PROCESS CHEMISTRY CENTRE

ÅBO AKADEMI UNIVERSITY

Fate of ***Alkali metals*** during Co-combustion of ***Biodiesel Residues*** with ***Coal*** in a Semi-Industrial ***CFB*** boiler

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9th International Conference on CFBs,
May 2008, Hamburg - Germany

PRESENTATION OUTLINE

- INTRODUCTION
- EXPERIMENTAL SET-UP:
  - *fuel*
  - *boiler*
  - *tests*
- ALKALI METALS:
  - *in bottom ash*
  - *entering convective pass*
  - *in fly ash*
  - *distribution*
- CONCLUSIONS

INTRODUCTION

3.25 t

1.08 t

Rapeseed oil

Rapeseed cake

2.17 t

Source: ***S. Friedrich***

A worldwide review of the commercial production of biodiesel,Vienna University of Economics and Business Administration, Institute of Technology and Sustainable Product Management, Austria, 2004.

FUEL – rapeseed cake

Ash (at 550 C)	[% db]	7,5
HHV	[MJ/kg db]	22,2
LHV	[MJ/kg db]	20,7
C	[% db]	49,9
H	[% db]	6,9
N	[% db]	5,1
S	[% db]	0,7
O(calculated)	[% db]	29,9

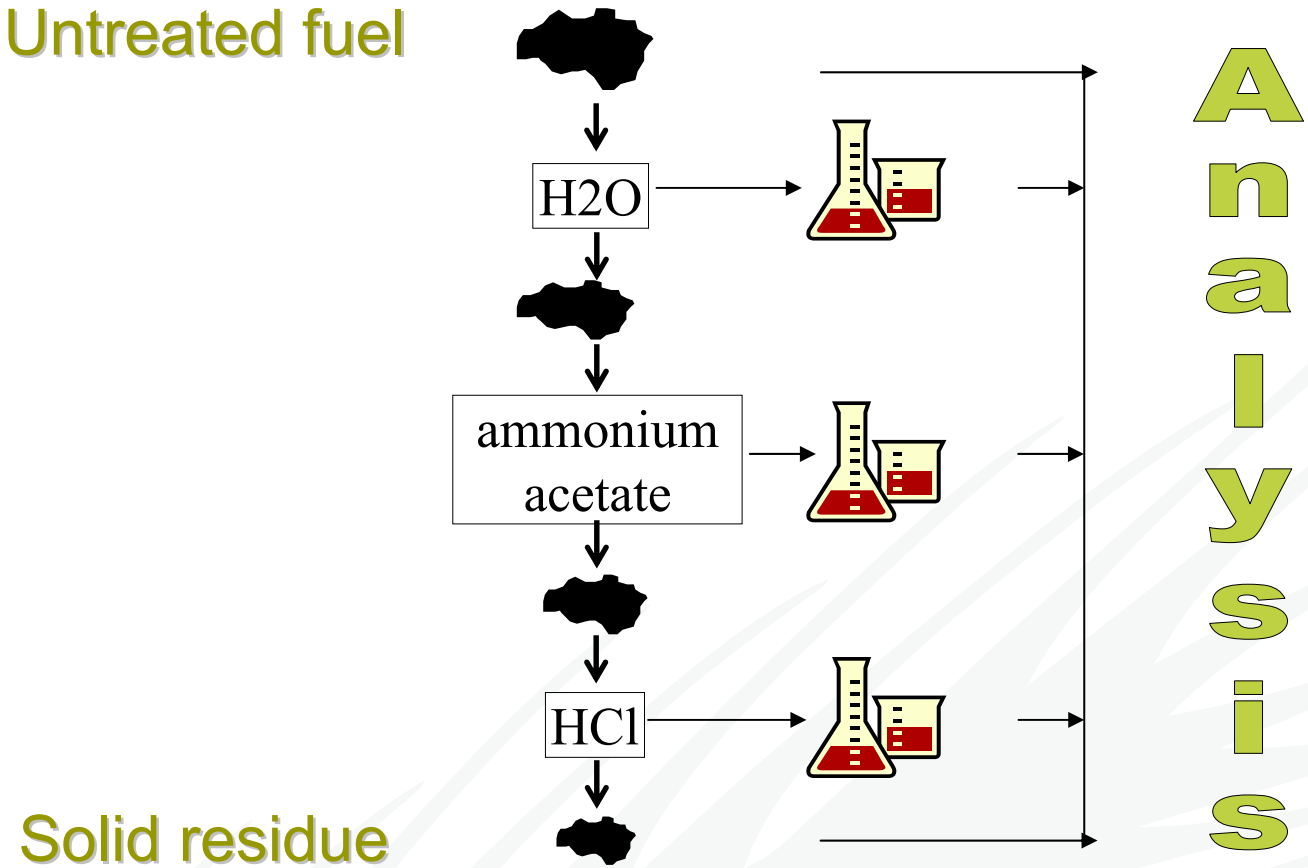
Si	[mg/kg db]	261
Al	[mg/kg db]	43
Fe	[mg/kg db]	152
Ti	[mg/kg db]	4
Mn	[mg/kg db]	60
Ca	[mg/kg db]	7040
Mg	[mg/kg db]	4500
P	[mg/kg db]	11500
Na	[mg/kg db]	4660
K	[mg/kg db]	12300
Cl	[mg/kg db]	2600

