Deposit formation during combustion of different waste wood qualities and co-combustion of waste wood and sewage sludge

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Agenda

- Introduction
- Chemical content of different waste wood qualities
- Deposit formation during combustion of waste wood in a grate furnace
- Deposit formation during combustion of different waste wood qualities in a CFB
- Deposit formation during co-combustion of waste wood and sewage sludge in a CFB
- Conclusions

Introduction

Demolition wood = Waste wood

Waste wood: Sorted demolition wood from old buildings and wood packing material. These materials are crushed to a suitable fuel size.

Waste wood can contain different amounts of:

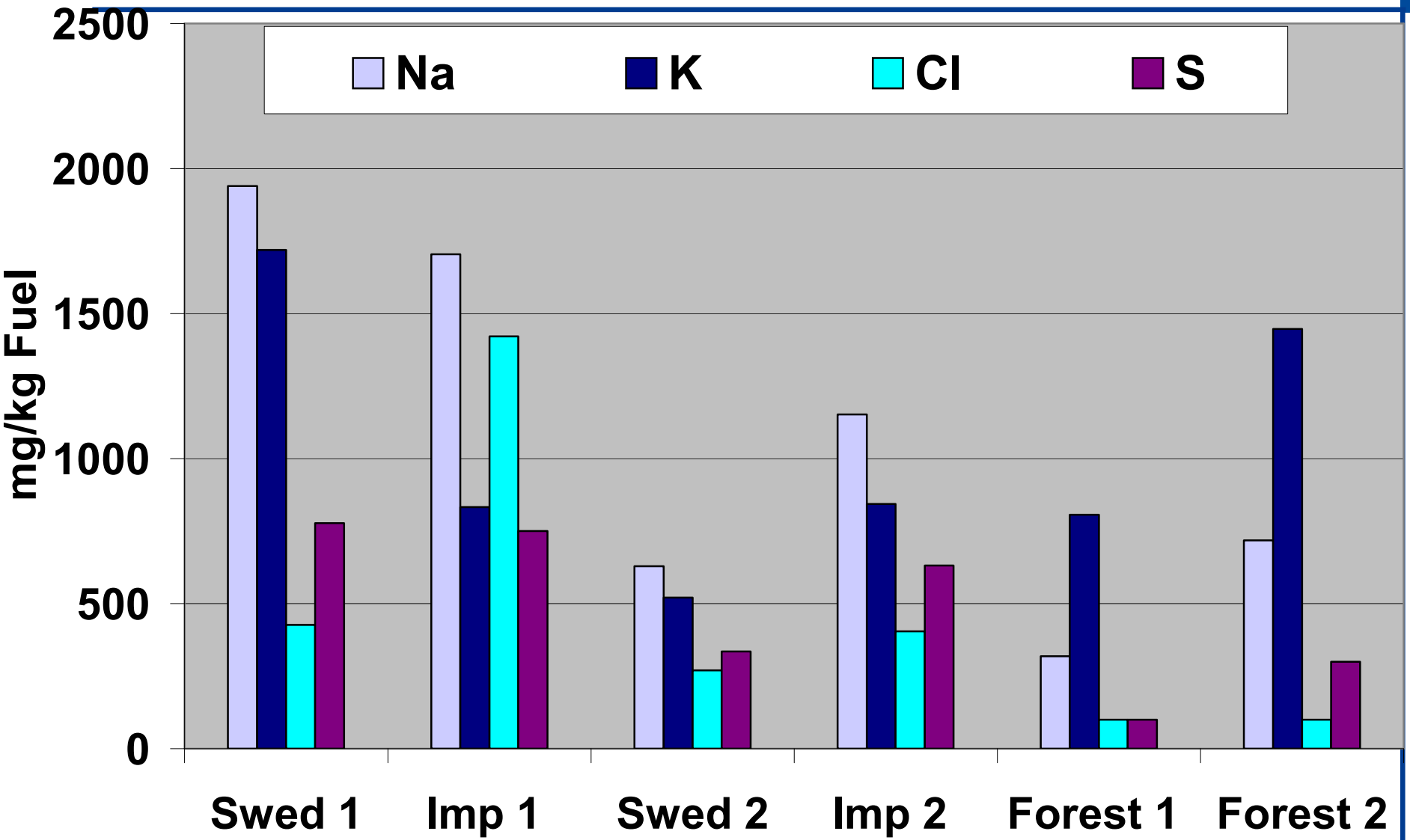
Metals (nails and fittings), creosote, plastic, gypsum, board

In some countries different classes of waste wood exists.

Waste wood often contains higher amounts of Zn, Pb, Cl and S compared to virgin wood. Causes problems with increased deposit formation and corrosion on super heaters.

ZnO and PbO were used as a pigment in old paint

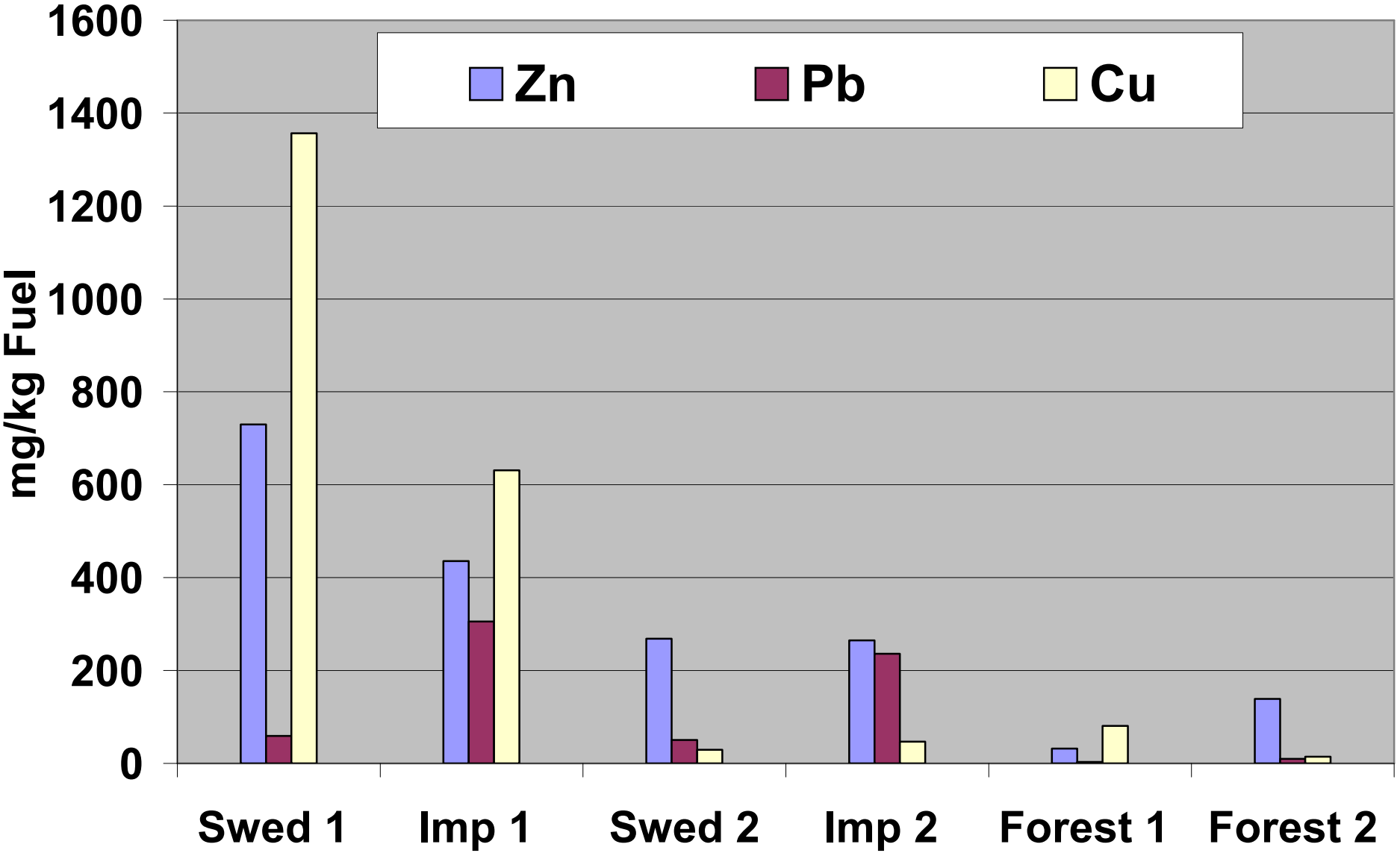
Chemical content of some different waste wood qualities – Na, K, Cl and S



