Co-firing and ash quality

IEA workshop on Cofiring Biomass with coal

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Overview

- Fly ash in concrete (EN-450)
  - EN 450 requirements
  - Calculating max co-firing percentages
- Ash formation
- Utilization of Non EN-450 ashes

Fly ash in concrete (EN-450)

- Compliance with EN-450: Fly ash for concrete (to be published end of 2012)

- Possible limitations/issues
  - Limiting list of allowed biomass
  - Maximum co-firing percentages (40-50% biomass)
  - Strength development (cement/fly ash mixtures)
  - (Free, Reactive) CaO content
  - Alkalis
  - Unburnt matter

prEN-450 requirements (2010 draft)

Max. Co-firing percentage:

- Mass based: **< 40 %** (50% if green wood) (2005 limit: < 20%)
- Ash based: **< 30%** (2005 limit: < 10%)

Types of co-combustion materials allowed

1	Solid Biofuels conforming to CEN/TS 14588 incl. husbandry residues
2	Animal meal (meat and bone meal)
3	Municipal sewage sludge
4	Paper sludge
5	Petroleum coke
6	Virtually ash free liquid and gaseous fuels

prEN-450 requirements (2010 draft)

Property	Requirement	unit	req.
workability	LOI (Cat. A)	% m/m	≤ 5,0
	fineness fraction > 45 µm (Cat. N)	% m/m	≤ 40
initial strength development	soluble P_2O_5	% m/m	≤ 0,01
	initial setting	min.	2C**
strength development	sum SiO_2 + Al_2O_3 + Fe_2O_3	% m/m	≥ 70
	reactive SiO_2	% m/m	≥ 25
	activity index 28 days 91 days	%	≥ 75 ≥ 85
Alkali Silica Reaction ()	Na_2O equivalent	% m/m	≤ 5,0
	reactive CaO	% m/m	≤ 10,0
soundness/durability	SO_3	% m/m	≤ 3,0
	free CaO*	% m/m	≤ 1,5
	soundness	mm	≤ 10
	total MgO	% m/m	≤ 4,0
	Cl^-	% m/m	≤ 0,10

KEMA Trace Model®

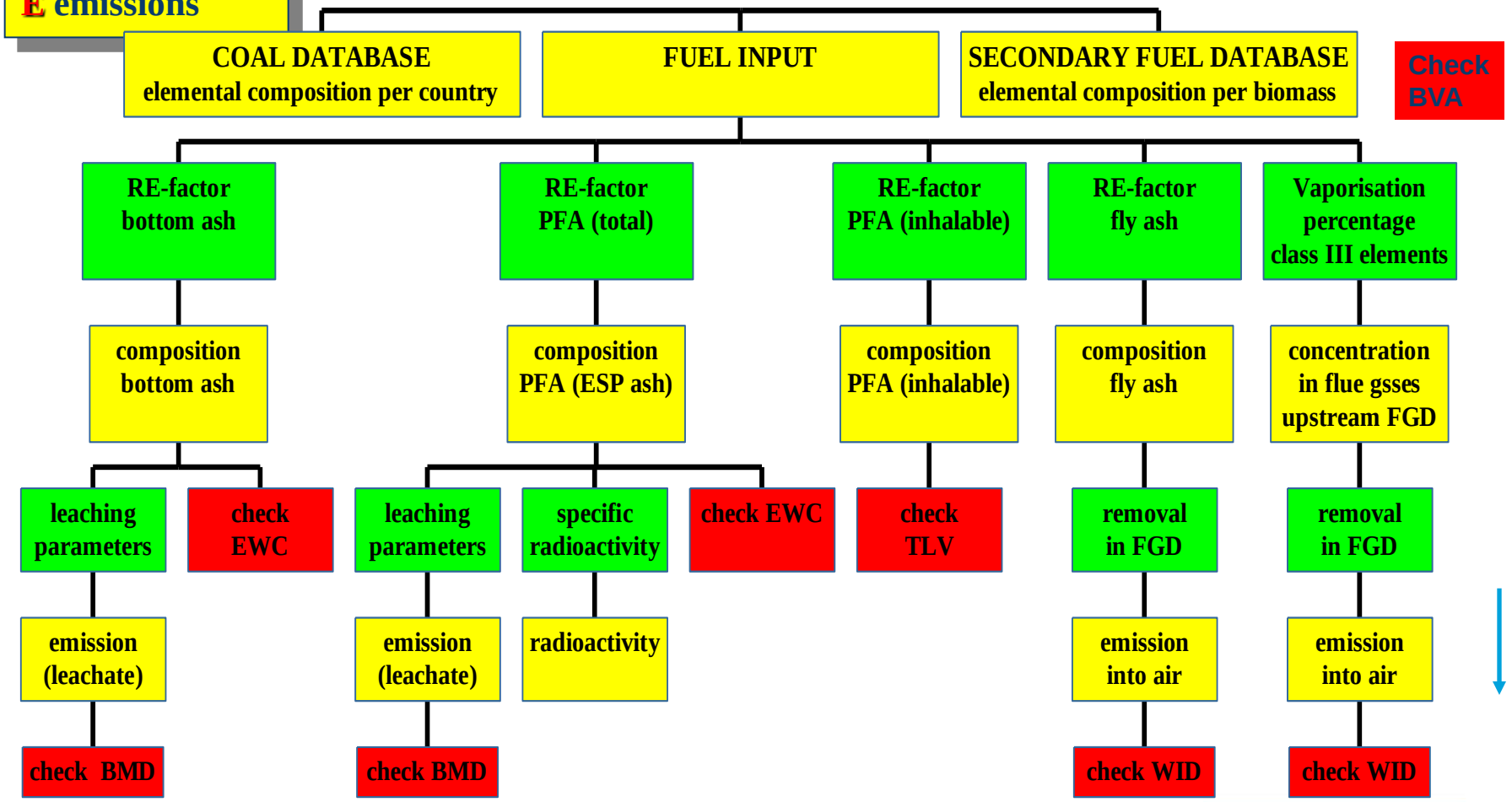
Has evolved from more than 25 years of experience with mass balance studies at coal-fired power plants in the Netherlands

