RESEARCH REPORT

VTT-R-04453-13/EN

In-furnace measurements at Rauman Voima Oy biomass power plant and at Stora Enso Oyj Anjalankoski power plant

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Summary

In this study new information has been produced by field experiments at Rauma and Anjalankoski power plants on alkali and heavy metal concentrations in the particle and gas phase of the furnace. The experiments have been focused to determine corrosive species in the superheater section. Data on elemental concentrations in furnace have been collected by impactor measurements and in the case of Anjalankoski power plant also by continuously operating Corrored alkali analyzer and KCl-laser analyzer.

The studies aim to simplify the sampling of particles, to decrease analysis costs, and to develop a reliable sampling method. A long term goal in MMEA research program is to develop cost-effective methods and devices for in-furnace real-time particle analysis.

Confidentiality	Confidential

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1. Introduction

The In-furnace task of the work package 4.2.2 is related to the main themes of the MMEA research program, namely, the development of new monitoring methods and their demonstrations in production scale power plants. The In-furnace task produces information which can be utilized by energy producers, boiler manufacturers, measurement device manufacturers and monitoring service companies.

In this task we have continued the activities started already in the FP1 for the sampling of gases and particles from a boiler´s superheater section and for the real time analysis of particles. In this FP2 task we have been developing methods for the collection of gas and particle samples at 700-1000 °C temperature in the superheater section.

The field experiments have been carried out in cooperation with VTT, Metso Power Oy and the power plants. During FP2 the measurement sites were the biomass power plant of Rauman Voima Oy and the power plant of Stora Enso Oyj at Anjalankoski.

2. Field experiment at Rauman Voima Oy biomass power plant on 14.-21.3.2012

2.1 General

The preliminary goals of the field experiments were as follows:

- the real time particle analysis by VTT´s ICP-AES device
- comparison of the results with the results of a 5-stage impactor
- the elemental concentration to be determined: alkali and heavy metals
- gas analysis by FTIR
- sampling at superheater section with T > 1000 °C
- two fuel mixtures: with peat and without peat

VTT´s task was to arrange the sampling system, to run the ICP-AES device, to carry out the gas measurements, and to operate the 5-stage impactor and to make the calculations for elemental concentrations.

Later the plans were changed so that the use of the ICP-AES device in plant conditions was postponed. The ICP-AES device was tested in laboratory conditions and the related sampling was tested at Anjalankoski power plant.

The actual field experiment was decided to be carried out as follows:

- a profile measurement with a 5-stage impactor and with 2 FTIR analyzers will be done at Rauman Voima Oy`s HK6 boiler
- the sampling for FTIR measurements will be performed during the impactor sampling, and HCl and SO_2 will be analysed at the second draw
- the fuel matrix will be as follows (appendix 1.):
    - during the 1. measurement day the mixture is bark+forest converted chips+sludge+REF, the share of peat corresponds to 15% of total energy input, no meat-bone powder
    - during the 2. measurement day the mixture is bark+forest converted chips+sludge+REF, no peat, no meat-bone powder, minimum amount of sludge.

Figure 1. shows a schematic view of the biomass power plant of Rauman Voima Oy and the locations for temperature measurements. The new 120 MW boiler utilizes sludge from a pulp and paper factory and also bark and peat. In addition to these, the plant utilizes also recovered fuel (REF), logging residue, and cast-off railway sleepers. Fuel oil is used as start-up and reserve fuel.

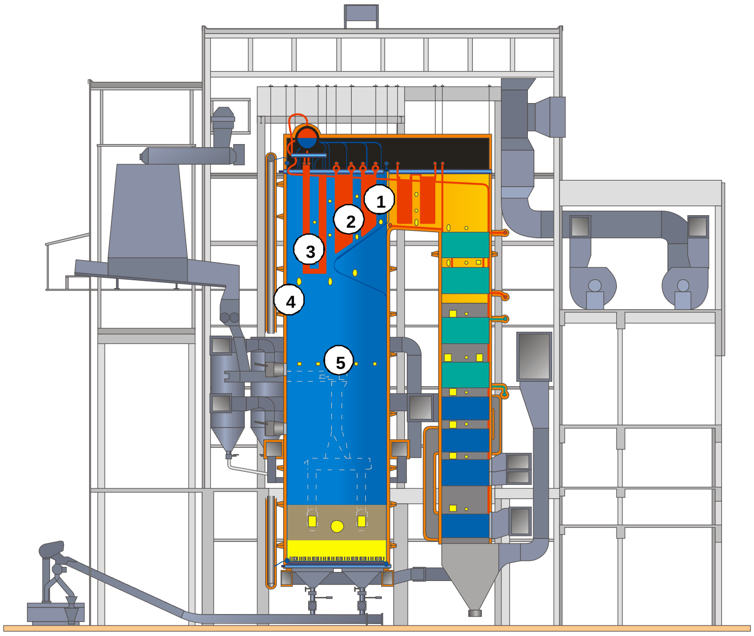


Fig.1 Biomass power plant of Rauman Voima Oy. The temperature measurement locations are indicated by numbers 1 to 5.

