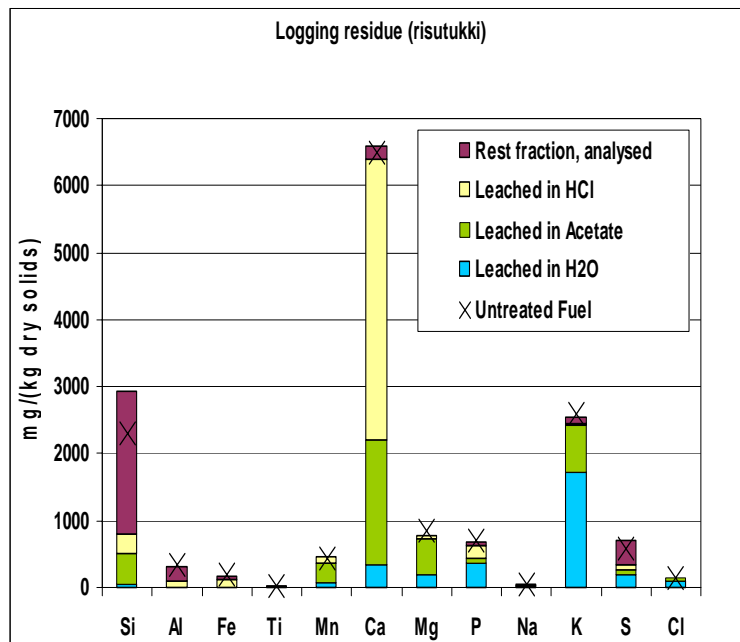


Spring 2000: Exposure time c. 140 hour

Severe increase of probe side and leeward temperatures during the test → deposition onto probe surface

How to improve plant availability and controllability?

- ◆ **Fuel quality and treatment** - handling, feeding etc. - even fuel quality
 - new measurements for fuel quality and feeding to guarantee stable combustion process
 - attention to fuel handling at power plants: new solutions are needed



Fuel analysis

- basic fuel analysis
- ash composition
- ash melting behaviour
- ash solubility (by Åbo Akademi)

Conclusion

- ◆ Use of biomass based fuel may decrease plant availability and performance if the fuel characteristics are not taken into account.
- ◆ At deregulated markets the need for optimisation of multi-fuel operation will increase in the future to achieve the most economical operation and profit.
- ◆ New monitoring methods and measurements are needed to achieve the most flexible operation