Swed: Swedish waste wood qualities

Imp: Imported waste wood qualities

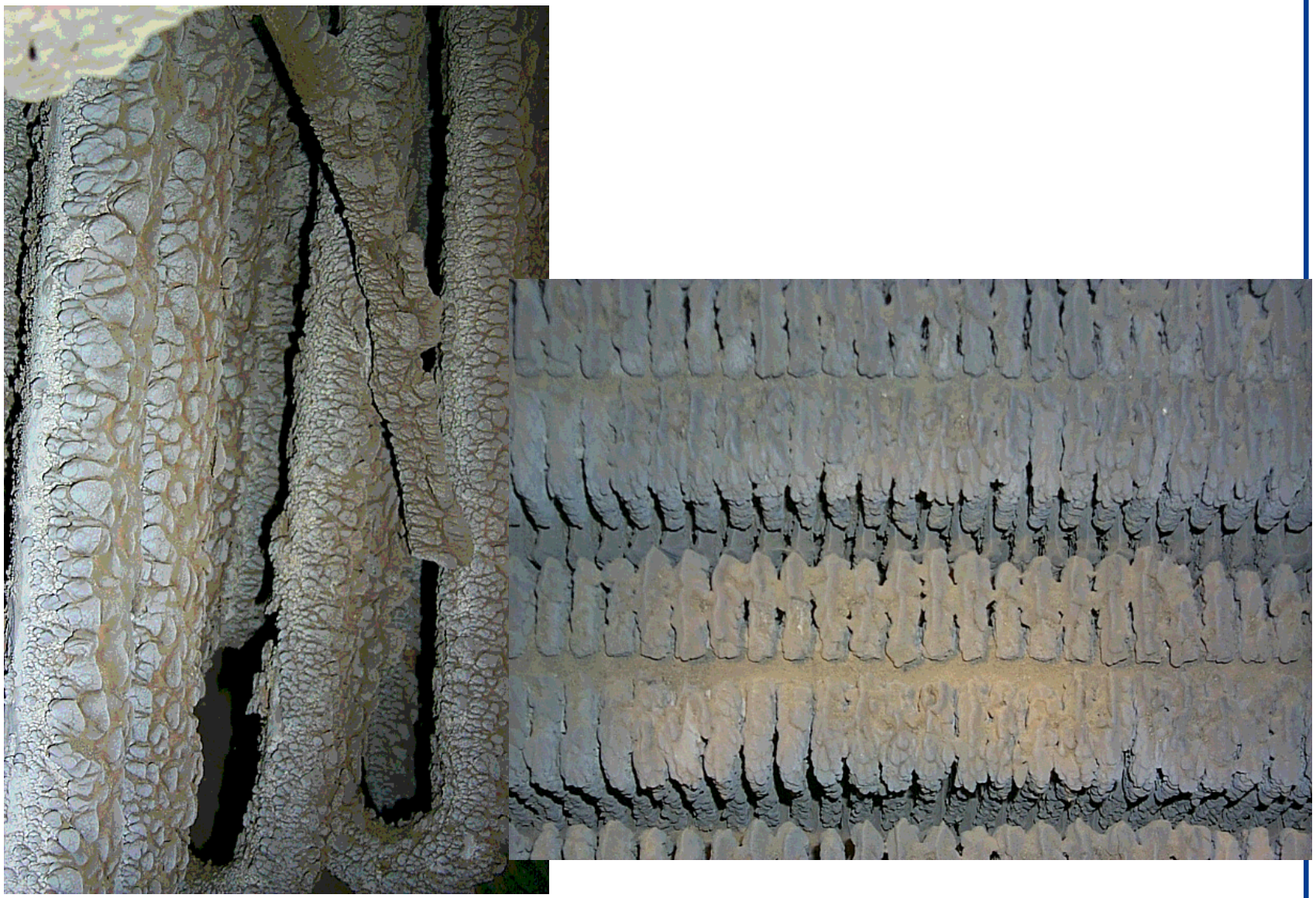
Chemical content of some different waste wood qualities – Zn, Pb and Cu



