



ECN

Lab scale experiments and full-scale findings

Rianne Visser

h.visser@ecn.nl

re-combio

REcovered Fuels
COMBined with BIOmass

Content



- R&D support: Lab-scale results
 - BioBS (SRF plus wood)
 - Co-firing BioBS with lignite
 - Co-firing BioBS with lignite and agro-residues
- Full-scale measurements and sample analysis
 - An example of helping to identify the cause of a problem.

Experimental set-up

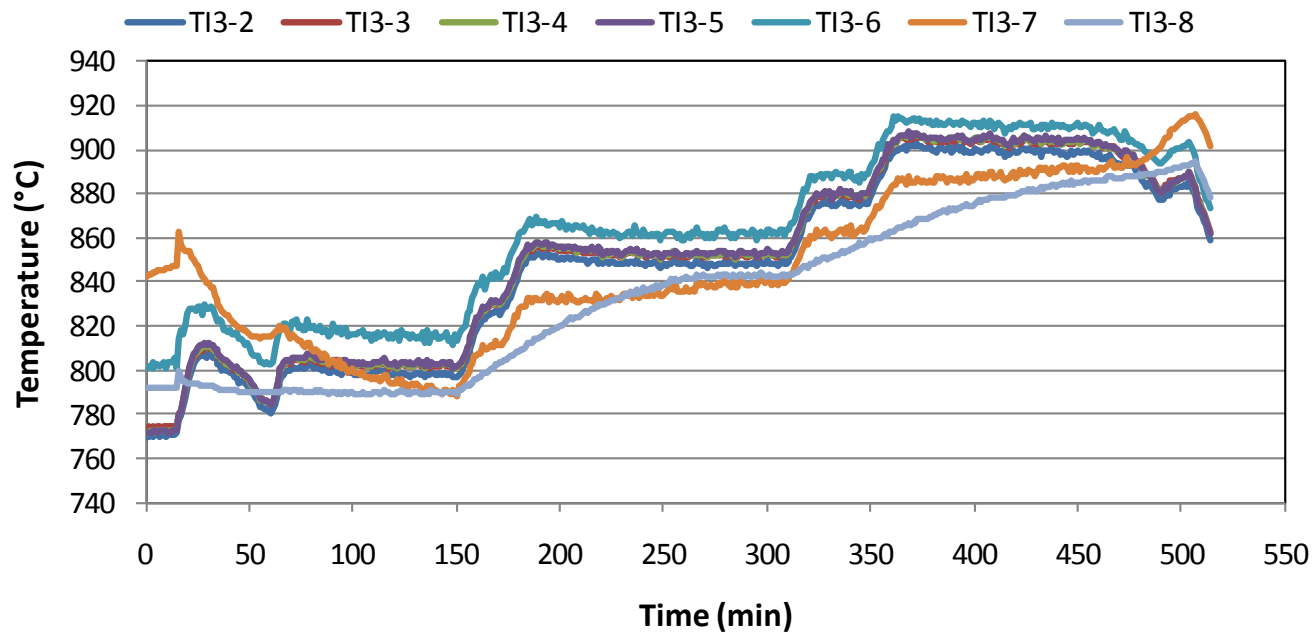


The WOB is a lab-scale atmospheric bubbling fluidised based facility suitable for:
Combustion, Gasification and Pyrolysis experiments

Electrically heated walls enable simulation of adiabatic conditions and provide the power needed for the heat demanding processes like pyrolysis.

Air, oxygen, argon, nitrogen and steam can be added as fluidising medium. The gasses pass a cyclone and can be analysed on-line