Table 1. shows the fuel characteristics as classified to Bio, REF and Peat proportions in %. A detailed plan for the field measurement is shown in the appendix 1, the field book is given in the appendix 2. The results of the particle analyses is shown in the appendices 5 and 6.

Table 1. The fuel characteristics during the experiments.

Fuel	Bio	REF	Peat
15.3.2012	75	10	15
20.3.2012	90	10	

Location	Flue gas temp
1	~300
2	460
3	750
4	900
5	950

	Höyry kg/s
15.3	30
20.3	35

The 5-stage impactor sampling locations and FTIR sampling location in the second draw are shown in Fig. 2 The numbering in Fig. 2 corresponds to numbering in the appendix 2. (Note: the order in numbering differs from that in Fig. 1)

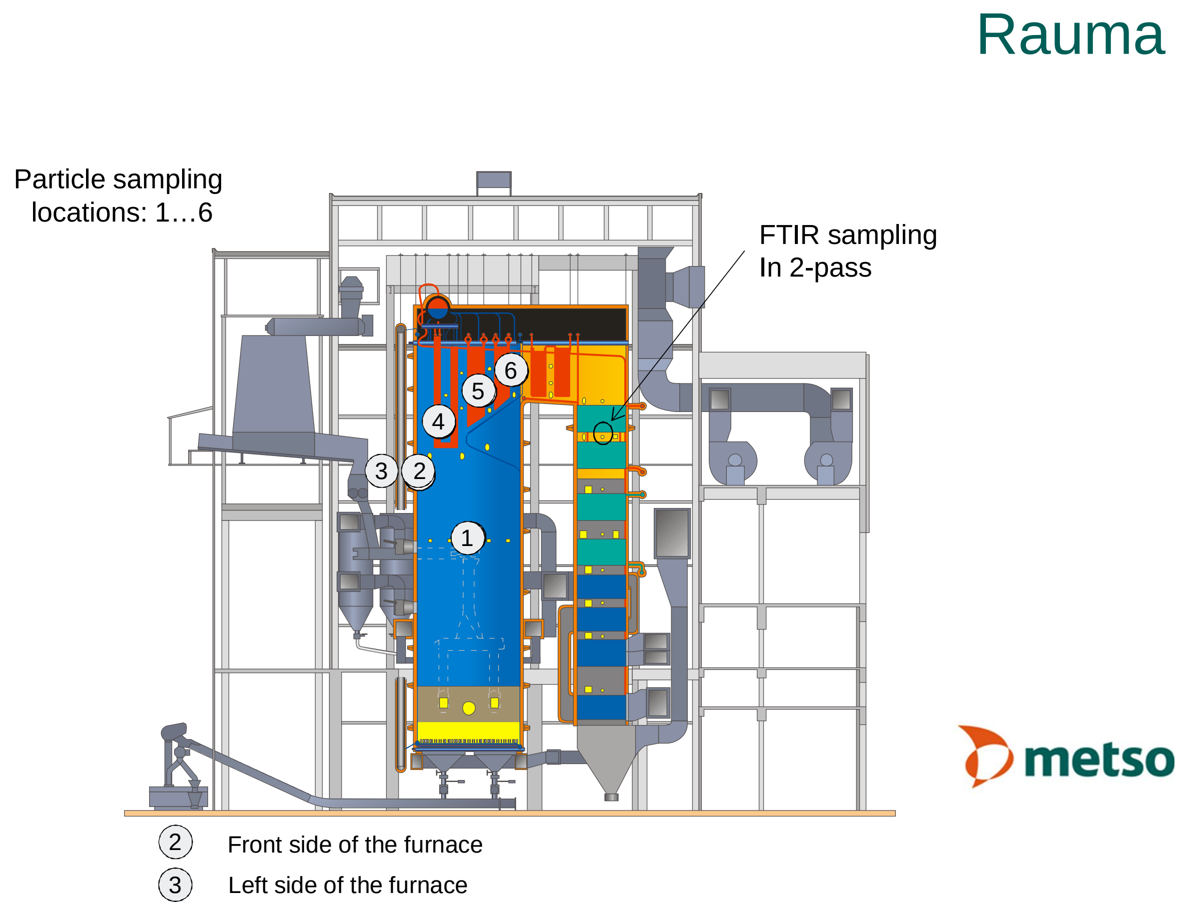
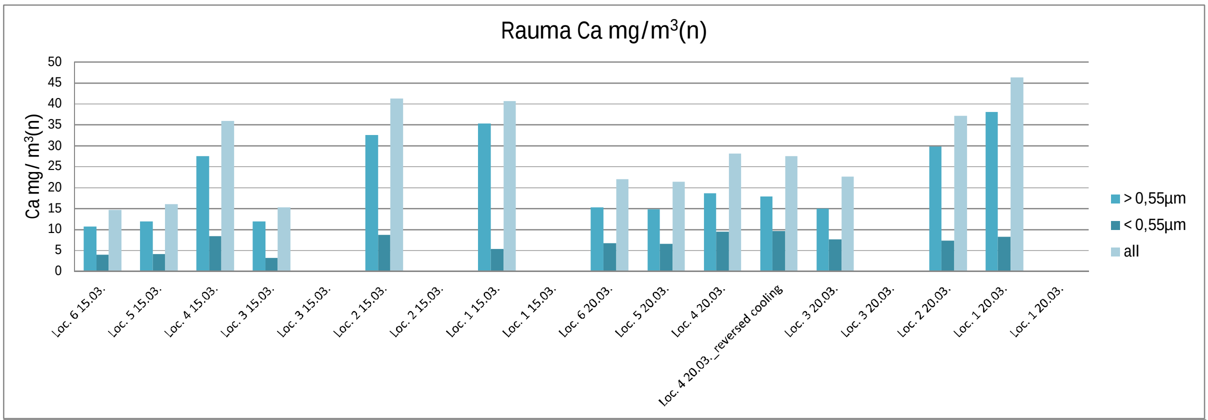
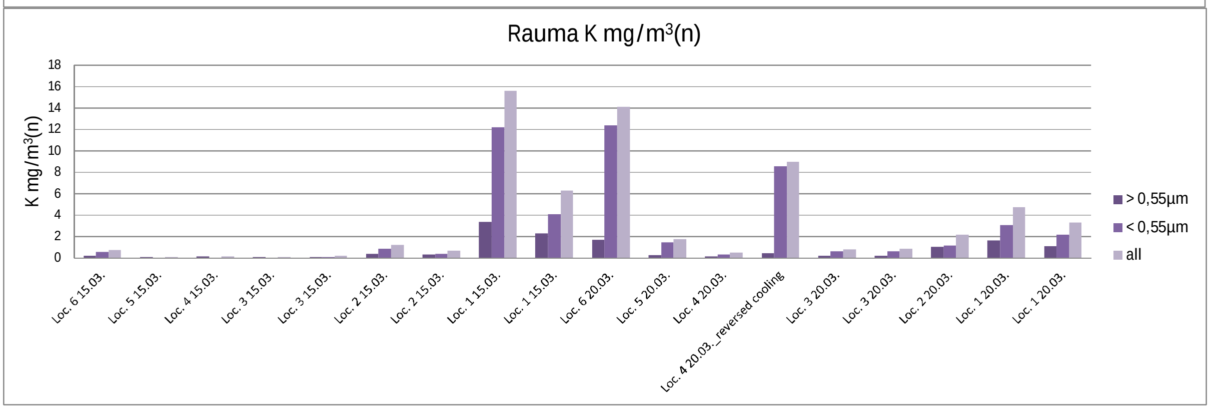