FUEL – coal

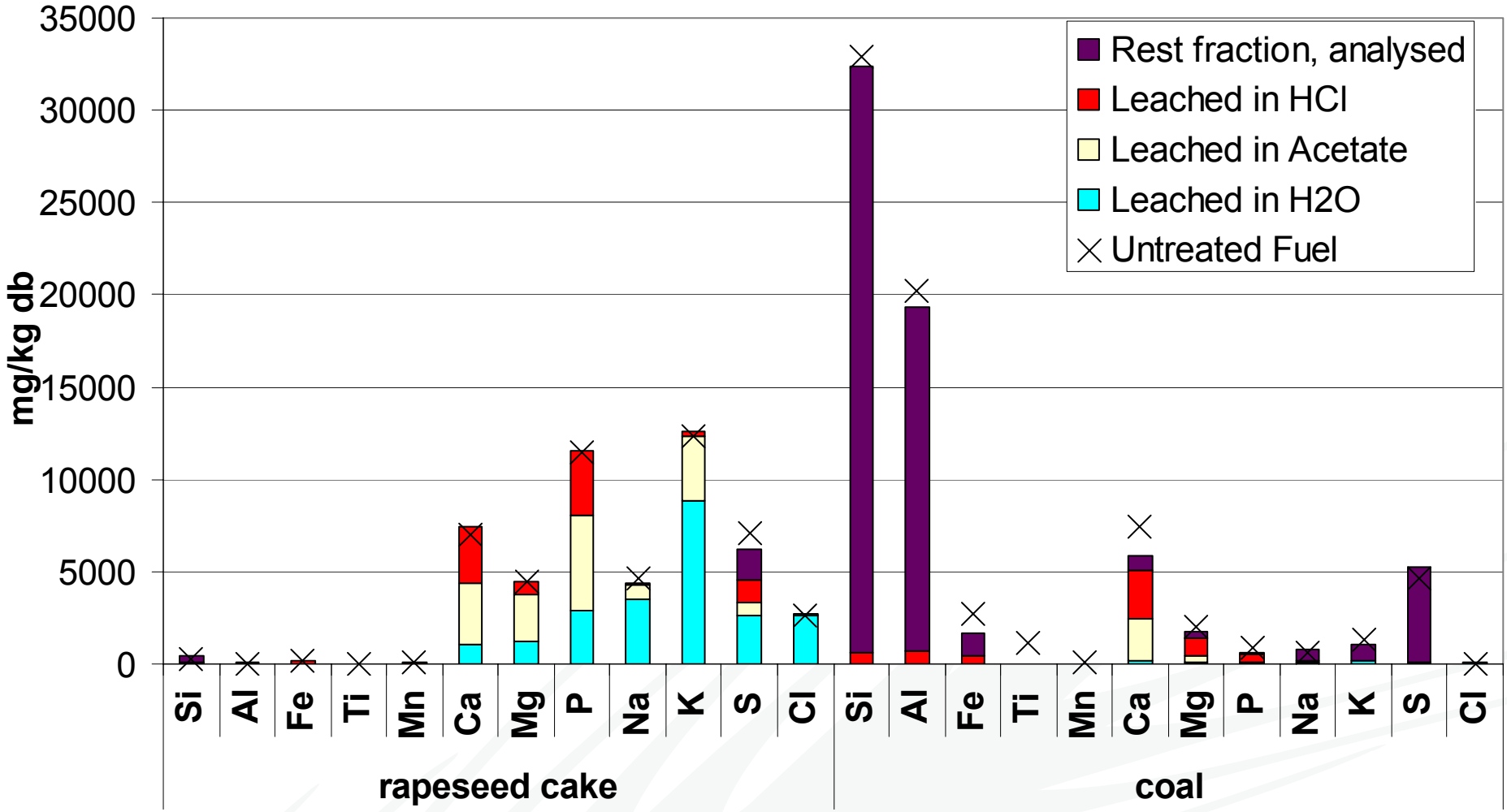
Ash (at 1000°C)	[% db]	14,0
HHV	[MJ/kg db]	28,0
LHV	[MJ/kg db]	27,1
C	[% db]	69,3
H	[% db]	4,4
N	[% db]	1,8
S	[% db]	0,5
O(calculated)	[% db]	10,0

Si	[mg/kg db]	32900
Al	[mg/kg db]	20200
Fe	[mg/kg db]	2690
Ti	[mg/kg db]	1180
Mn	[mg/kg db]	58
Ca	[mg/kg db]	7470
Mg	[mg/kg db]	2030
P	[mg/kg db]	915
Na	[mg/kg db]	637
K	[mg/kg db]	1310
Cl	[mg/kg db]	<500