The results of the model calculations give a good impression of the average composition of byproducts and emissions into the air

Results of model calculations are being used and accepted in official documents in discussions with governmental authorities, in Environmental Impact Statements,permit applications and for Annual Environmental Reports.

T trace
R radioactivity
A ash
C coal
E emissions

KEMA TRACE Model ®



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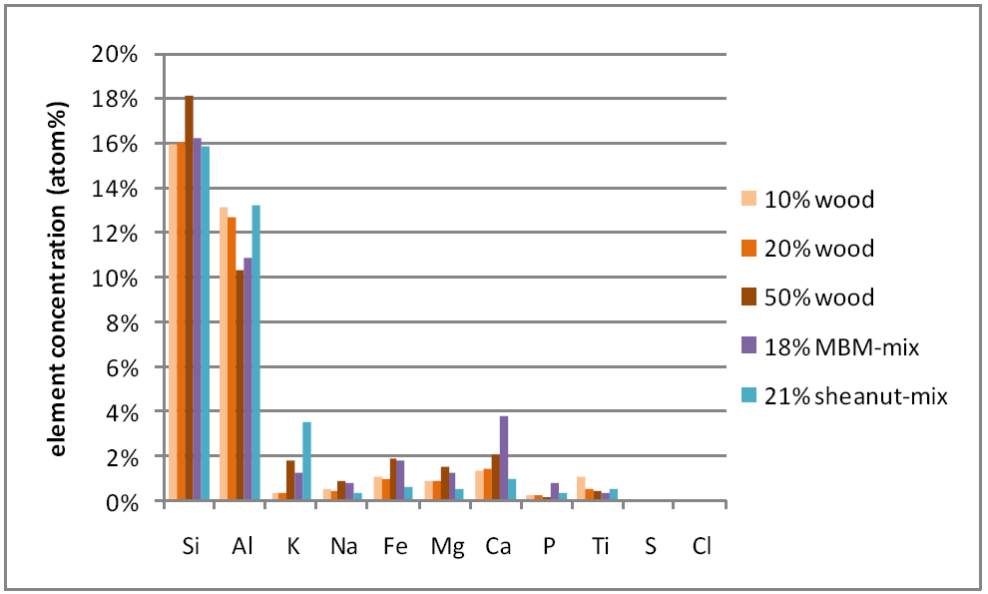
Calculation results

secondary fuel	maximum co-combustion percentage		limiting criterion
	fuel based	ash based	
mun. sewage sludge	5-13	21	total P_2O_5
poultry dung	7-16	15	reactive CaO
meat & bone meal	6-10	12	total P_2O_5
green wood 1	40 (50)	9-20	Co-combustion fuel based
green wood 2	40 (50)	1-4	Co-combustion fuel based
green wood 3	40 (50)	2-4	Co-combustion fuel based
bark wood	26-40	10-13	reactive CaO and co-combustion fuel based
cacao shells	15-30	15	Na_2O equivalent (K)
palm kernels	22-40	15-16	total P_2O_5 and co-combustion fuel based