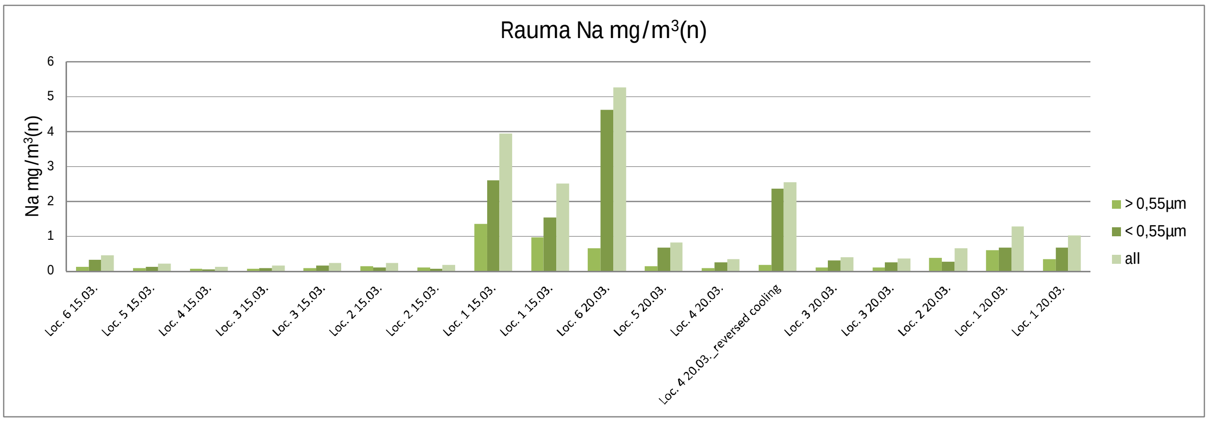
Figure 2. The biomass power plant of Rauman Voima Oy. The particle sampling locations are indicated by 1-6, and the FTIR sampling location in the second draw is indicated by an arrow.

2.2 The analysis of impactor samples

The results of the impactor measurements are shown graphically in Fig. 3. The elemental concentrations (mg/m[3](n)) are shown in two particle size classes: over 0.55 µm and below 0.55 µm.