Chemical Fractionation

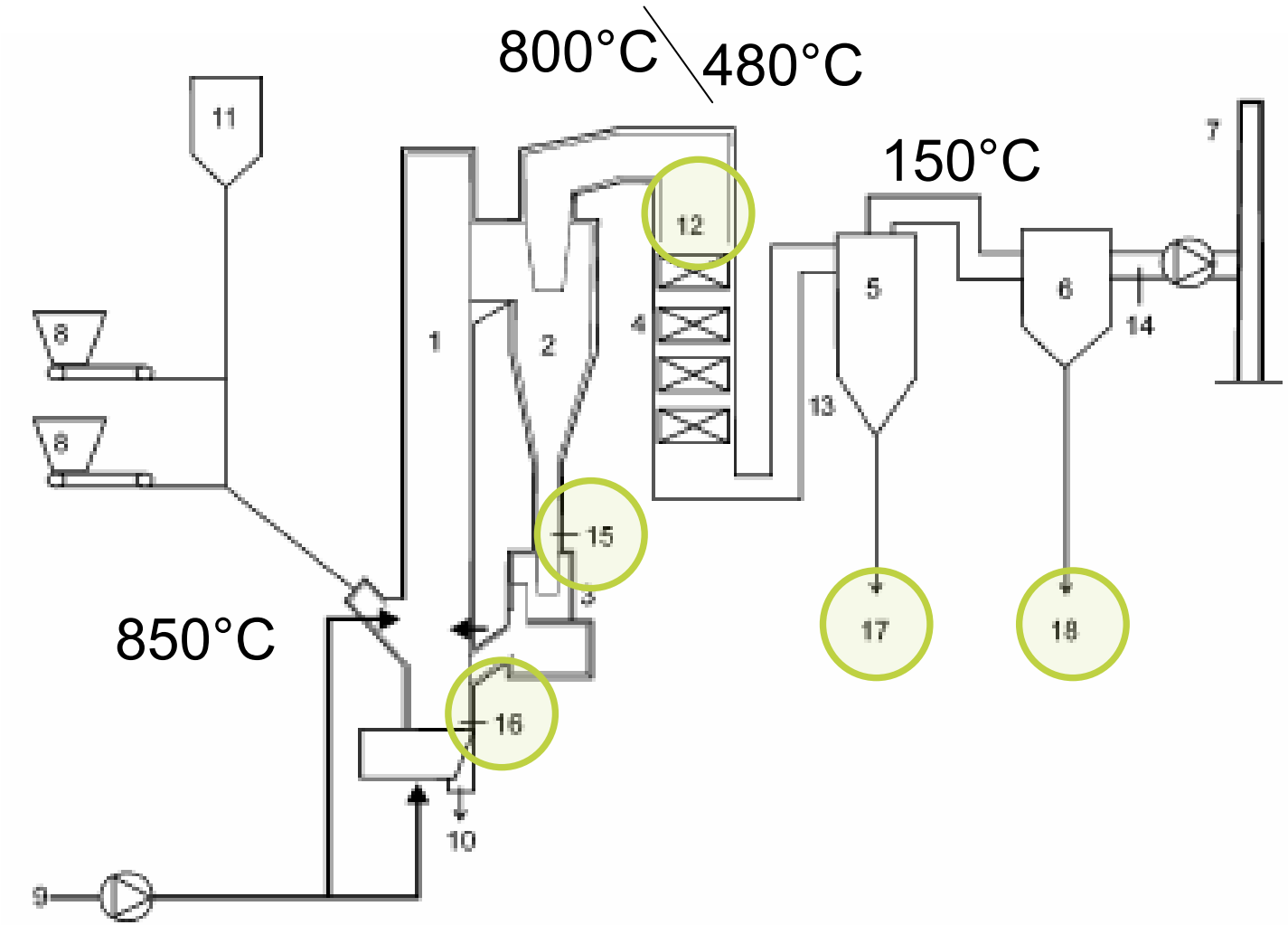


FUEL – Chemical Fractionation



BOILER

12 MWth CFB at Chalmers University of Technology

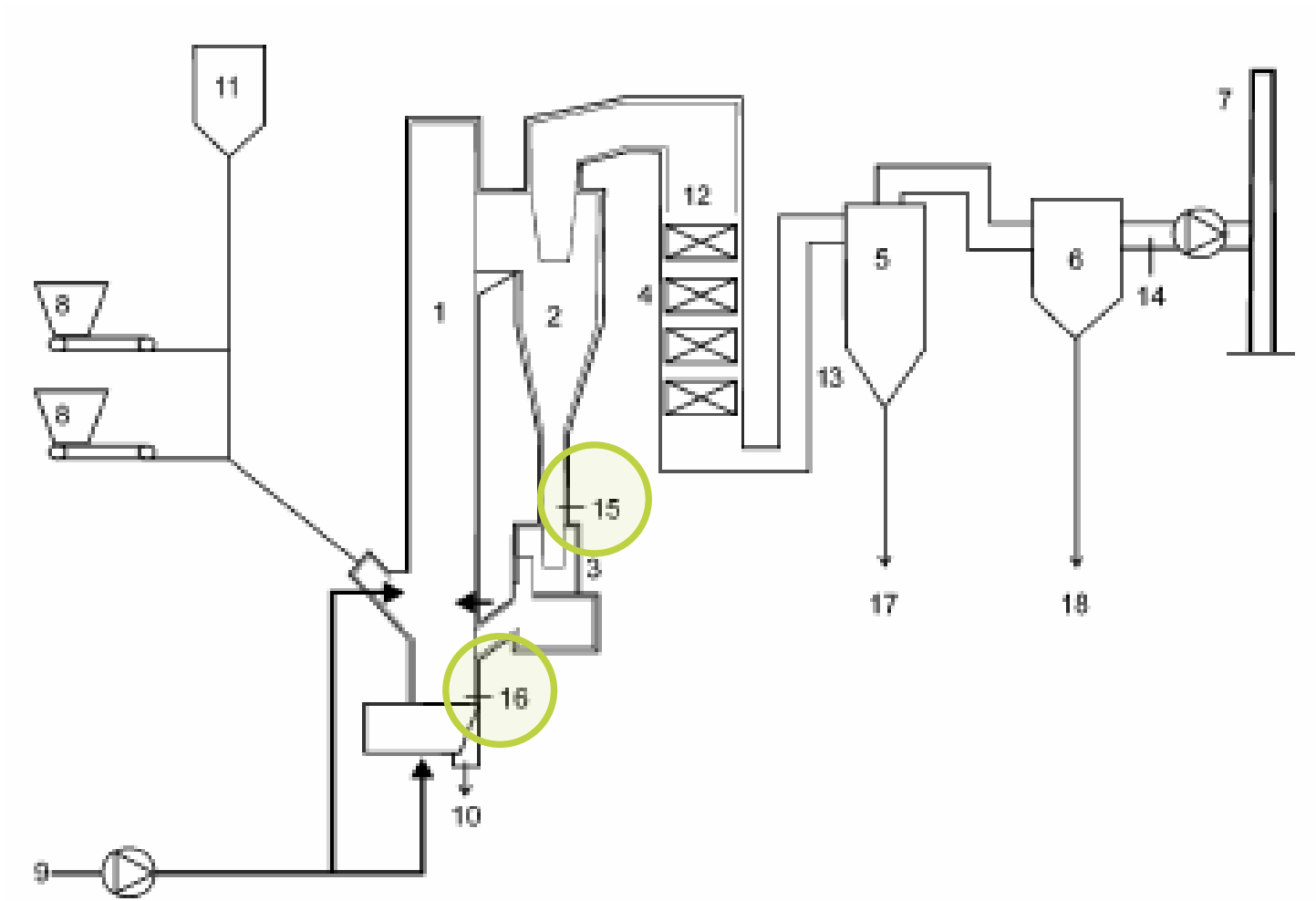


Source: ***M. Svane et al.*** *:*
Cesium as a Tracer for Alkali Processes in a Circulating