Experiment: Reference with 10% BioBS, stepping up in Temp



Sampling of Cl and SO_x in gas phase

Experiment	Cl	SO _x
	mg/mn ³	ppm (mol)
100% BioBS 800 C	229,2	24,5
100% BioBS 850 C	208,1	61,6
100% BioBS 900 C	260,9	167,0
90% BioBS + 10% Papersludge 800 C	123,0	< 1
90% BioBS + 10% Papersludge 850 C	112,2	< 1
90% BioBS + 10% Papersludge 900 C	104,1	< 1
90%lignite + 10% sew .sludge=ref 800 C	83,9	< 1
90% lignite + 10% sew .sludge=ref 850 C	102,1	94,9
90%lignite + 10% sew .sludge=ref 900 C	169,6	77,0
90%Ref + 10% BioBS 800 C	133,0	44,0
90%Ref. + 10% BioBS 850 C	230,0	164,3
90%Ref. + 10% BioBS 900 C	219,2	215,5
75%Ref. + 25% BioBS 800 C	110,2	18,1
75%Ref.+ 25% BioBS 850 C	100,9	90,6
75%Ref. + 25% BioBS 900 C	391,6	423,2
80%Ref + 10% BioBS+ 10%papersludge 800 gr C	error	error
80% ref+ 10% BioBS+ 10%papersludge 850 gr C	42,6	<1
80% Ref + 10% BioBS+ 10%papersludge 900 C	56,5	8,7

Conclusions experimental series on BioBS /BioBS-mixtures



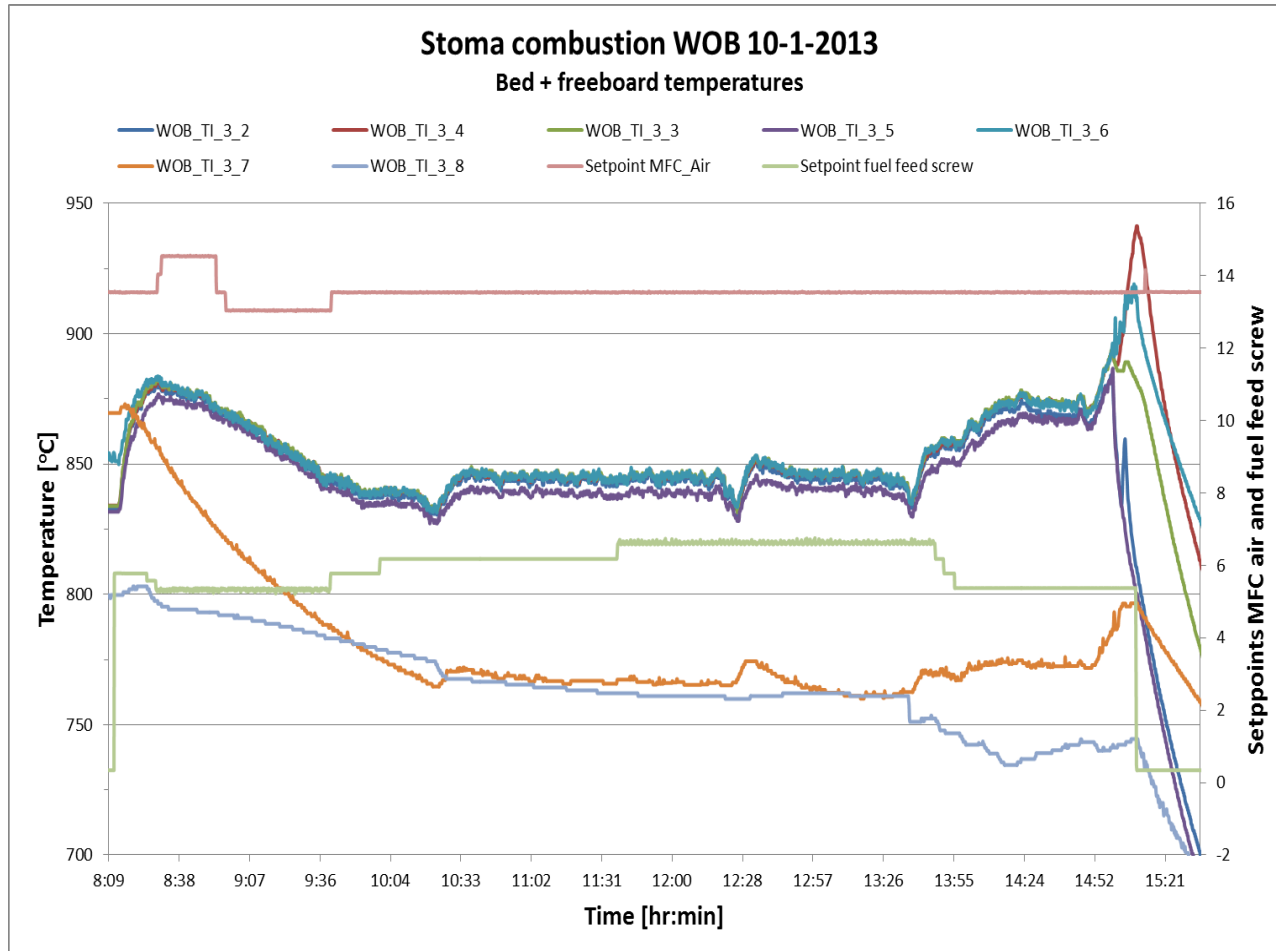
- All experiments did run smoothly once feeding problems were solved.
- The addition of paper sludge had a positive effect on the feeding characteristics and on the CO levels.
- No agglomeration occurred. Alkali-problems do not occur in the bed section.
- Some fouling of the exit of the reactor took place due to alkali-related problems.
- The level of SO_x when using BioBS increases with temperature and with the increase of BioBS percentage.
- Chlorine and SO_x levels in the gas phase were measured. On both mixtures tested, paper sludge use lead to a very significant reduction of SO_x and Cl. However, not to the same extent. The effect on Sox is much larger and reduces the gas phase content to