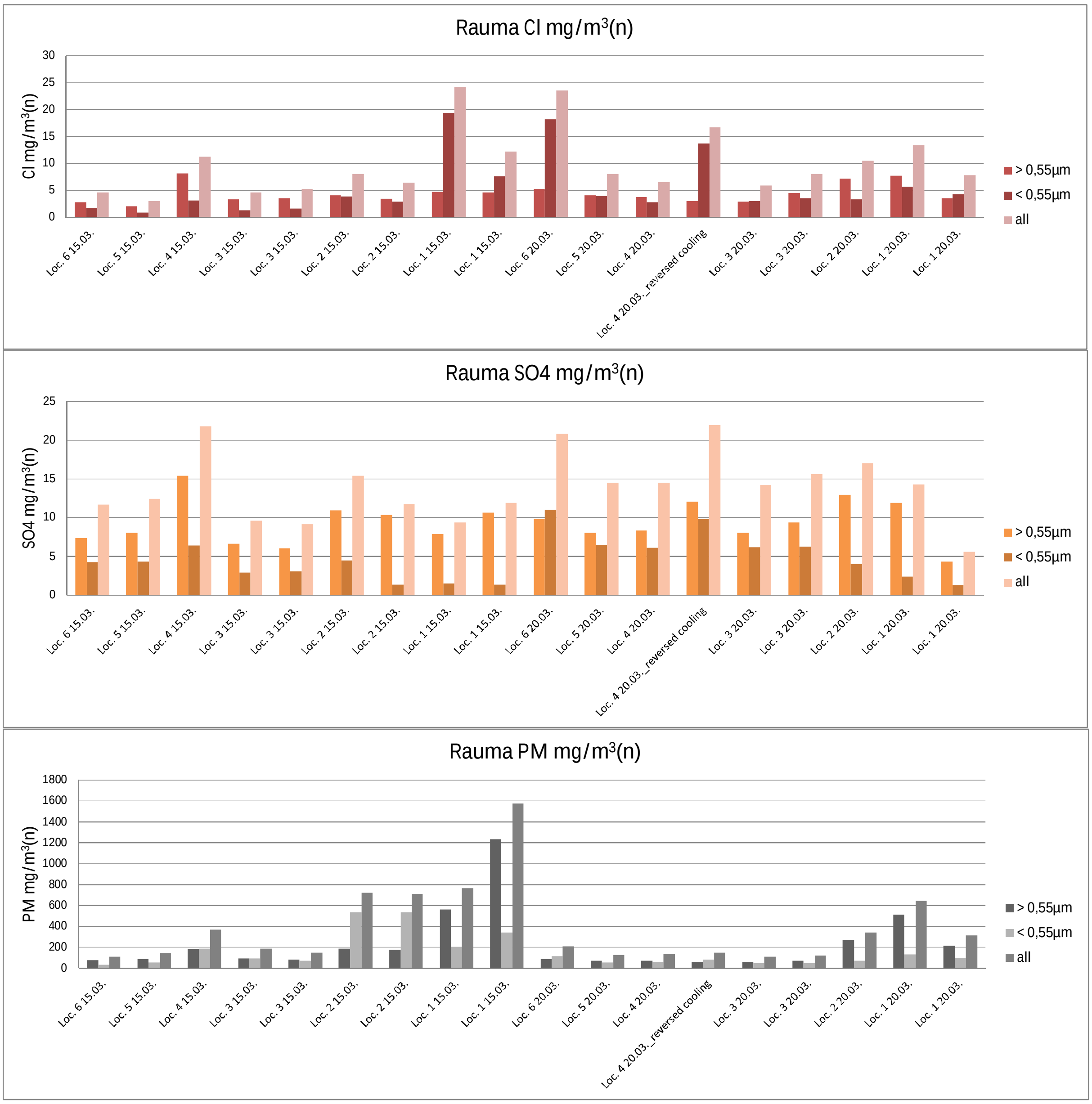


Figure 3. The results of the 5-stage impactor measurements. Biomass power plant of Rauman Voima Oy 15.3.2012 and 20.3.2012.

The uppermost figure shows that Ca is mainly in the larger particle size class. K and Na are both in the lower size class and, moreover, their concentrations are larger at the lower part of the boiler. However, the result obtained at the location 6 on the 20.3.2012 experiment is a significant deviation of this trend for both elements. The distribution of Ca, K and Na to different size classes corresponds to the results obtained in earlier experiments /1., 2., 3./.

There is an increasing trend also in Cl concentration when going downwards in the boiler. The distribution of Cl and S in different size classes deviates from a typical situation where both elements are in < 0.55 µm size class /1., 2., 3./. However, it is known that S can be also present in larger particles if calsium sulphite is formed /4./.

2.3 Experiments on sampling efficiency and losses

During the experiments at Rauman Voima Oy the particle sampling efficiency was tested by changing the direction of the cooling circulation of the sampling probe. As a consequence of changing the direction of the cooling air flow the temperature of the sample gas increases near the sampling probe inlet. As Fig. 3 shows the concentrations of K, Na and Cl increase significantly, and there is also a small increase in the concentration of S. There was no increase in the concentration of Ca which ís mainly in the larger particle size class. There was no change in the total particle concentration. The results are shown in Fig. 4.