Fluidized Bed Reactor, Energy & Fuels, 2006.

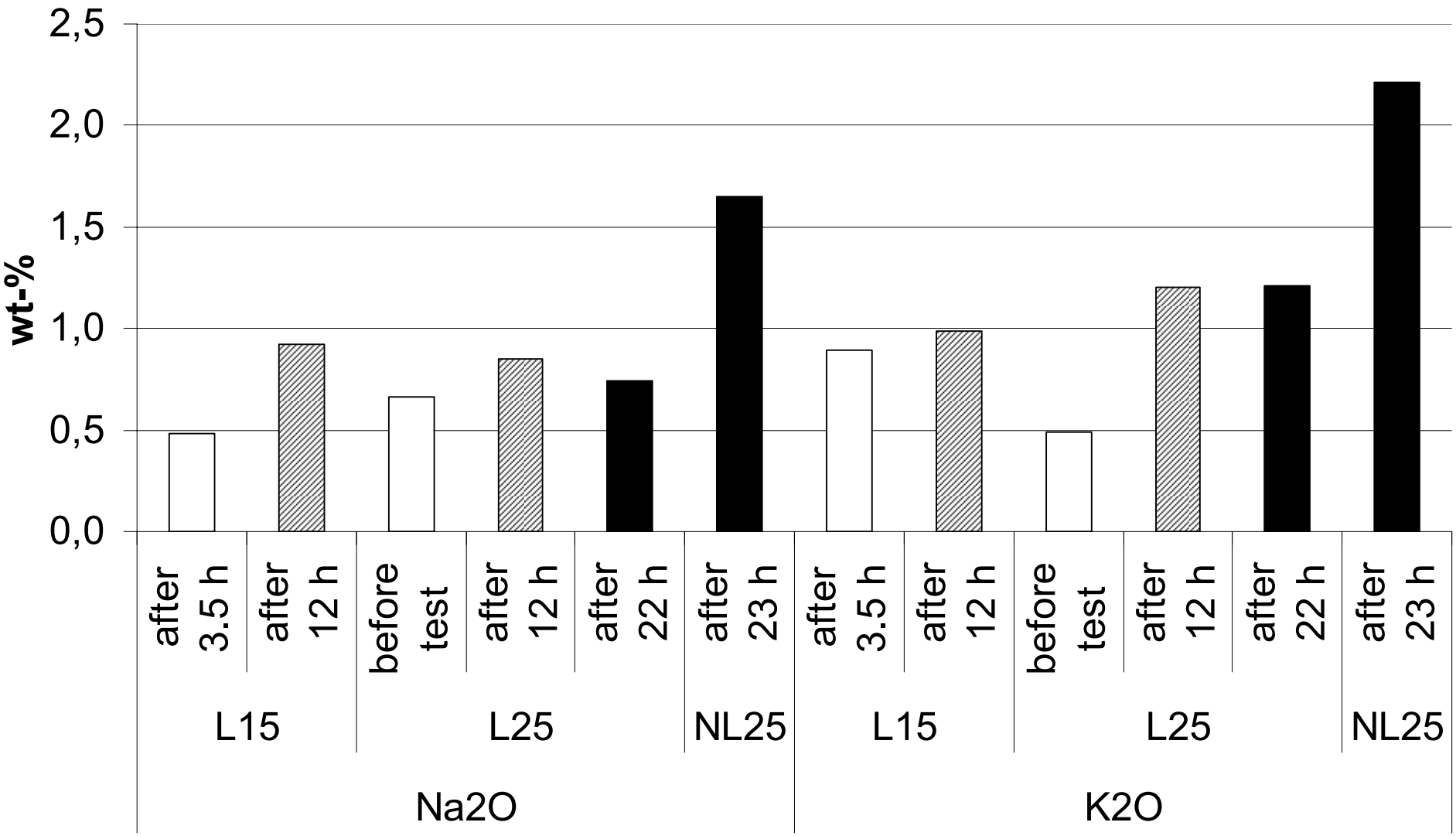
TESTS

	co-combustion with COAL		
	L15	**L25**	**NL25**
rapeseed cake ratio	*15%$_{en}$*	*25%$_{en}$*	*25%$_{en}$*
lime addition	*yes*	*yes*	*no*
test duration	*12h 25min*	*22h 16min*	*22h 53min*