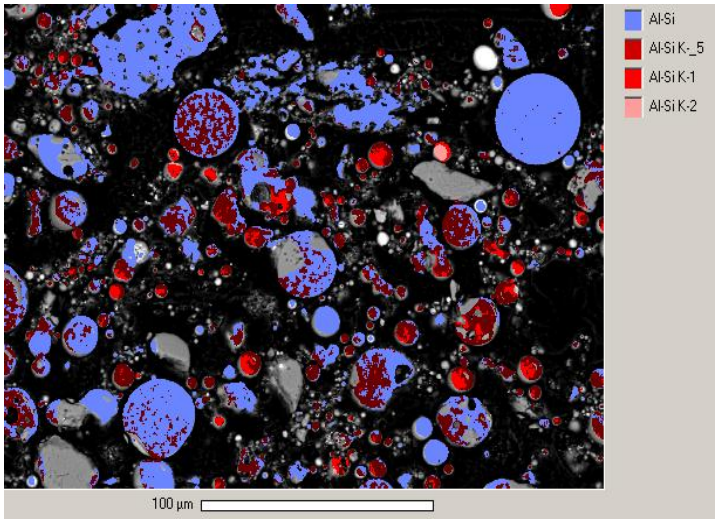
Ash formation (1)

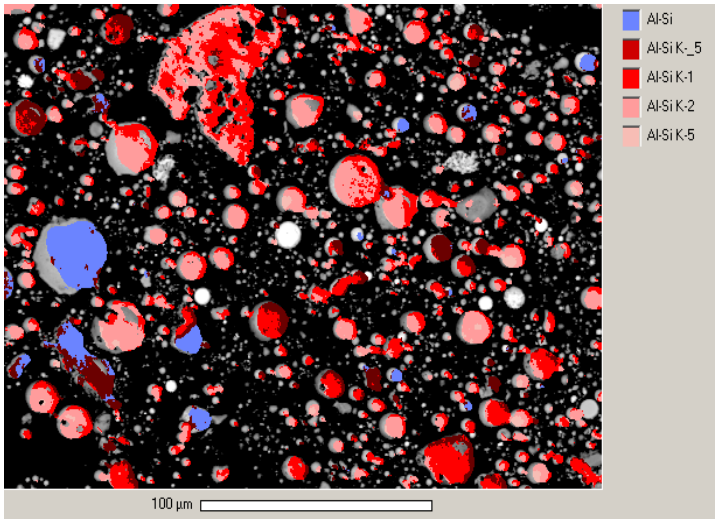


- Overall composition:
  - Mainly molten slag particles
    - K increase sheanut, MBM and high rates of wood
    - Ca increase: MBM
    - P increase: MBM
  - Few other molten particles:
    - iron oxide (all)
    - calcium phosphate with additions of Al and Si (co-firing MBM)
    - Ca-based particles with Si, Al, Fe, P and S (co-firing MBM)
  - Non-molten particles: mainly (meta-)kaolinite and quartz
    - Calcium phosphate (co-firing MBM, so both molten and non-molten)

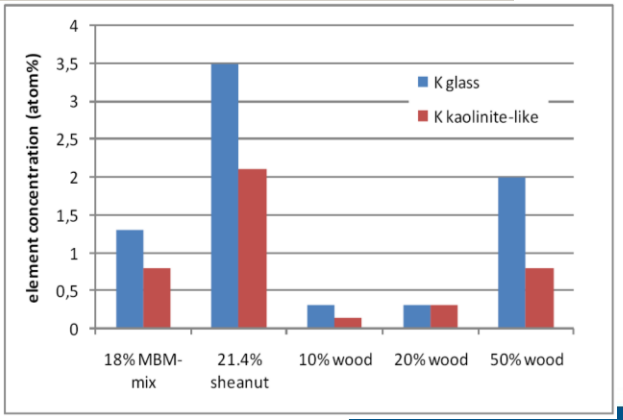
Ash formation (2)

- Example: co-firing wood (10% and 50% (thermal heat input))



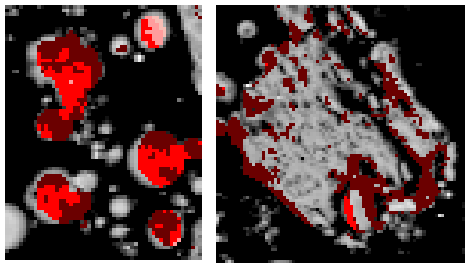


- Focus on alkalis (K, Na)
- Interaction with coal ash
  - 1: dissolution in molten glass phase
  - 2: absorption by (meta-)kaolinite
- Concentrations K: sheanut > MBM > wood