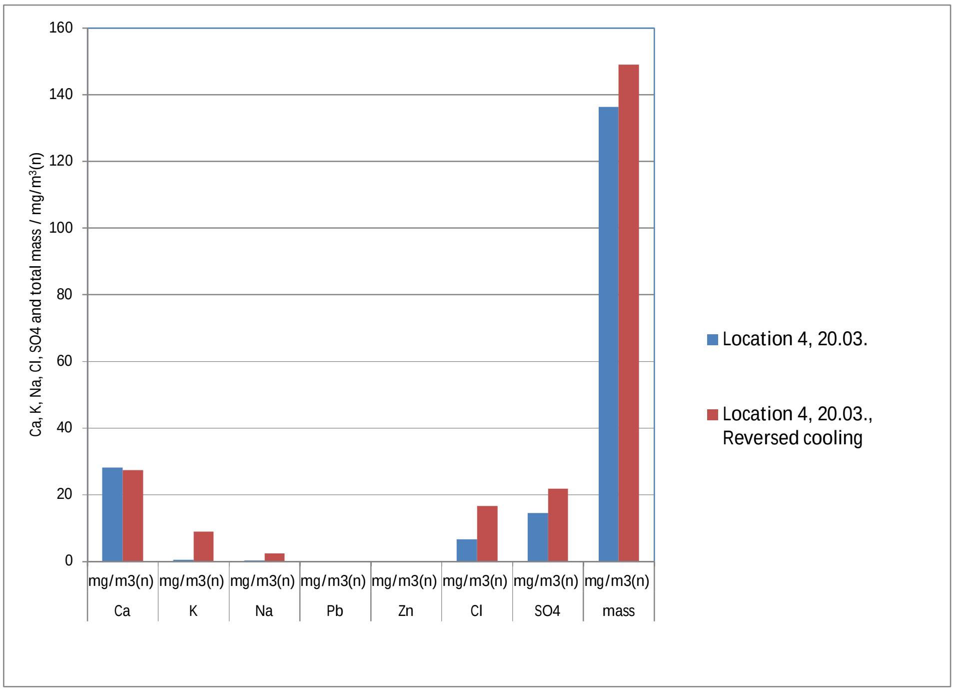


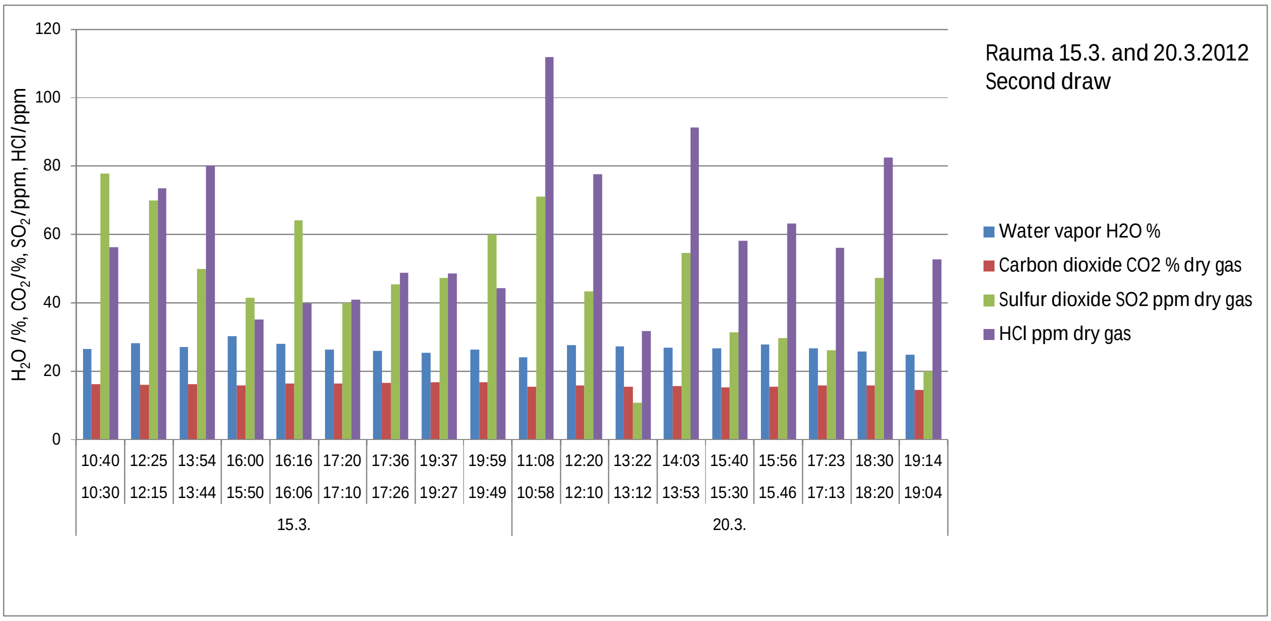
Figure 4. The test on the effect of changing the direction of the cooling circulation. The figure shows the concentrations of the elements Ca, K, Na, Cl, and SO_4. Rauman Voima Oy, 20.3.2012

The preliminary conclusion was that the change of the flow direction has an effect on the efficiency of particle sampling. Table 2. summarizes the FTIR results from the furnace and from the second draw. These results indicate, however, that SO_2 and HCl concentrations change significantly on the 20.3.2012 at 11-15 o´clock, and also on the 15.3.2012 at 12-16 o´clock. During the experiment at the location 4 on the 20.3.2012 SO_2 and HCl concentrations increase by a factor 2 or 3 both in the second draw and in the furnace.

These results show that the combustion process itself has changed significantly during the experiments. So we cannot be sure that the chance of the direction of the cooling flow would have caused the changes in the concentrations shown in Fig. 5.