BioBS plus lignite and agro-residues

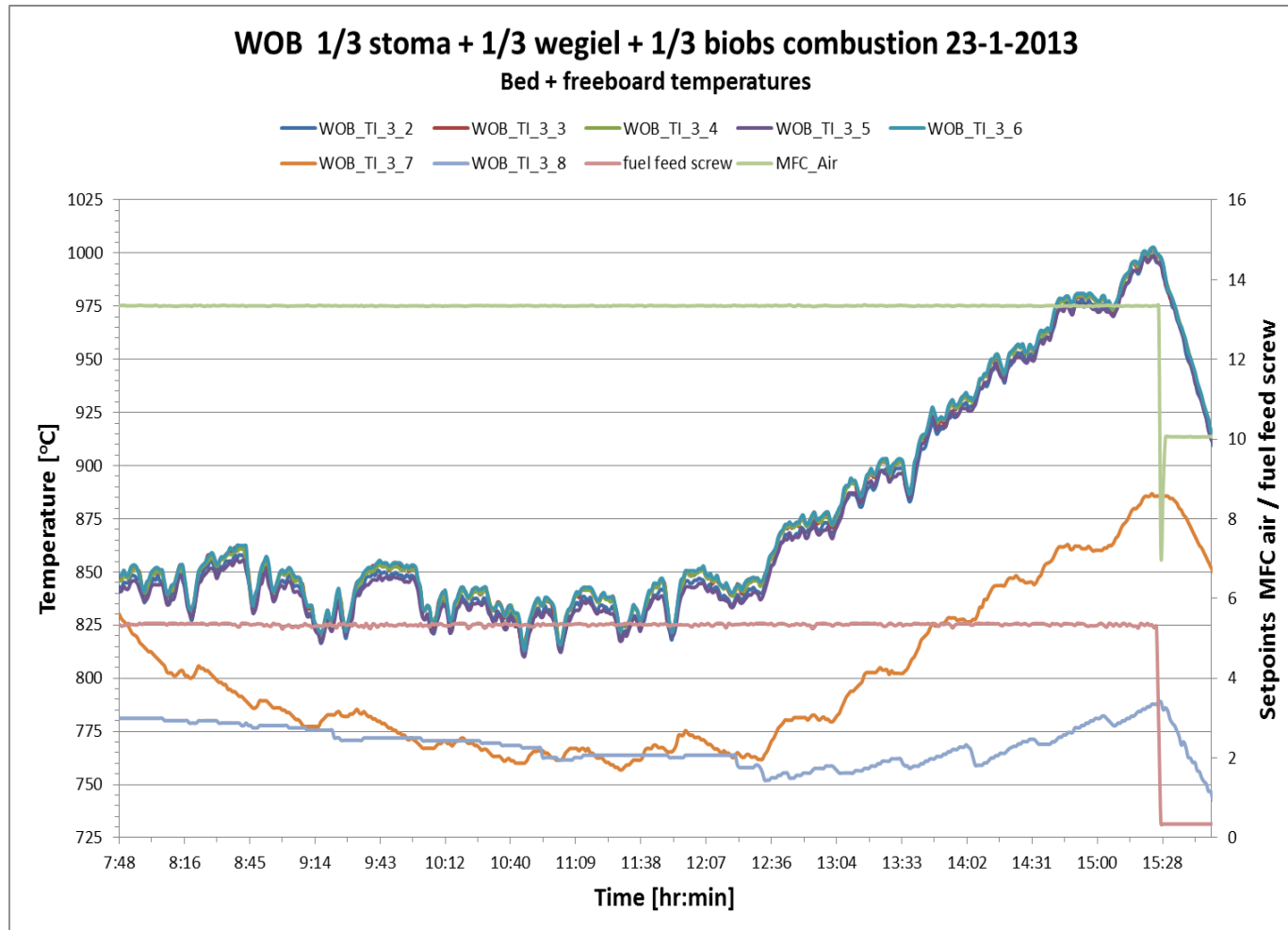
- Various combinations of Polish agro-residues with BioBS and Polish lignite were tested
- Aim is to study the behaviour of the mixtures, in particular the behaviour on agglomeration, Cl and S gas phase and ash distributions