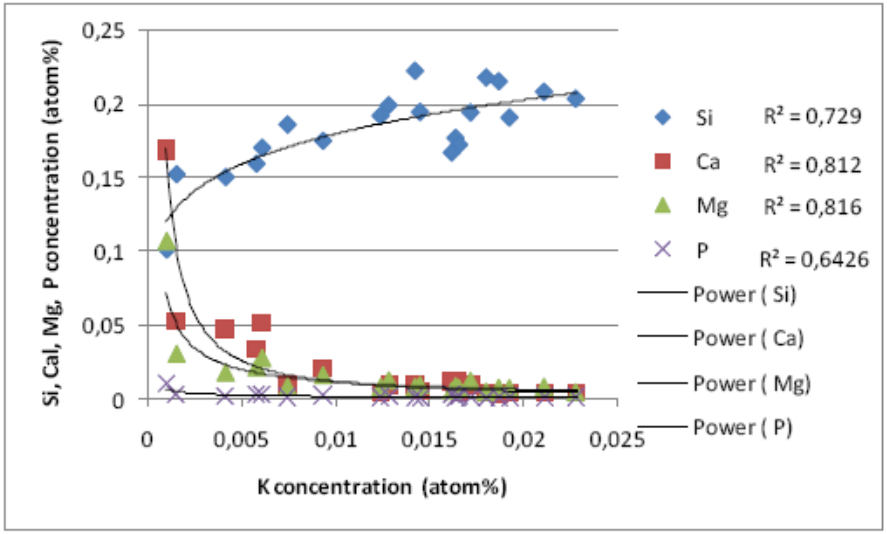


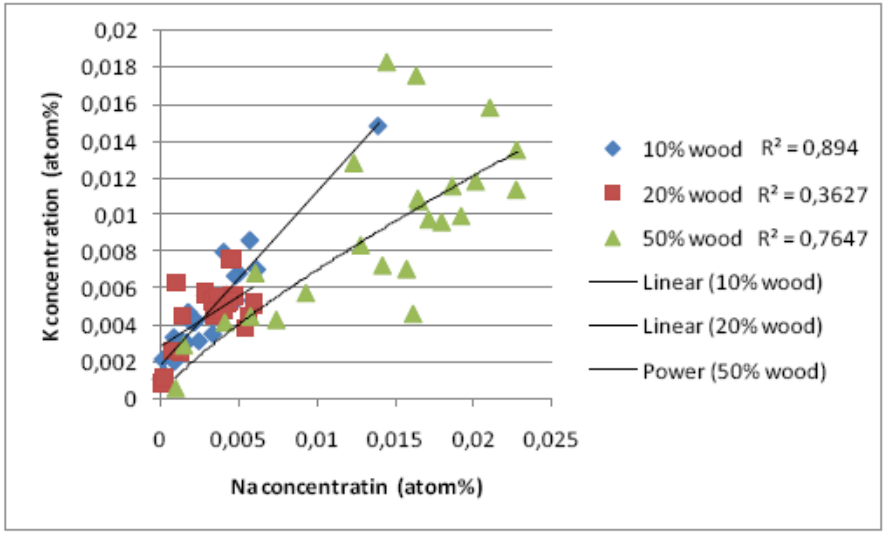
Ash formation (3)

- Concentration K > Na
- Distribution of alkalis
  - Glass (slag): evenly distributed
  - (Meta-)kaolinite: enriched at surface



- Alkalis in glass tolerate each other (Na – K) and positively correlate with Si
- No toleration between alkalis and Ca, Mg, P in glass





Non EN-450 ashes

- For example
  - High LOI ashes
  - High CaO ashes (lignite/peat ashes)
  - >50% co-firing ashes
  - 100 % biomass ashes

Current utilization

- Cement replacement
- Concrete additive
- Asphalt additive
- Fertilizer
- Soil stabilization
- Mine stabilization
- *Disposal*

Potential (future) utilization

- Raw material compost production
- Soil improvement
- Road construction
- Landscaping
- Raw material in building industry
  - Cement clinker
  - Bricks
  - Synthetic aggregates
- Industry and Energy
  - Trace metal recovery
  - Filler in metals and polymers
  - Phosphor production

Bottlenecks

- Low market volumes
- Variation in ash quality
- Limitations by regulations
- Lack of knowledge on utilization options

End sheet

Thank you for your attention.

ACKNOWLEDGEMENTS

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