Table 2. FTIR results from the second draw and from the furnace

Summary: Rauma March 2012																				
Second draw		**date**	15.3.									20.5.								
Concentration in dry gas		**start at**	10:30	12:15	13:44	15:50	16:06	17:10	17:26	19:27	19:49	10:58	12:10	13:12	13:53	15:30	15.46	17:13	18:20	19:04
		stop at	10:40	12:25	13:54	16:00	16:16	17:20	17:36	19:37	19:59	11:08	12:20	13:22	14:03	15:40	15:56	17:23	18:30	19:14
			10 min average	10 min average	10 min average	10 min average	10 min average	10 min average	10 min average	10 min average	10 min average	10 min average	10 min average	10 min average	10 min average	10 min average	10 min average	10 min average	10 min average	10 min average
Water vapor H2O	**%**		26	28	27	30	28	26	26	25	26	24	28	27	27	27	28	27	26	25
Carbon dioxide CO2	**%**	**dry gas**	16	16	16	16	16	16	17	17	17	15	16	15	16	15	15	16	16	15
Sulfur dioxide SO2	**ppm**	**dry gas**	78	70	50	41	64	40	45	47	60	71	43	11	55	31	30	26	47	20
HCl	**ppm**	**dry gas**	56	74	80	35	40	41	49	49	44	112	78	32	91	58	63	56	83	53
Furnace																				
Concentration in dry gas			loc. 6	loc. 5	loc. 4	loc. 3	loc. 3	loc. 2	loc. 2	loc. 1	loc. 1	loc. 6	loc. 5	loc. 4	loc. 4 reversed coolin(	loc. 3	loc. 3	loc. 2	loc. 1	loc. 1
Sulfur dioxide SO2	**ppm**	**dry gas**	129	189	158	140	126	125	114	498	392	109	111	46	166	106	106	114	352	301
HCl	**ppm**	**dry gas**	46	32	44	37	40	17	13	31	20	169	138	75	148	81	95	82	102	94



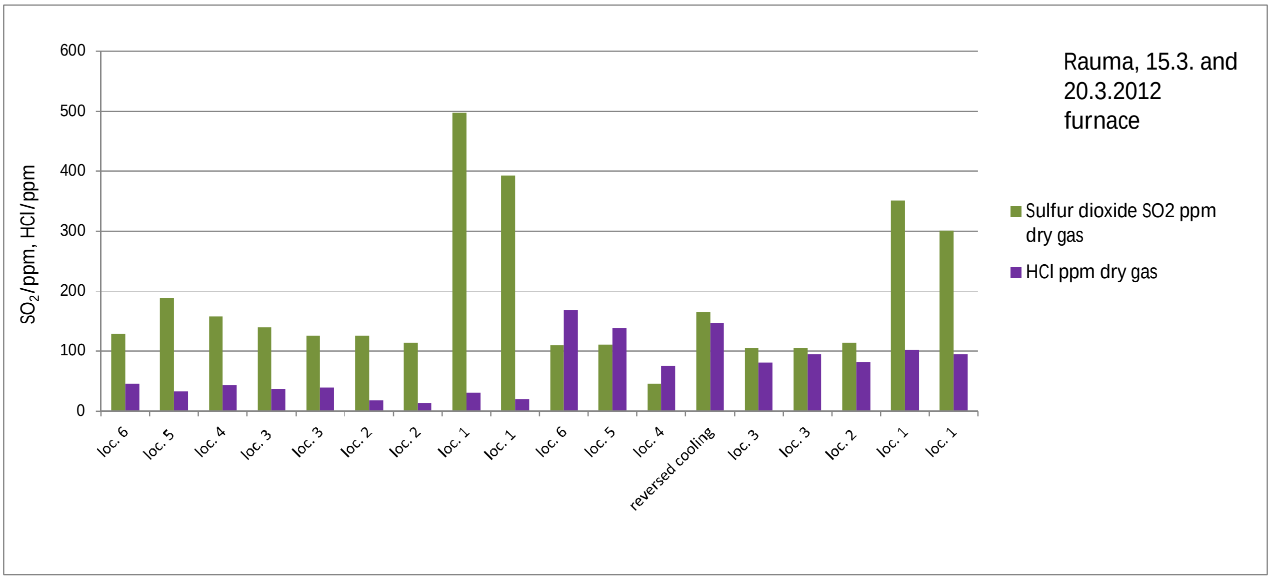


Figure 5. The gas phase measurement results from the second draw and from the furnace, 15.3.2012 and 20.3.2012.

3. Field experiment at Stora Enso Oyj Anjalankoski power plant 22.-24.5.2012

3.1 General

Two goals were set to the experiment at Stora Enso Oyj Anjalankoski power plant:

- comparison of the 5-stage impactor results with the results from the continuously operating Corrored /5./ and KCl-laser analyzer /6./
- field tests of the sampling system for the ICP-AES analyzer

Corrored and KCl-laser analyzers were installed to the upper level together with the sampling system for the 5-stage impactor as shown in Fig. 6.

Corrored analyzer measures total concentration of Cl and effective S in real time in the boiler´s upper section or in the superheater section. With these concentration data it is possible to calculate a risk index for superheater corrosion, to calculate Cl concentration in fuel, and to control fuel quality. KCl-laser analyzer complements the corrosion measurements by giving real-time KCl concentration.