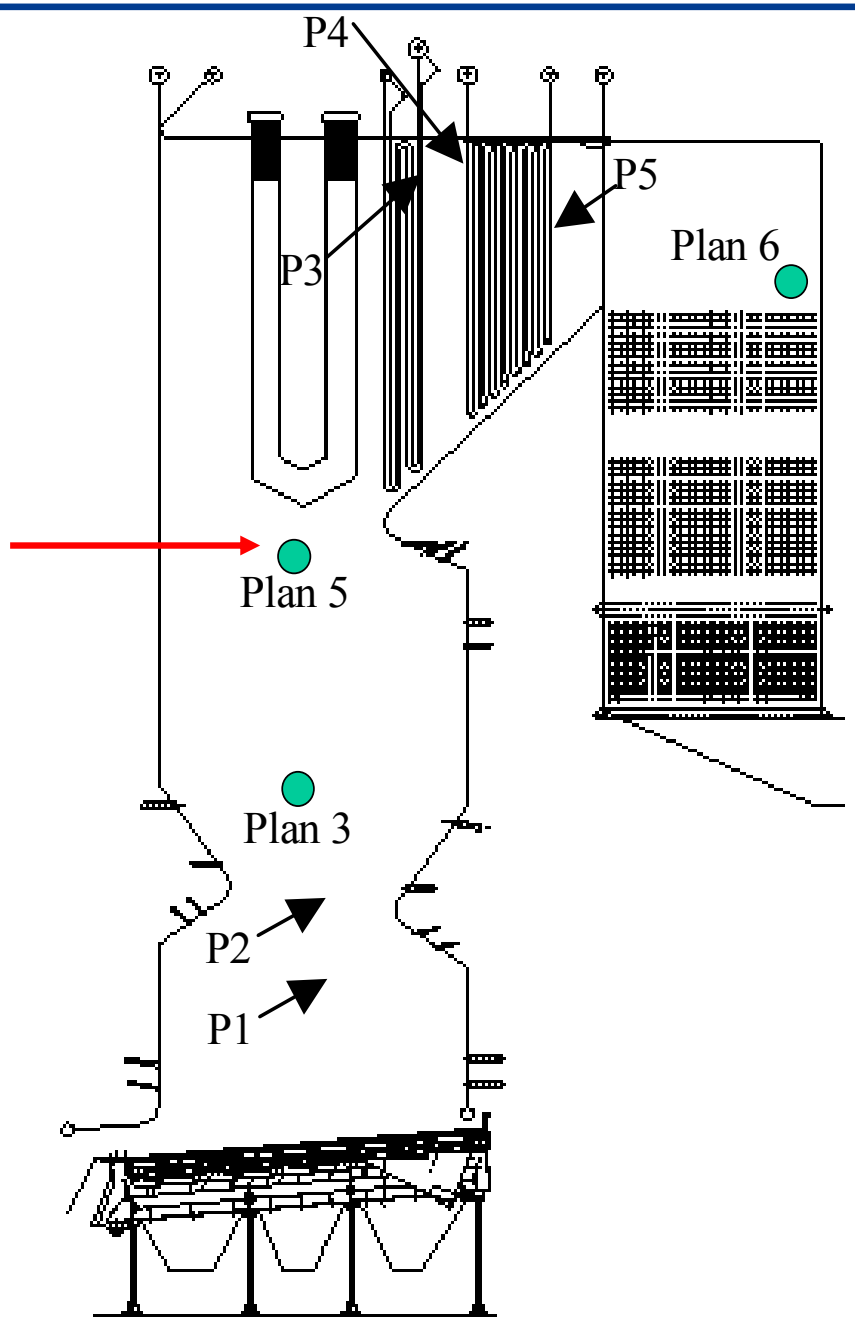
Swed: Swedish waste wood qualities

Imp: Imported waste wood qualities

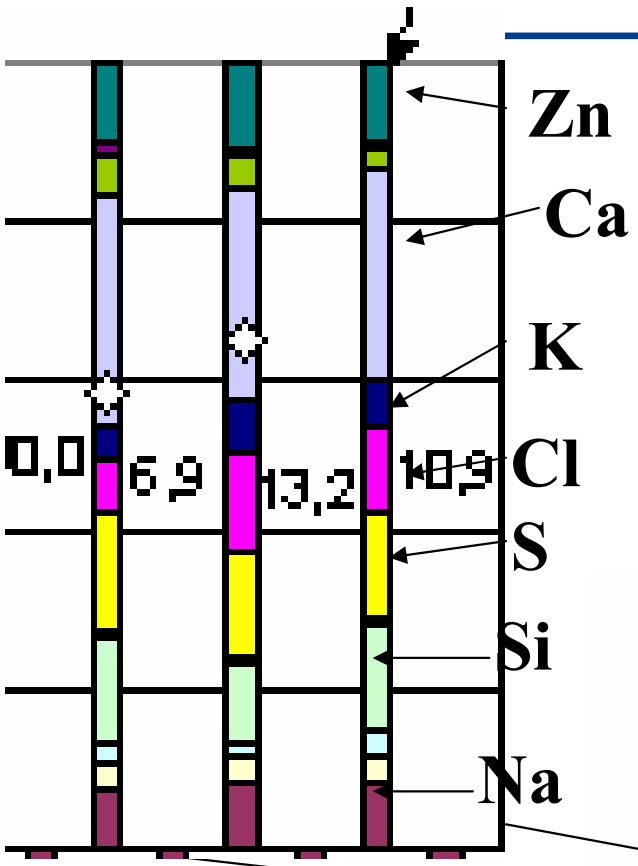
Example of deposit formation during waste wood combustion



Deposit formation during waste wood combustion Händelö P11 – Vibrating grate



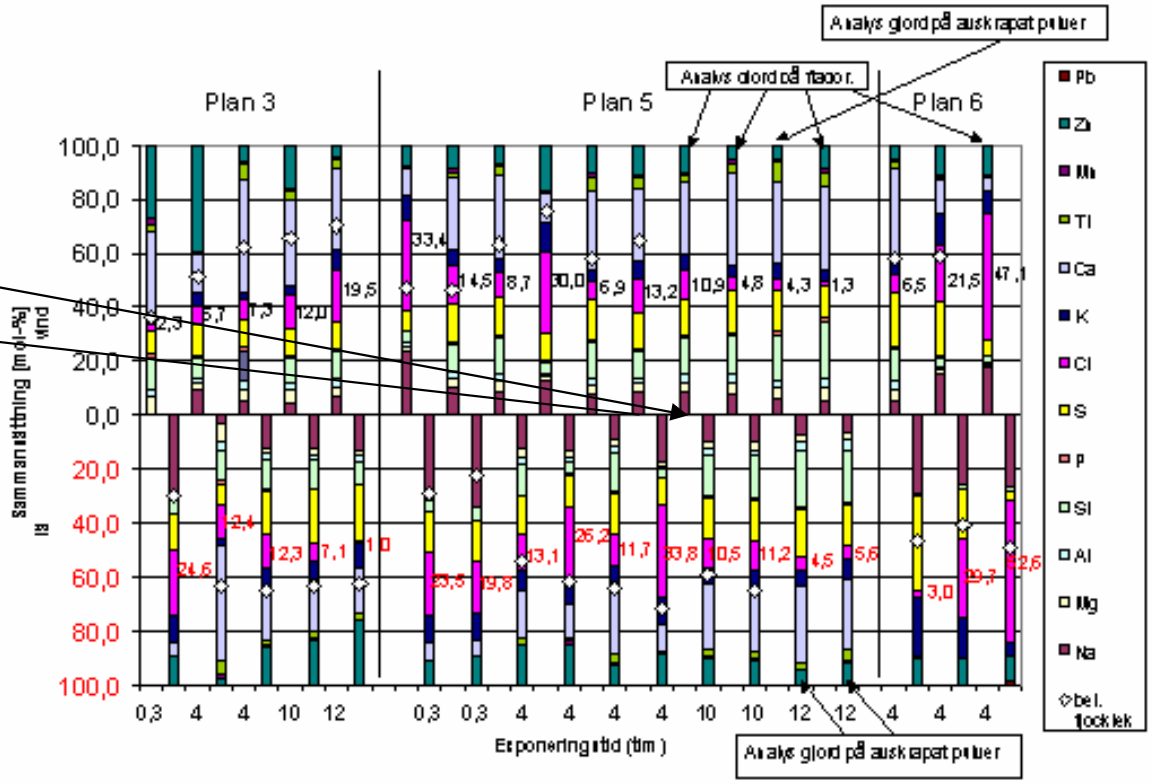
Combustion of imported waste wood with high chlorine content (0,14 w%) – Deposit content