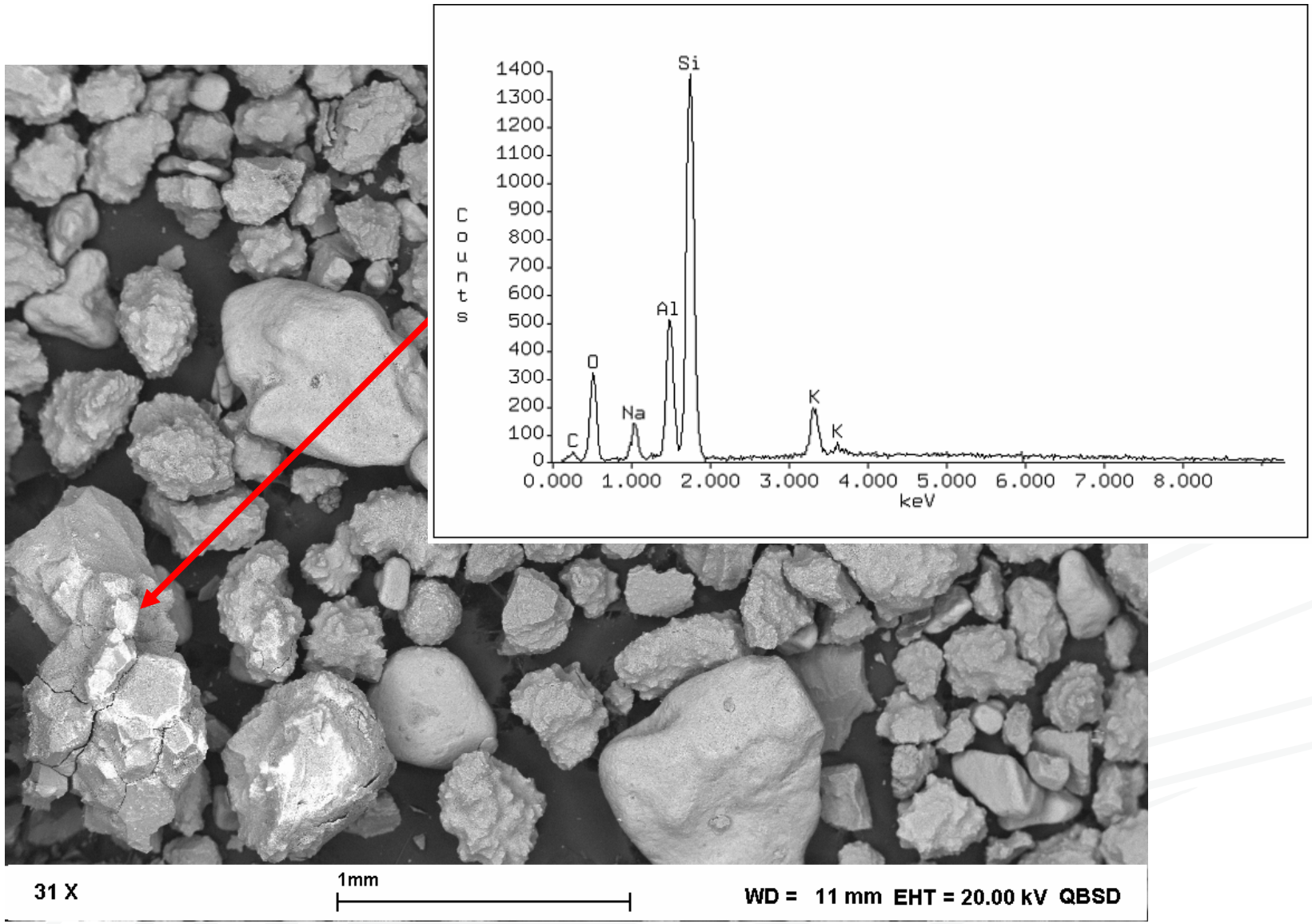
BOTTOM ASH



BOTTOM ASH

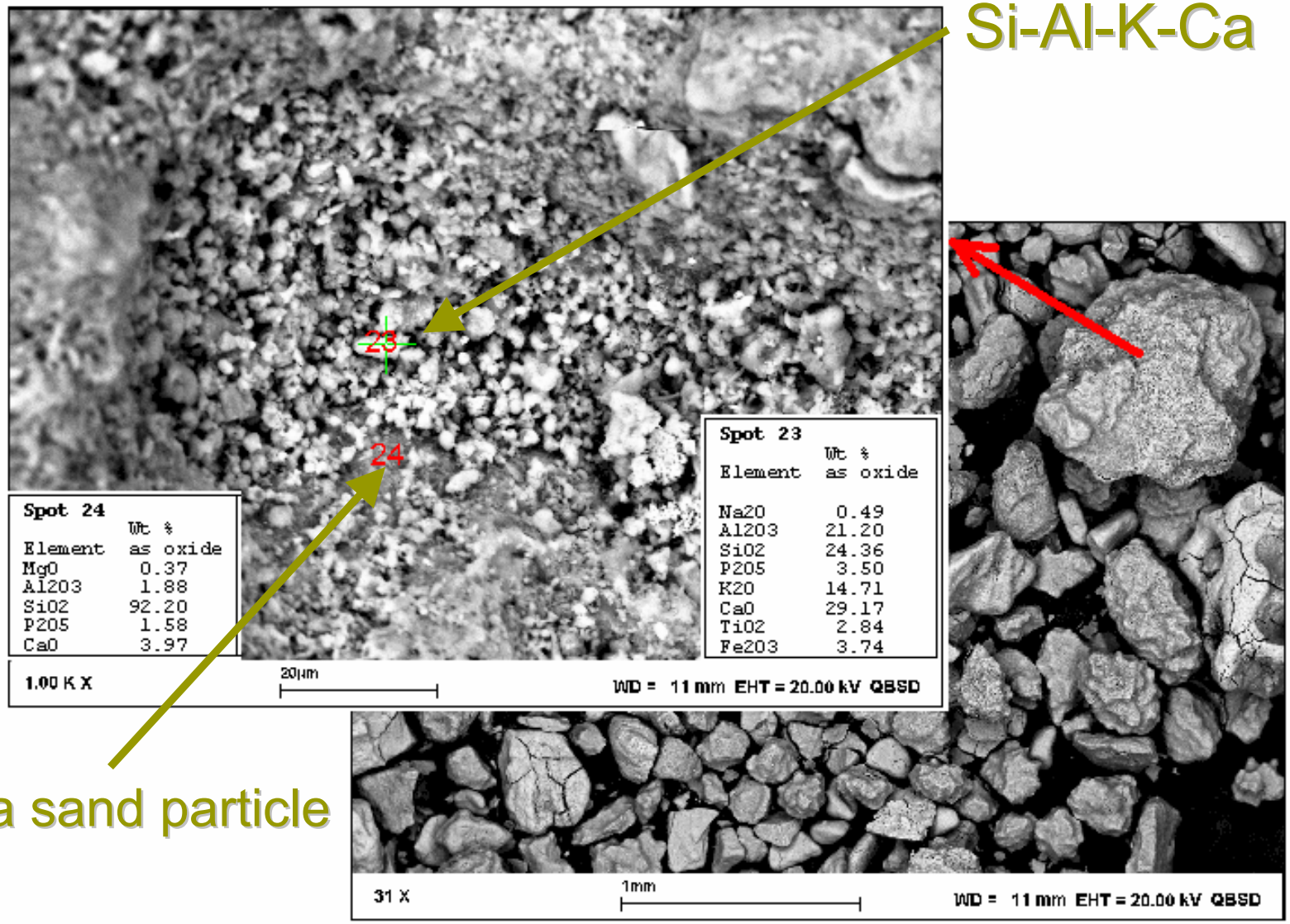

2,5
2,0
1,5
1,0
0,5
0,0
wt-%
after 3.5 h
after 12 h
before test
after 12 h
after 22 h
after 23 h
after 3.5 h
after 12 h
before test
after 12 h
after 22 h
after 23 h
L15
L25
NL25
L15
L25
NL25
Na2O
K2O