The comparison data from VTT´s 5-stage impactor includes water soluble Cl, S, K, Na from all the samples and water soluble Ca from a few samples. Moreover, also Pb and Zn concentrations were determined from specified samples. The fuel characteristics given in REF, Bio and Sludge proportions are shown in Table 3.

Table 3. Fuel characteristics of Anjalankoski power plant 22.-24.5.2012

Fuel	REF	Bio	Sludge
22.5	44	50	6
23.5	44	50	6
24.5	59	35	6

Flue gas temp	670	Höyry kg/s	20

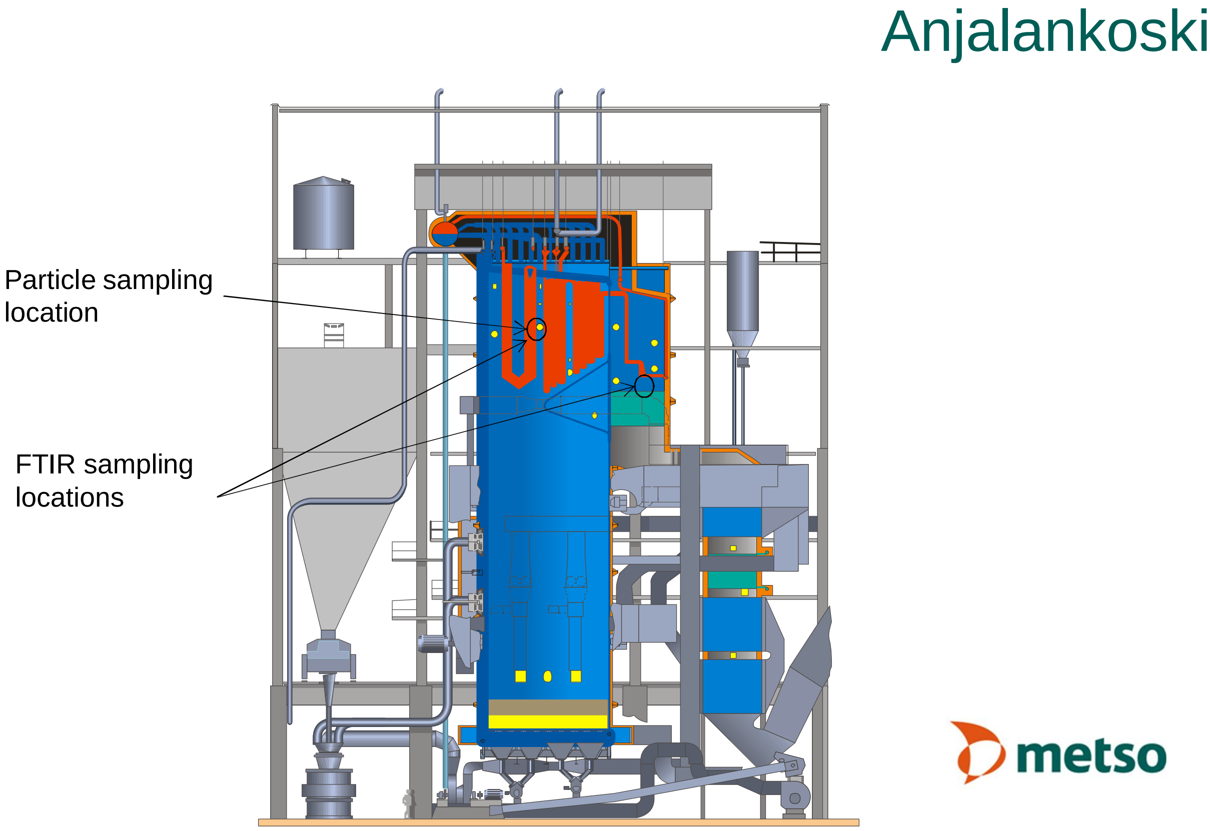


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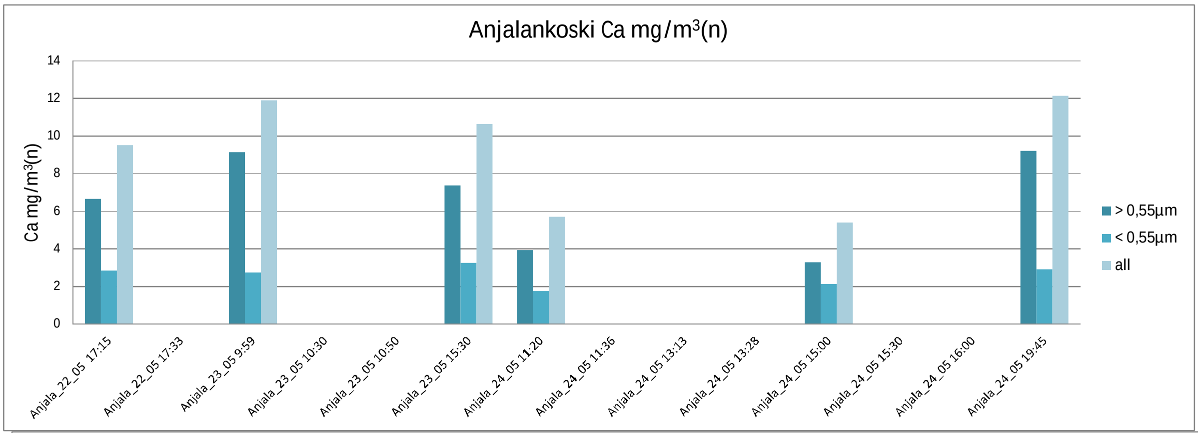
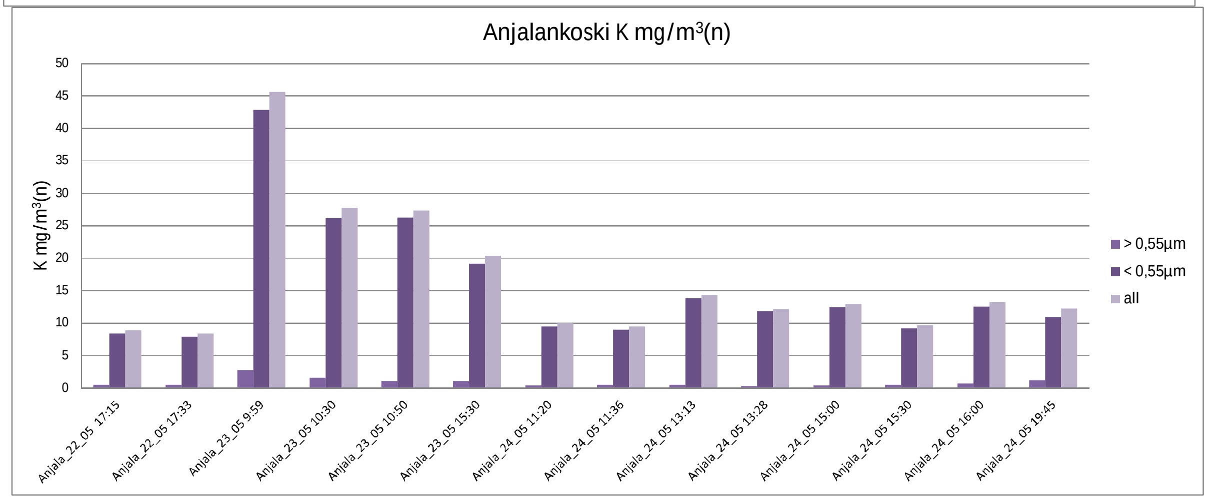