Flue gas temperature: 900 °C

Metal temperature: 500 °C

Melting point of deposit: 400 °C



Measured by Vattenfall

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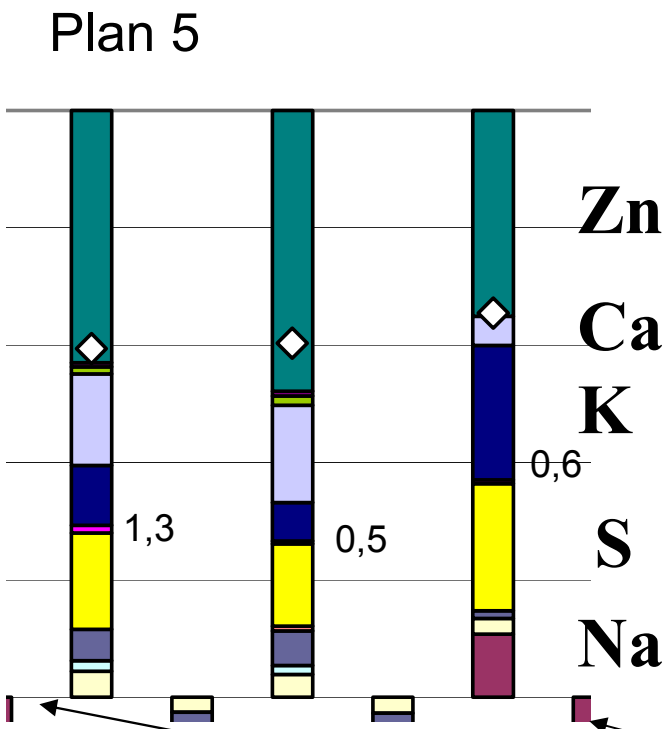
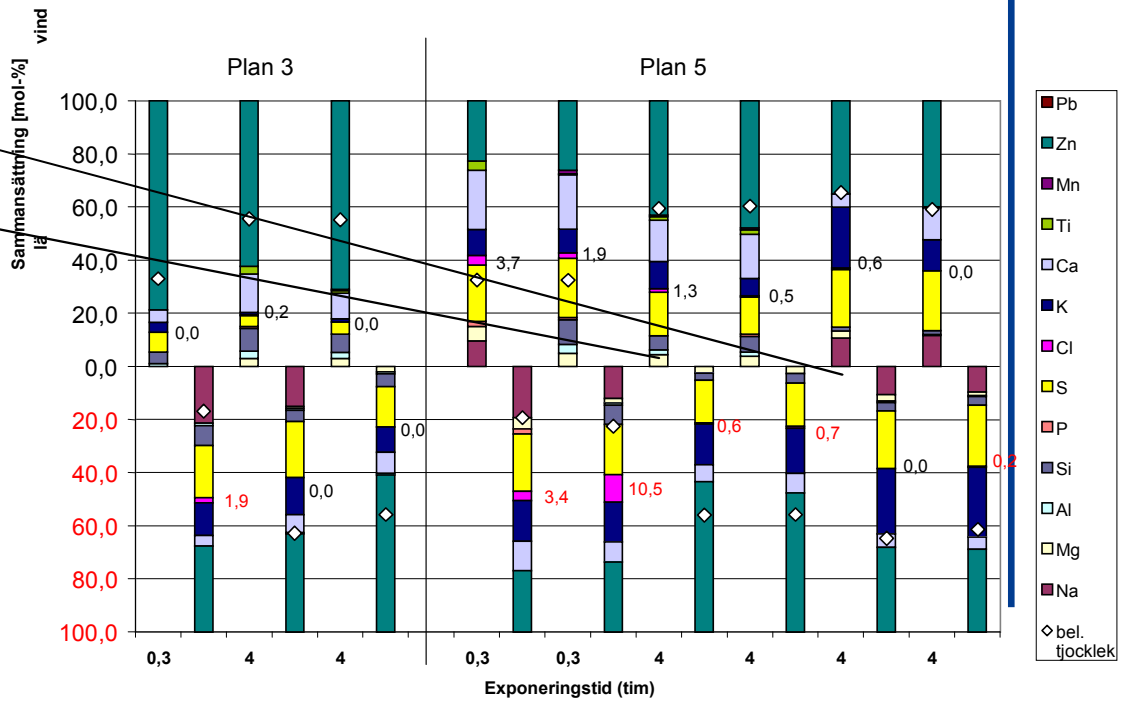
Combustion of Swedish waste wood with low chlorine content (0,04 w%) – Deposit content