BOTTOM ASH



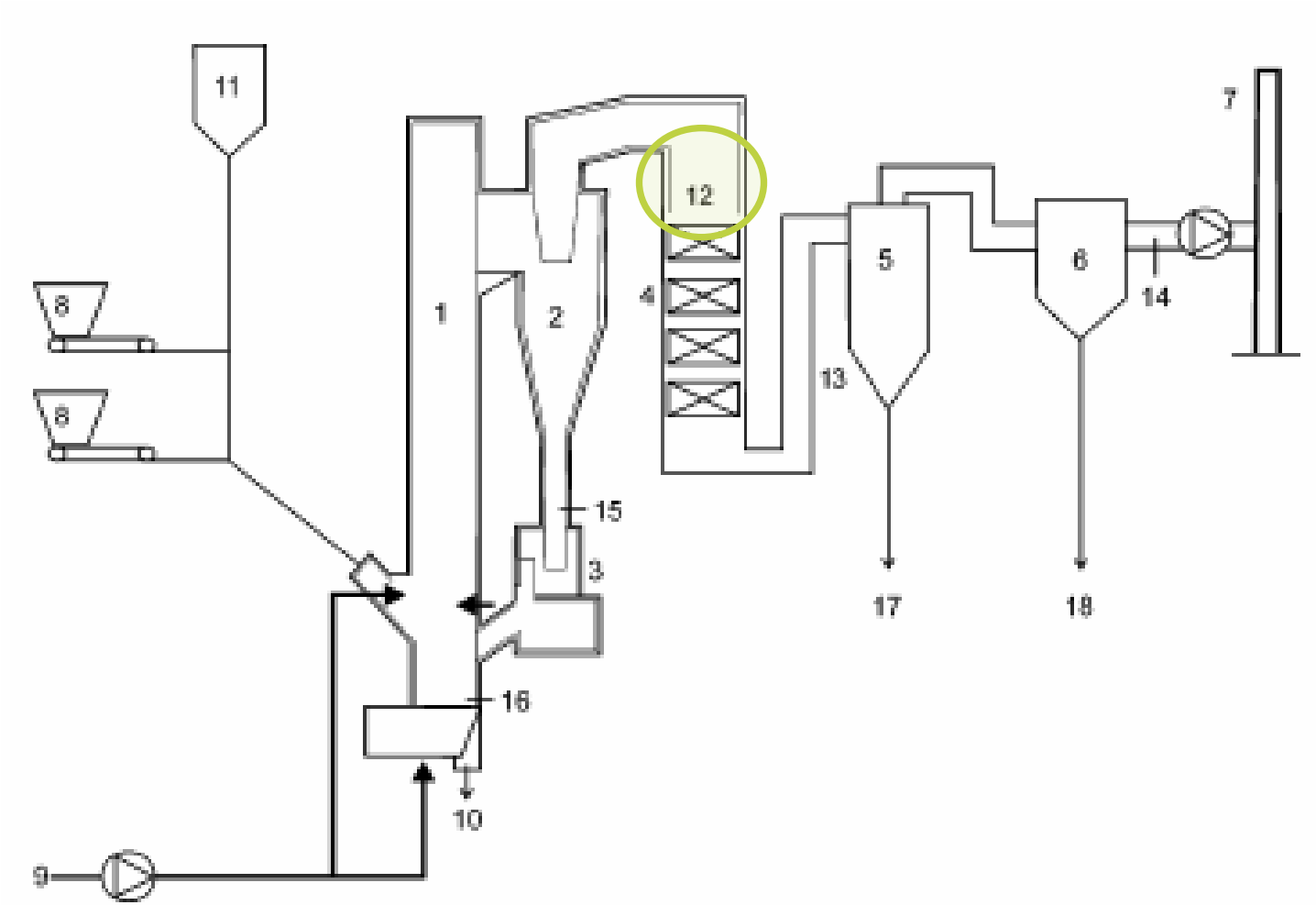
Bed material sample taken after 7.5h of test NL25

BOTTOM ASH



Cyclone leg sample after 7.5h of test L25

CONVECTIVE PASS



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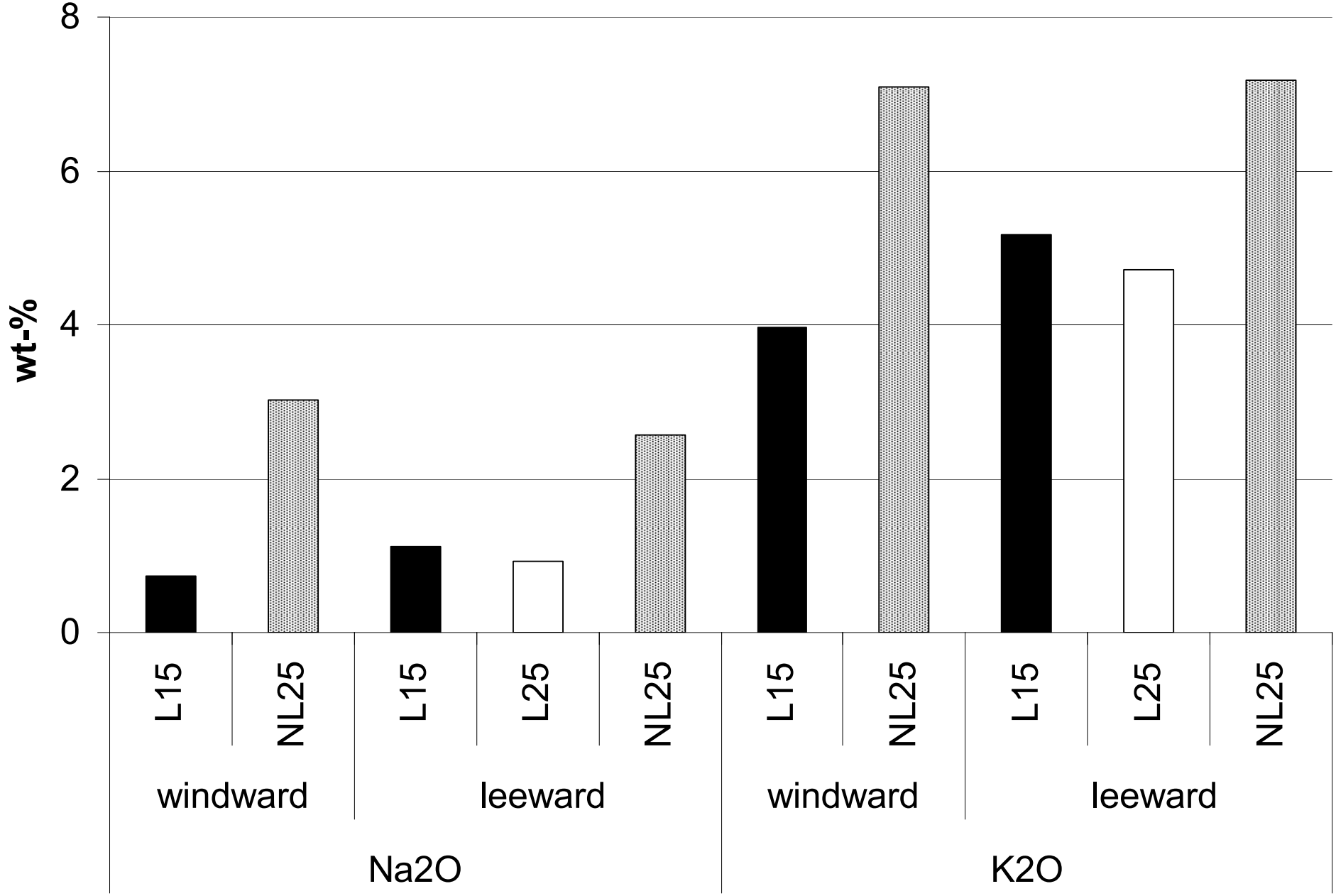