Straw (Turow) combustion as single fu

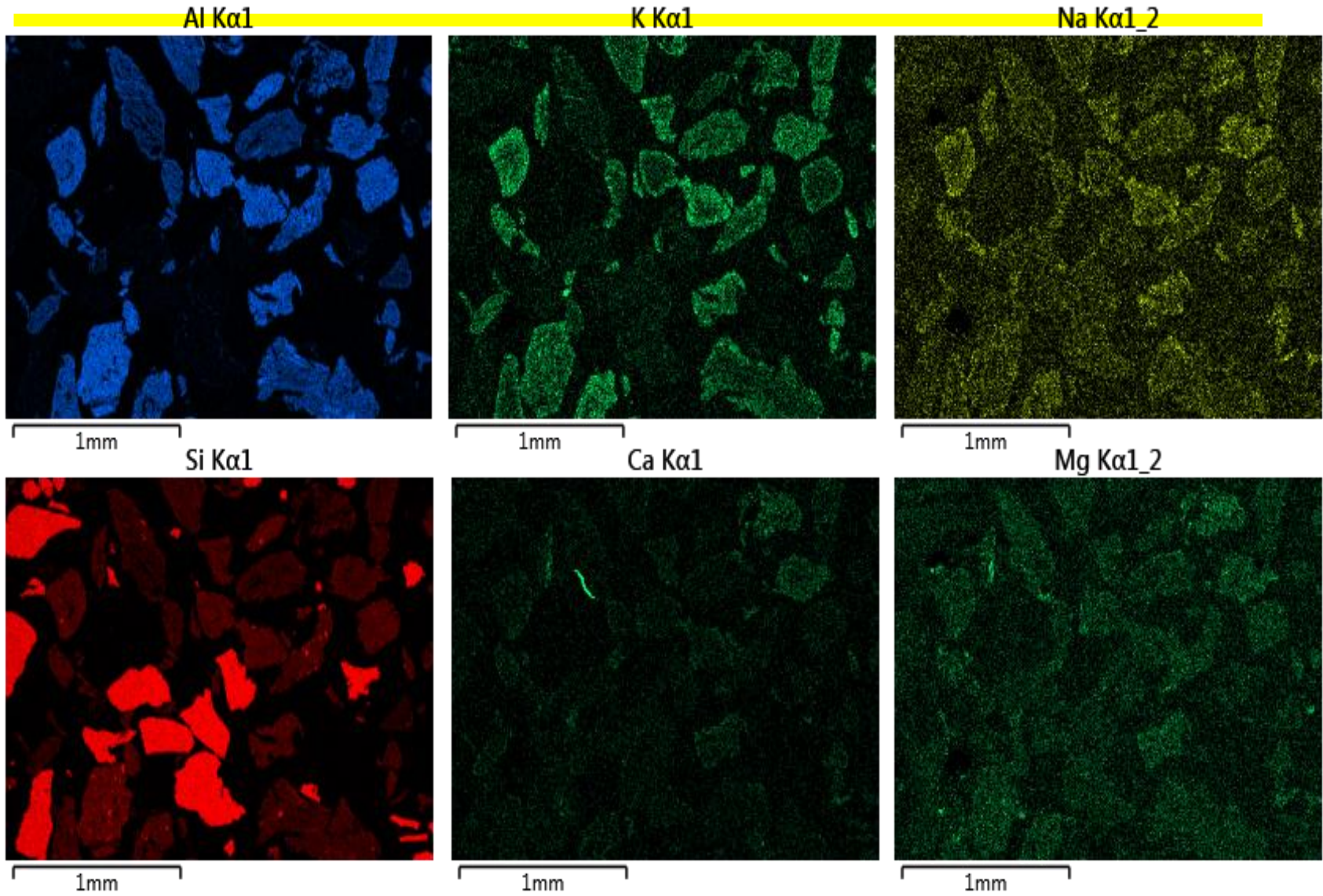
Taggl=890 C in FB



Straw/lignite/BioBS (=RDF with wood 1/3: 1/3: 1/3: No agglomeration



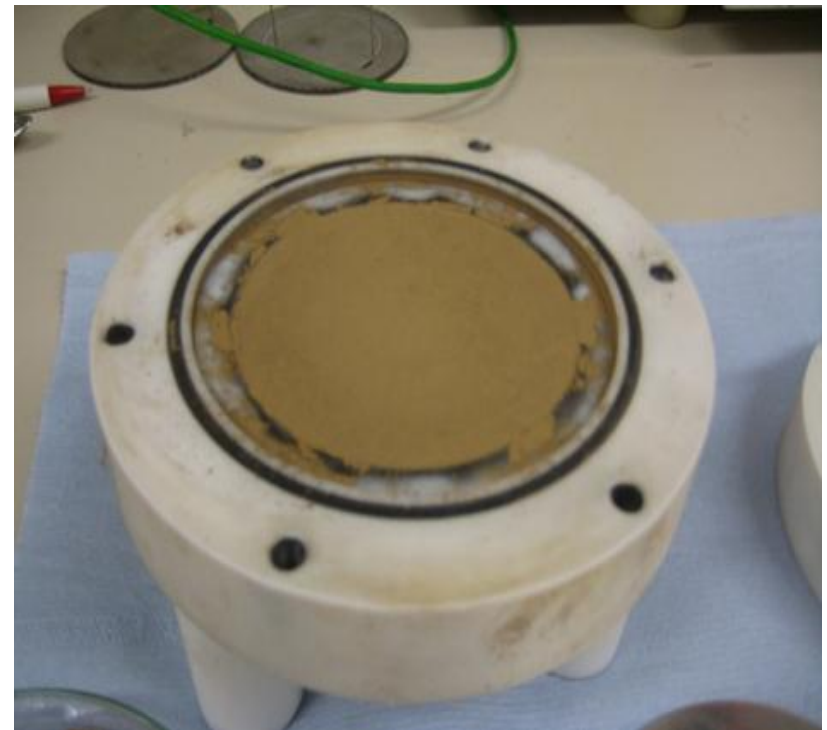
SEM analyses: K in Al-silicates



Unexpected problems

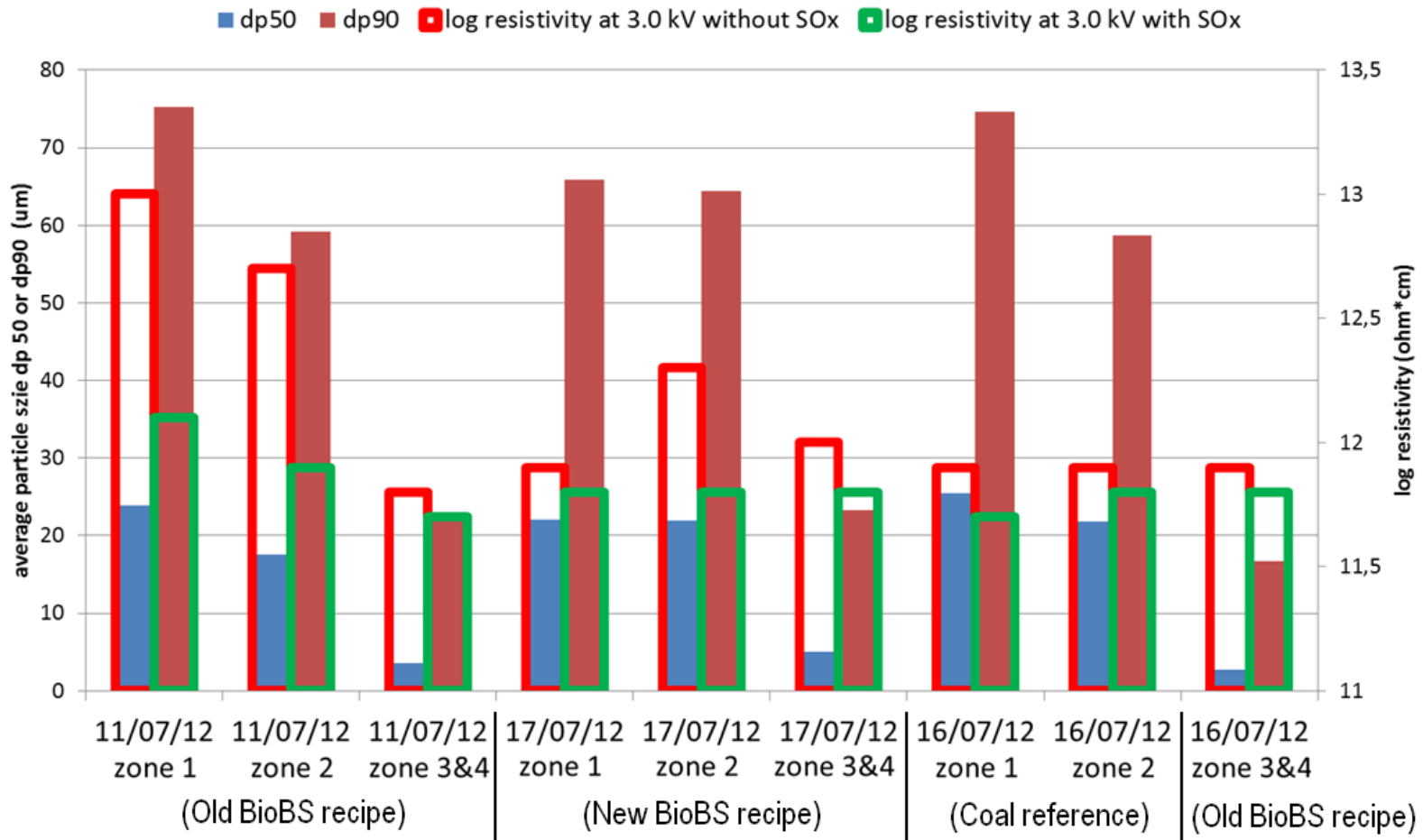
- Unexpected problems with ESP-collection of ash.
 - Back corona when co-firing BioBS pellets sewage sludge and lignite
 - Results in downtime
 - Emission of dust above the permit limit

The resistivity set-up at ECN



Plates can be solid or porous. The porous plates are used when a gas phase (moisture or moisture with sulphur) is pumped through the sample during measurement.

Conclusions on resistivity measurements



General Conclusions



- Fluidisation experiments were performed successfully for BioBS, BioBS plus Lignite and for BioBS/ligite/polish agro combinations at ECN.
- Differences in behavior and Cl and S emissions could be explained by considering the total chemical system.
- Studied samples on the lab-scale and the commercial scale showed good agreement and helped understand the processes occurring