Flue gas temperature: 900 oC
Metal temperature: 500 oC



Measured by Vattenfall

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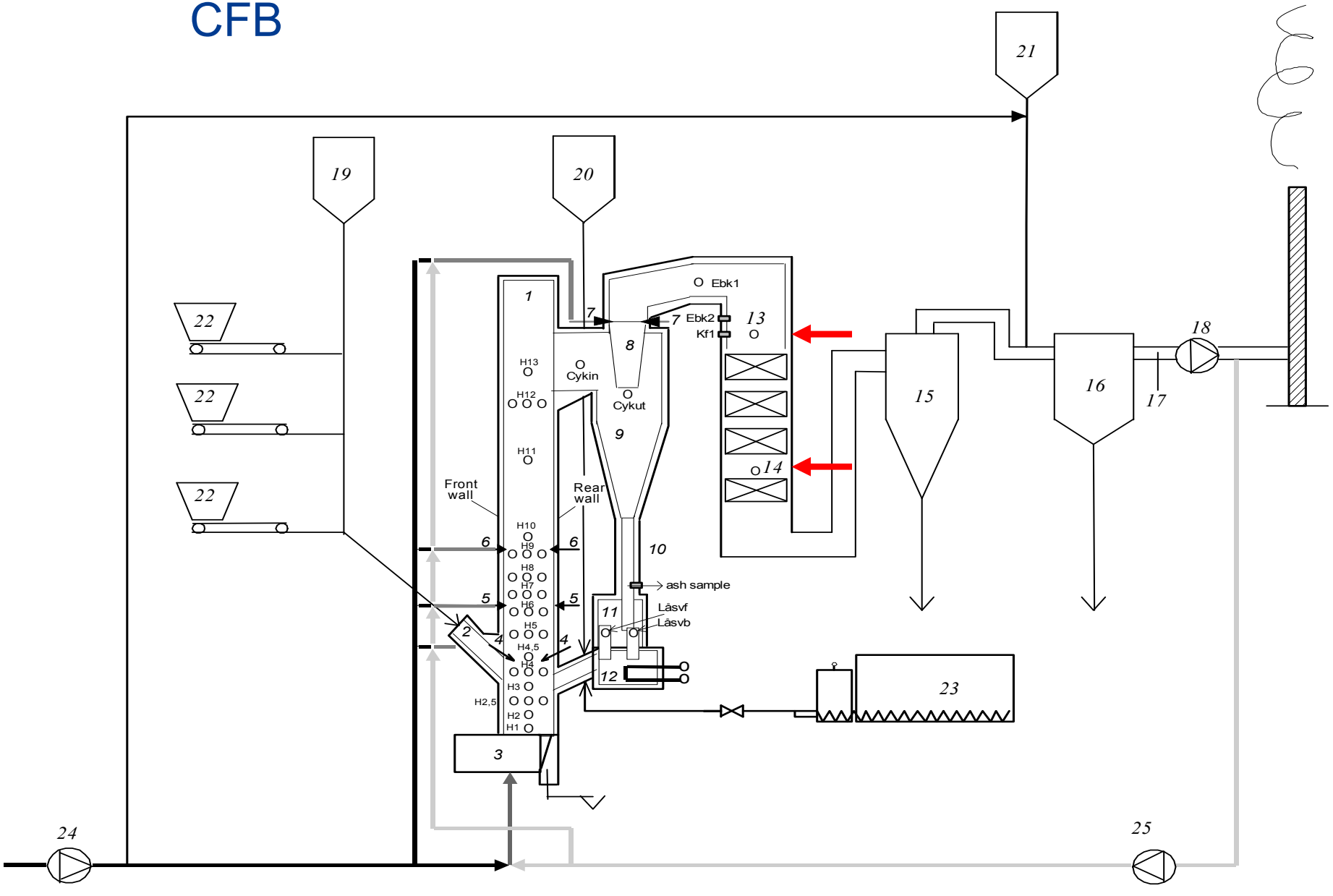
Combustion of different waste wood qualities and co-combustion of waste wood and sewage sludge in a CFB

Experiments have been performed in Chalmers 12 MW CFB



Experimental - Fuels

Almost equal amounts of wood pellets and demolition wood were fired.

In some cases sewage sludge was added.

Three different demolition wood qualities were simulated in a reproducible way:

1) “Clean” demolition wood
2) Painted demolition wood: Added ZnO (pigment in old paint)
3) Painted demolition wood with high chlorine content: Added ZnO and HCl