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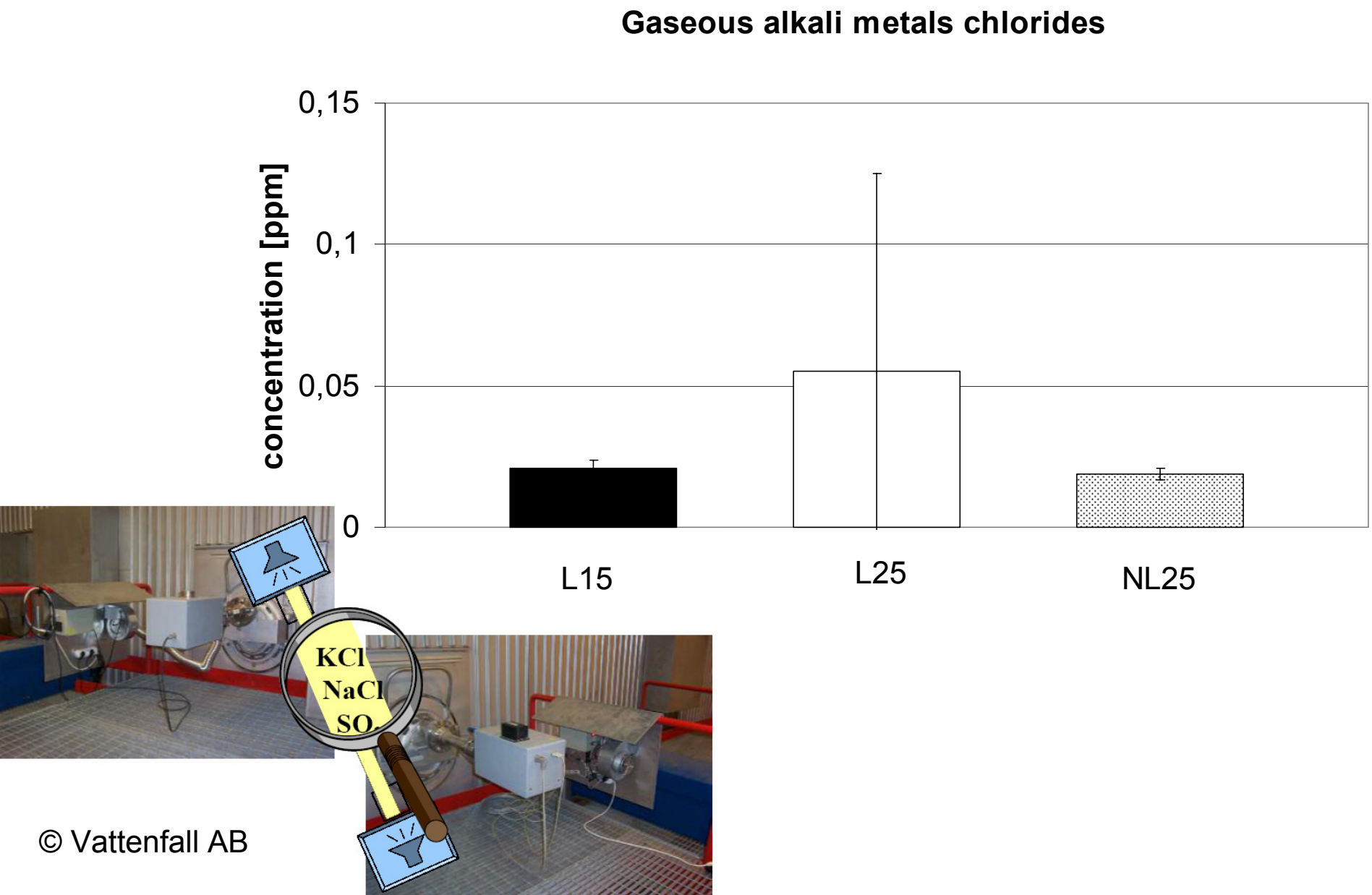
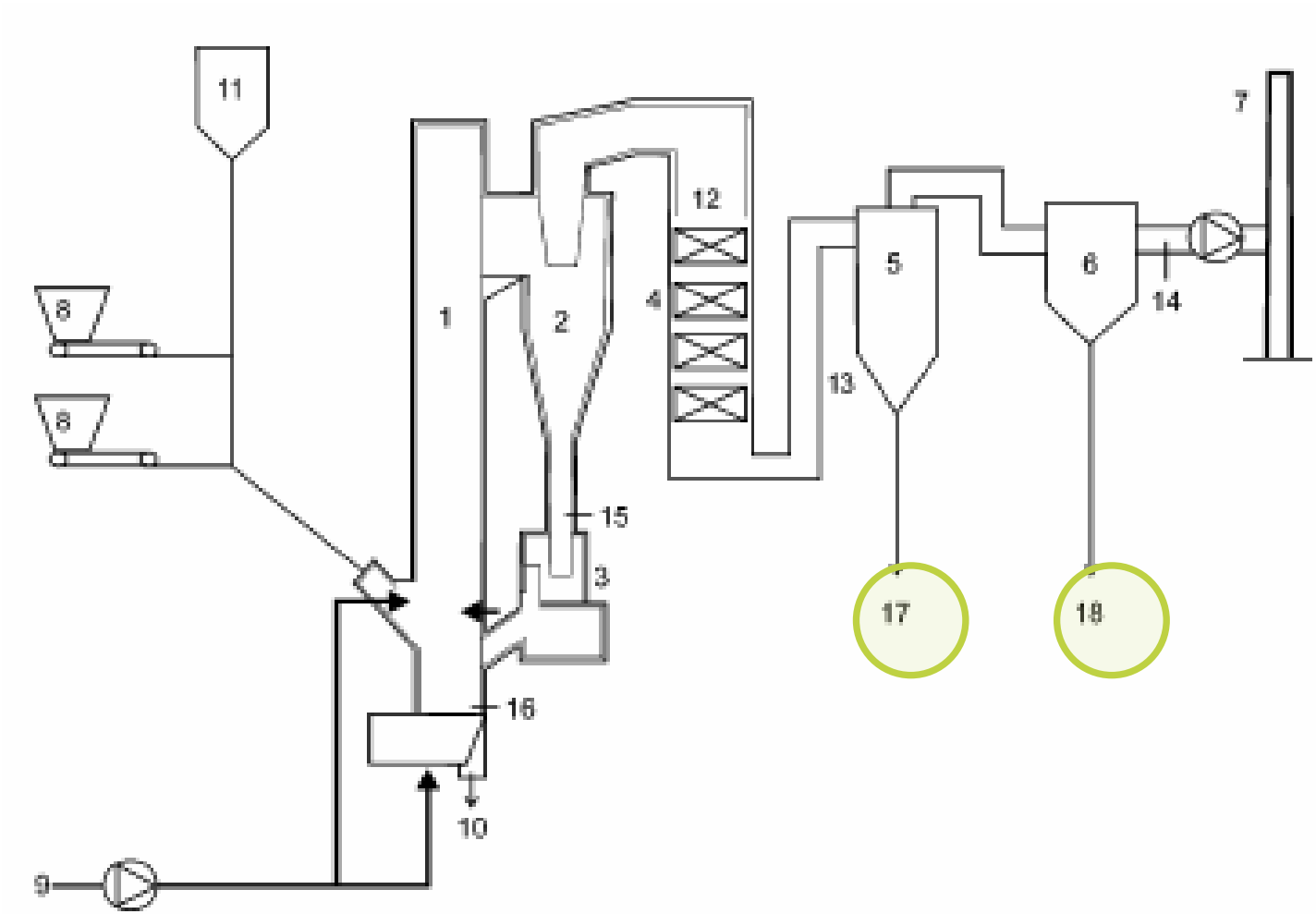
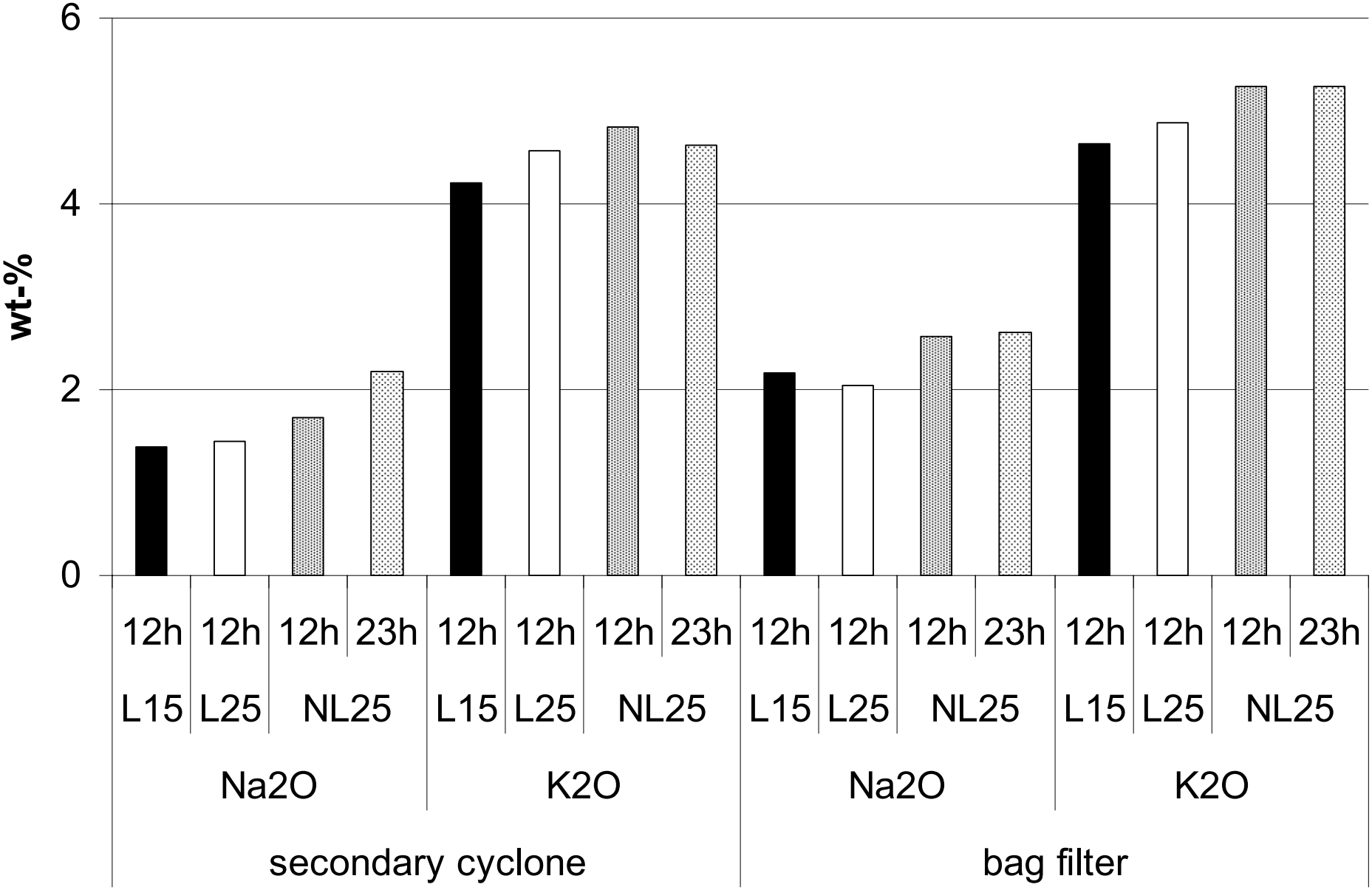