Experimental – Test program

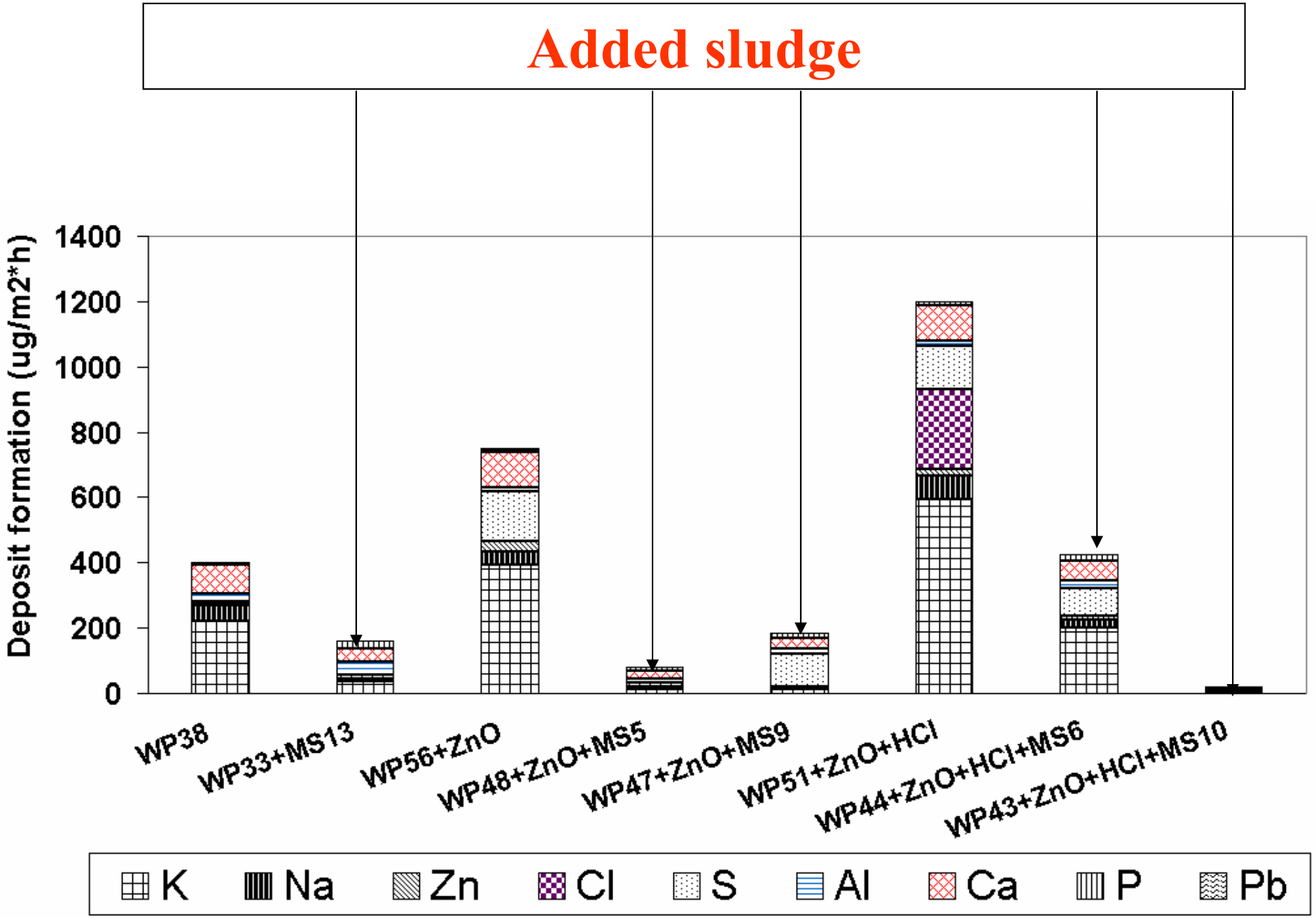
WP: Wood Pellets

MS: Municipal Sewage sludge

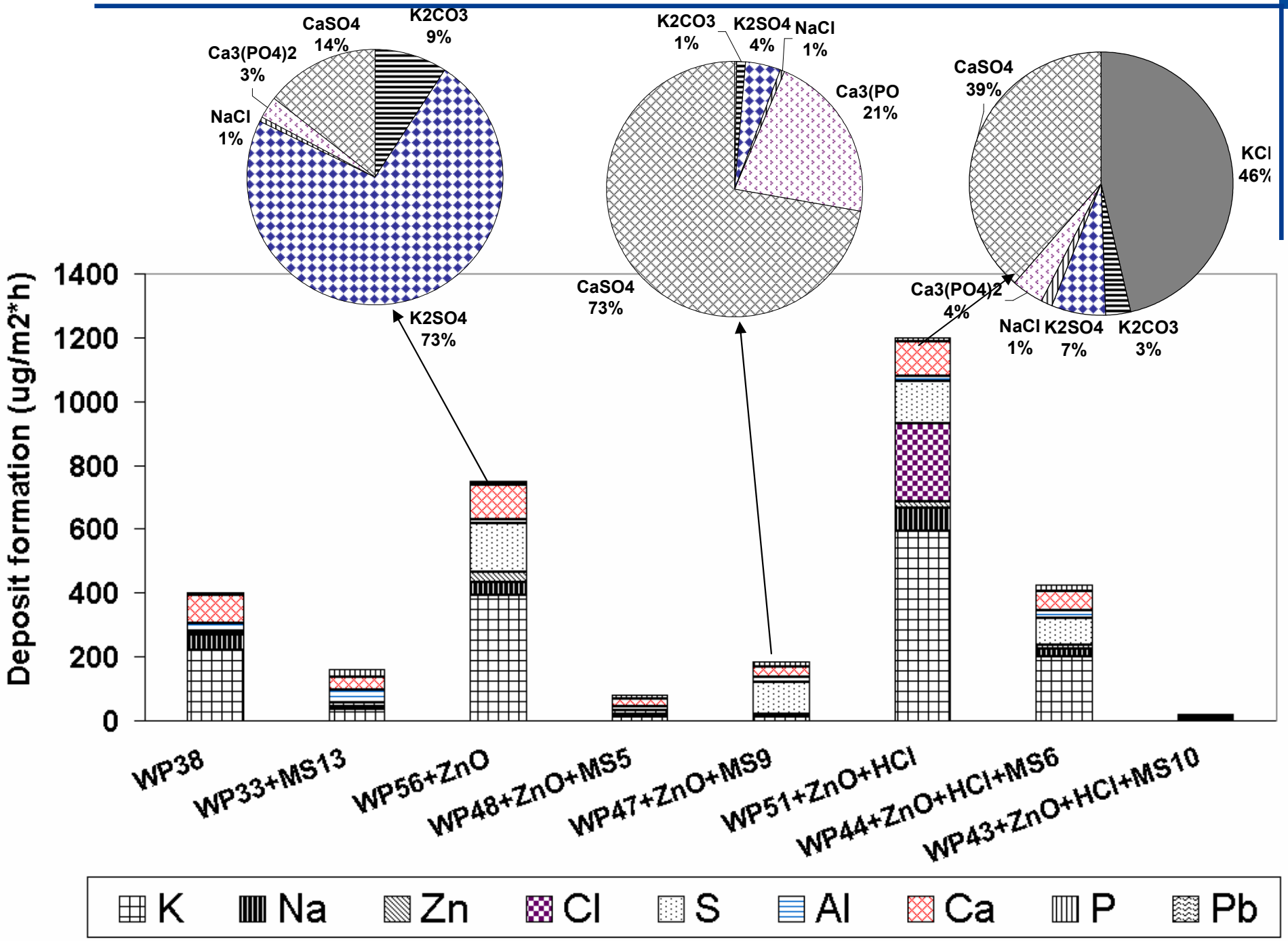
Number: mass dry fuel / mass total dry fuel

Runs	Molar ratio Cl/Zn	S/Zn	Cl / (K+Na)	2S / (K+Na)	2S/Cl
WP38	4.4	6.0	0.11	0.3	2.7
WP33+MS13	3.0	18	0.08	1.02	12.8
WP56+ZnO	0.91	0.64	0.27	0.4	1.5
WP48+ZnO+MS5	0.88	3.2	0.16	1.2	7.5
WP47+ZnO+MS9	0.97	5.9	0.16	1.9	11.9
WP51+ZnO+HCl	4.0	0.63	1.9	0.6	0.3
WP44+ZnO+HCl+MS6	3.9	3.8	0.80	1.6	2.0
WP43+ZnO+HCl+MS10	3.5	5.9	0.51	1.7	3.4

Results – Deposit formation



Results – Chemical analysis of the deposits



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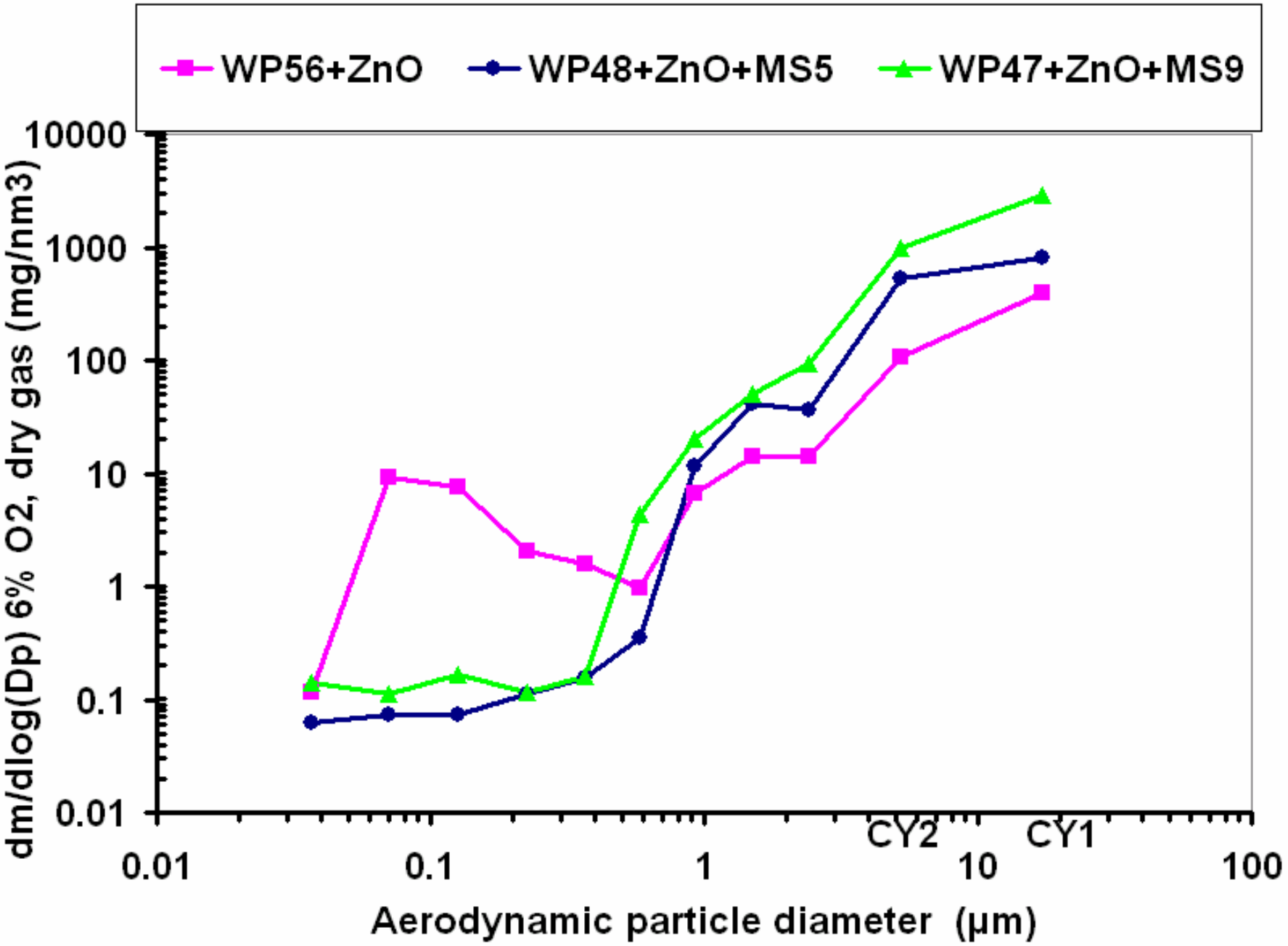
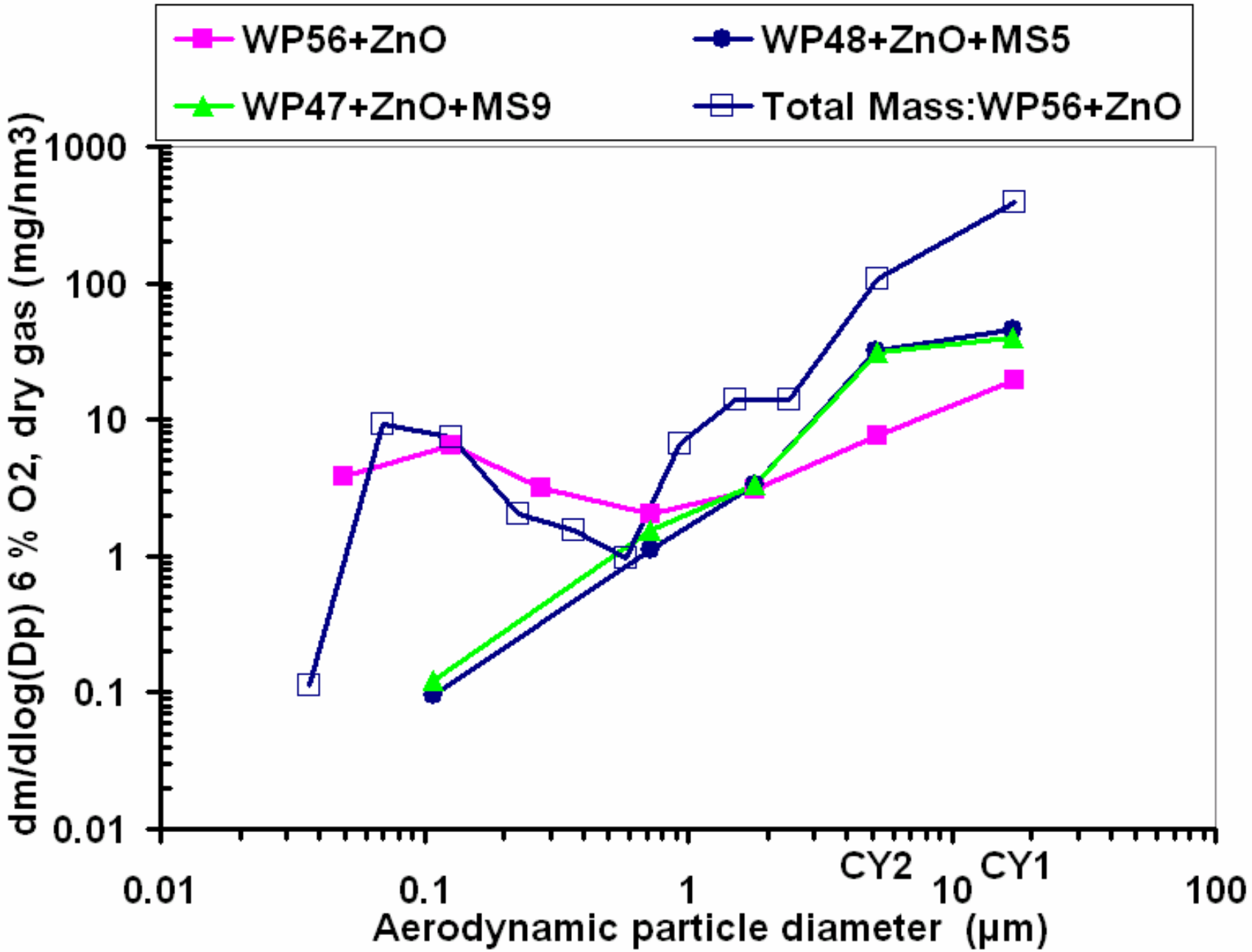
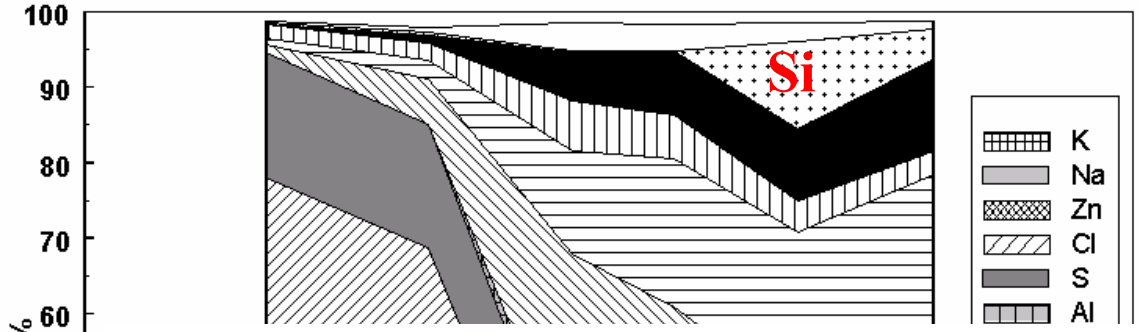
Results – Mass size distribution of the fly ash measured by a DLPI