FLY ASH



FLY ASH


6
4
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wt-%
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L15
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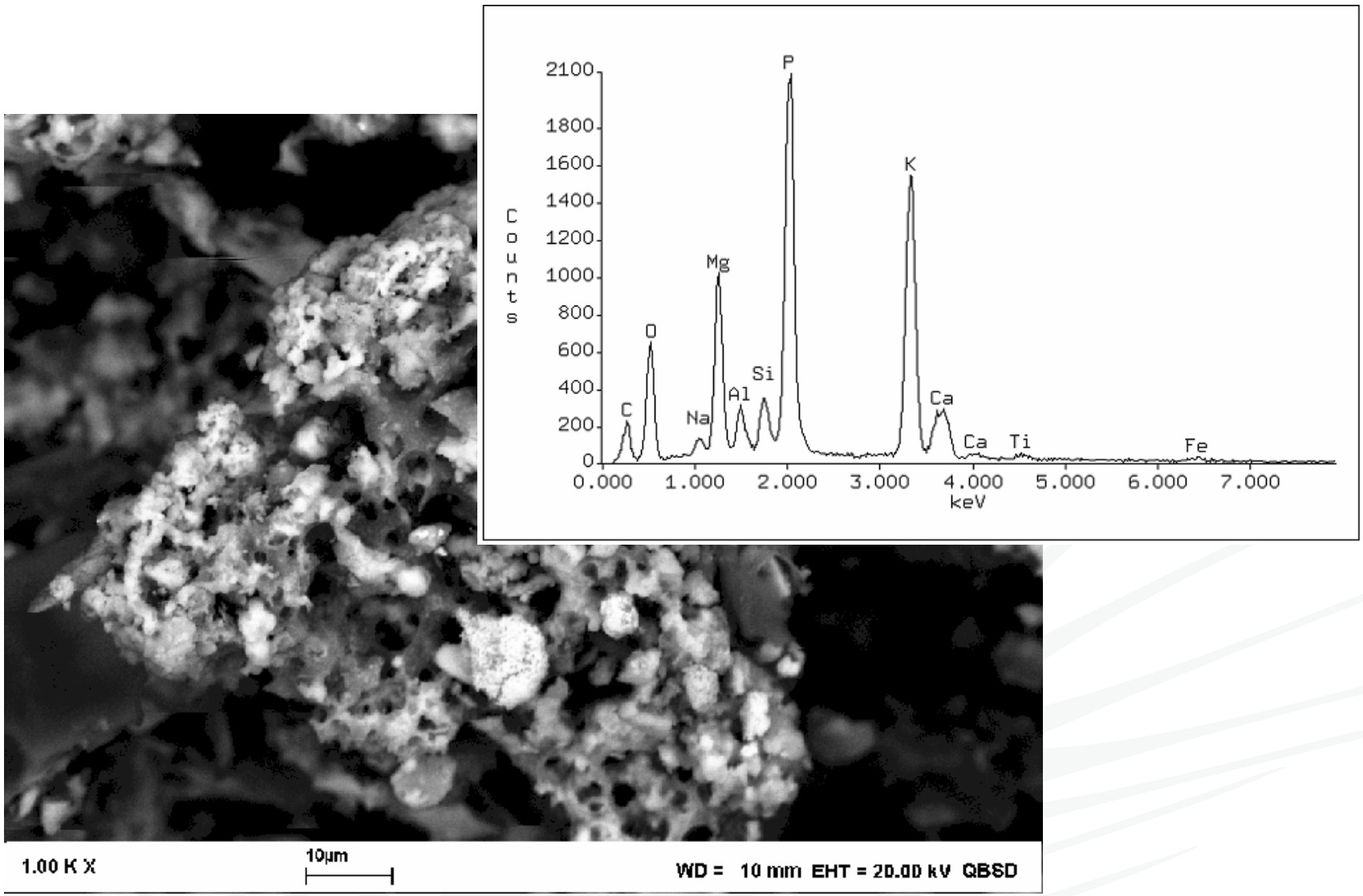
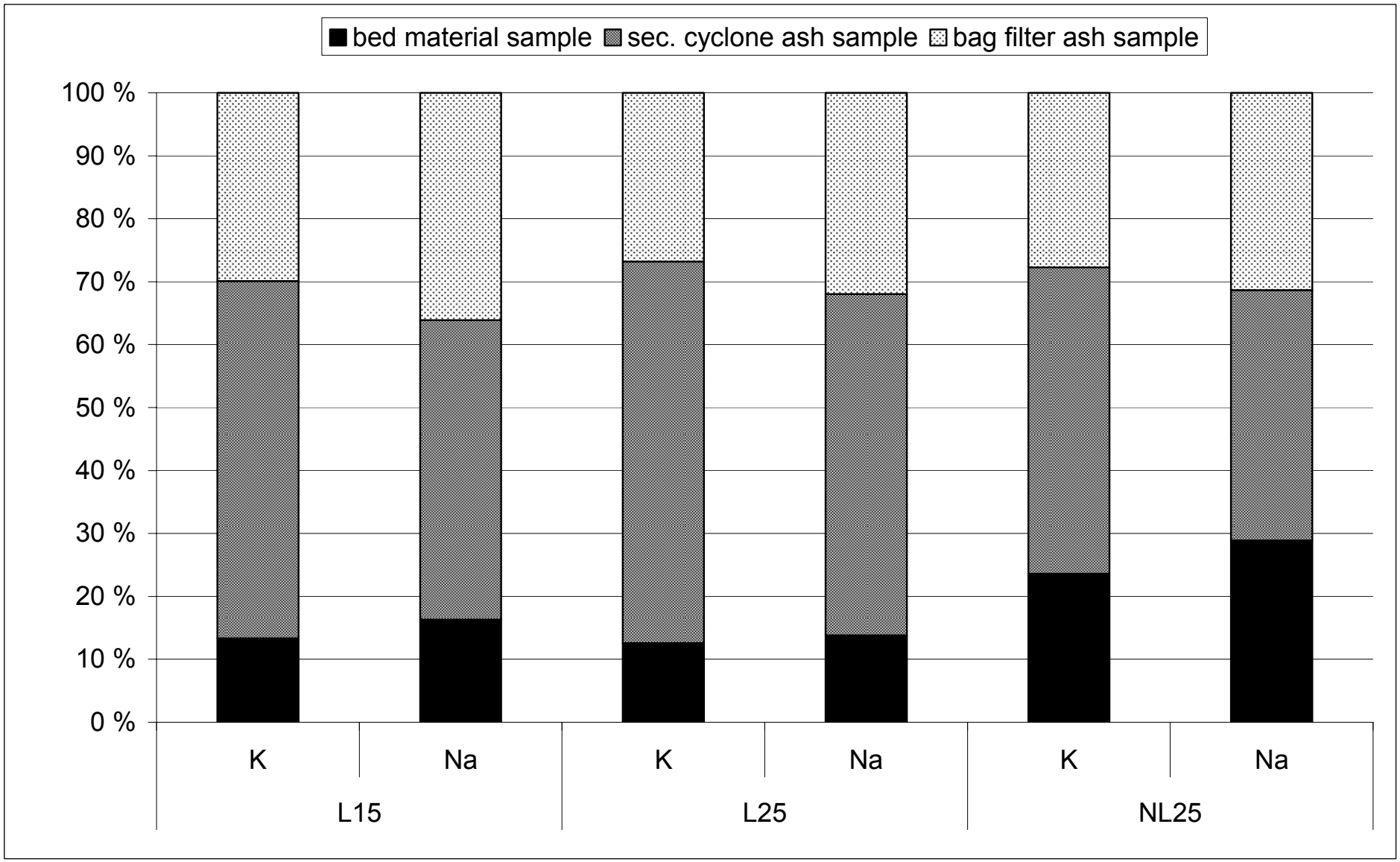
NL25
L15
L25
NL25
L15
L25
NL25
L15
L25
NL25
Na2O
K2O
Na2O
K2O
secondary cyclone
bag filter

FLY ASH



Secondary cyclone ash particle after 11.5h of test L15

ALKALI DISTRIBUTION



CONCLUSIONS

- Successful co-combustion of **up to 25%$_{en}$ rapeseed cake** with **coal** (48hours)
- Alkali metals major part found in fly ash fraction – secondary cyclone
- About 20% of alkali metals trapped in the bed
- Alkali metals leaving combustion chamber as: **alumino-silicates, phosphates, sulphates**
- Gaseous alkali metals chlorides – **below 1 ppm**
- **No heavy bed sintering or deposits** were noticed

ACKNOWLEDGEMENTS

- Finnish Funding Agency for Technology and Innovation (TEKES)
- Graduate School in Chemical Engineering (GSCE)
- Centre of Excellence program by the Academy of Finland (PCC)

Special thanks to:

- *Matti Hiltunen*
- *Staff of Inorganic Chemistry Laboratory*

  at Åbo Akademi University
- *Operational staff of CFB boiler*

  at Chalmers University of Technology