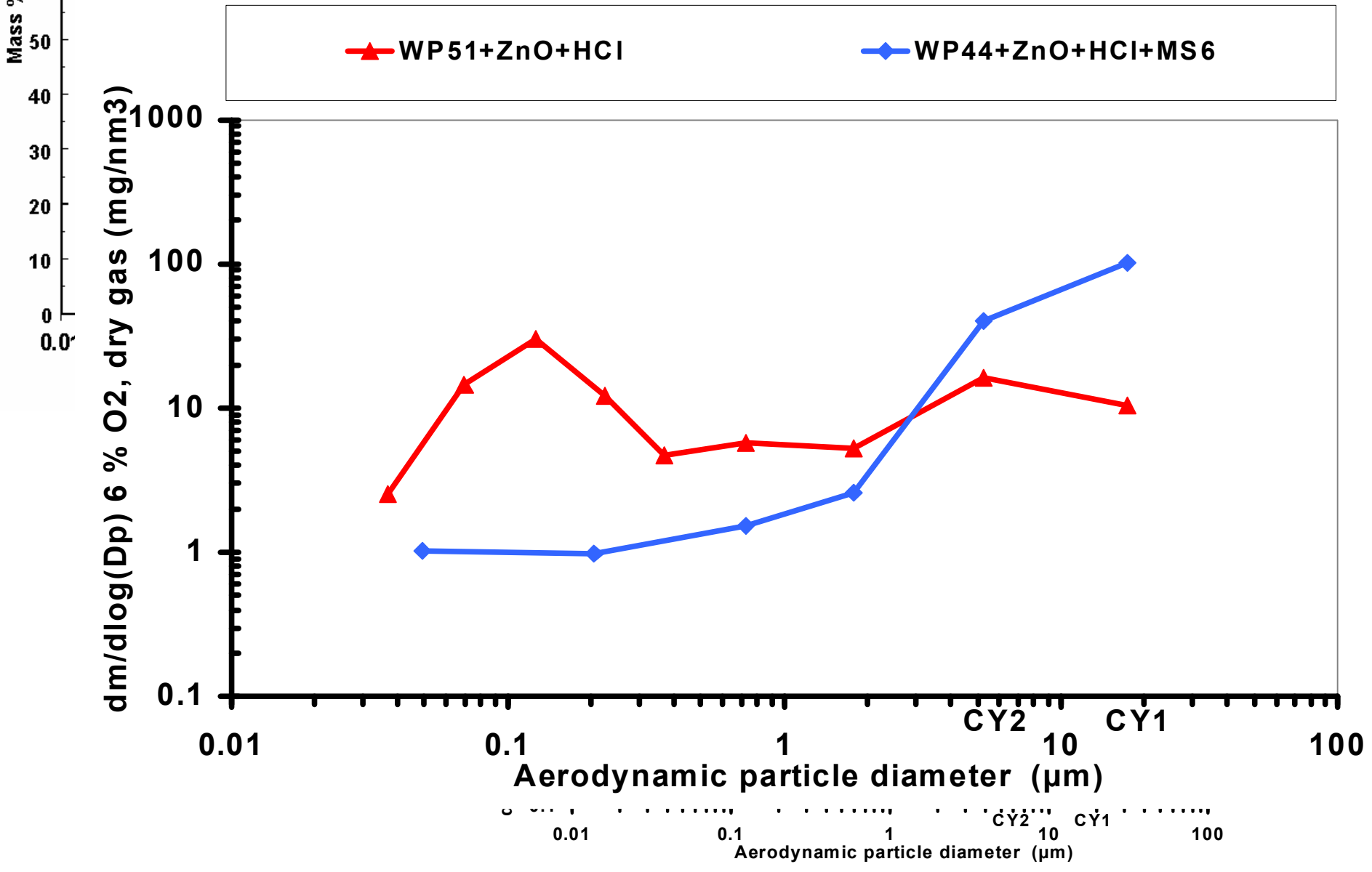


Results - Sum of elements related to fouling in fly ash particles (K, Na, Zn, Cl and S)



ger particles (Dp>1
lge





0.01 0.1 1 CY2 10 CY1 100
Aerodynamic particle diameter (µm)

Conclusions - waste wood combustion

- **Waste wood often has a higher content of chlorine, sulphur, zinc, lead and copper compared to virgin biomass.**

- **High amount of chlorine in the fuel increases the deposit formation and give a deposit with higher chlorine content.**

- **Zinc can in some cases evaporate from the combustion chamber and form deposits. In these studied furnaces the zinc evaporation was high during grate fired conditions.**

- **Zinc can lower the melting point of the deposit and increase the corrosion rate.**

The results from the combustion tests at Chalmers CFB have been reported in: Lars-Erik Åmand, Bo Leckner, David Eskilsson, and Claes Tullin , "Ash Deposition on Heat Transfer Tubes during Combustion of Demolition Wood" , Energy & Fuels, 20 (3), Pages 1001 -1007, 2006,

Conclusions - Co-combustion of waste wood and sewage sludge

- The deposit formation decreases radically when sludge is added to the combustion
- The fouling related elements (mainly KCl) in the submicron particles is transported to the bigger particles (Dp>1 µm) during sludge combustion
- During high S/Cl ratios, the potassium is sulphated
- Looking at the results from the elemental concentration of the bigger particles during sludge combustion indicates that a major part of the potassium could have reacted with aluminum-silica compounds
- Sludge contain high amounts (10 % dry basis) of zeolites (aluminum-silica compound) which derive from phosphate free washing detergent.

Lars-Erik Åmand, Bo Leckner, David Eskilsson and Claes Tullin, "Deposits on heat transfer tubes during co-combustion of biofuels and sewage sludge", Fuel Volume 85, July-August 2006, Pages 1313-1322

Acknowledgement

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Thank you for your attention!