Figure 6. A schematic view of Stora Enso Oyj Anjalankoski power plant´s fluidised-bed boiler K2.The sampling locations of the 5–stage impactor and FTIR analyzer are indicated by arrows. The rated thermal input of the boiler K2 is 218 MW.

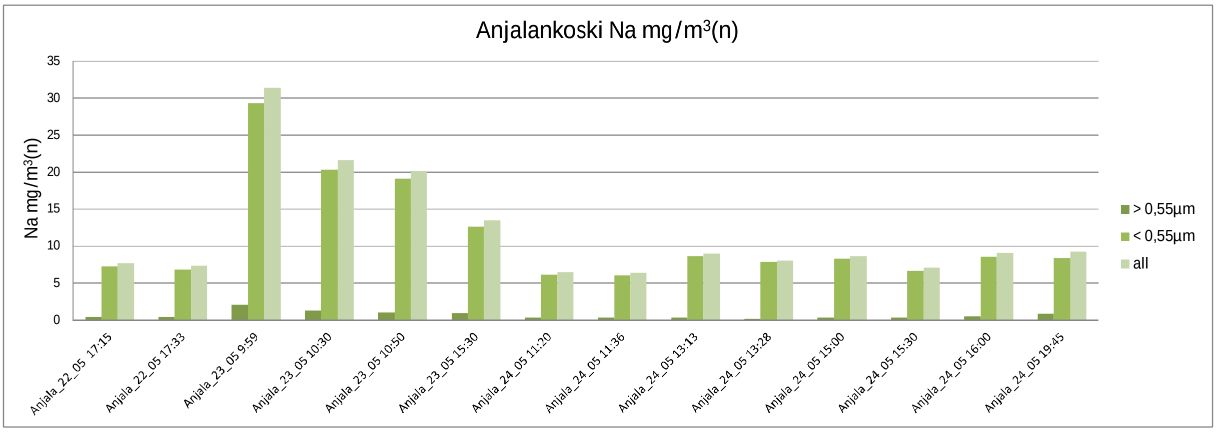
The log book of the experiments at Anjalankoski power plant is shown in appendices 3 and 4. The results of the elemental analyses of the impactor samples are shown in appendices 5 and 6. The fuel analysis data of Anjalankoski power plant is shown in appendix 7.

3.2 The analysis of the impactor samples

In Anjalankoski power plant the particle samples were taken by using a 5-stage impactor. The results are shown in Fig.7. The elemental concentrations (mg/m^3(n)) are given here in two particle size classes: darker blue indicates particle sizes > 0.55 µm, and lighter blue indicates sizes < 0.55 µm.







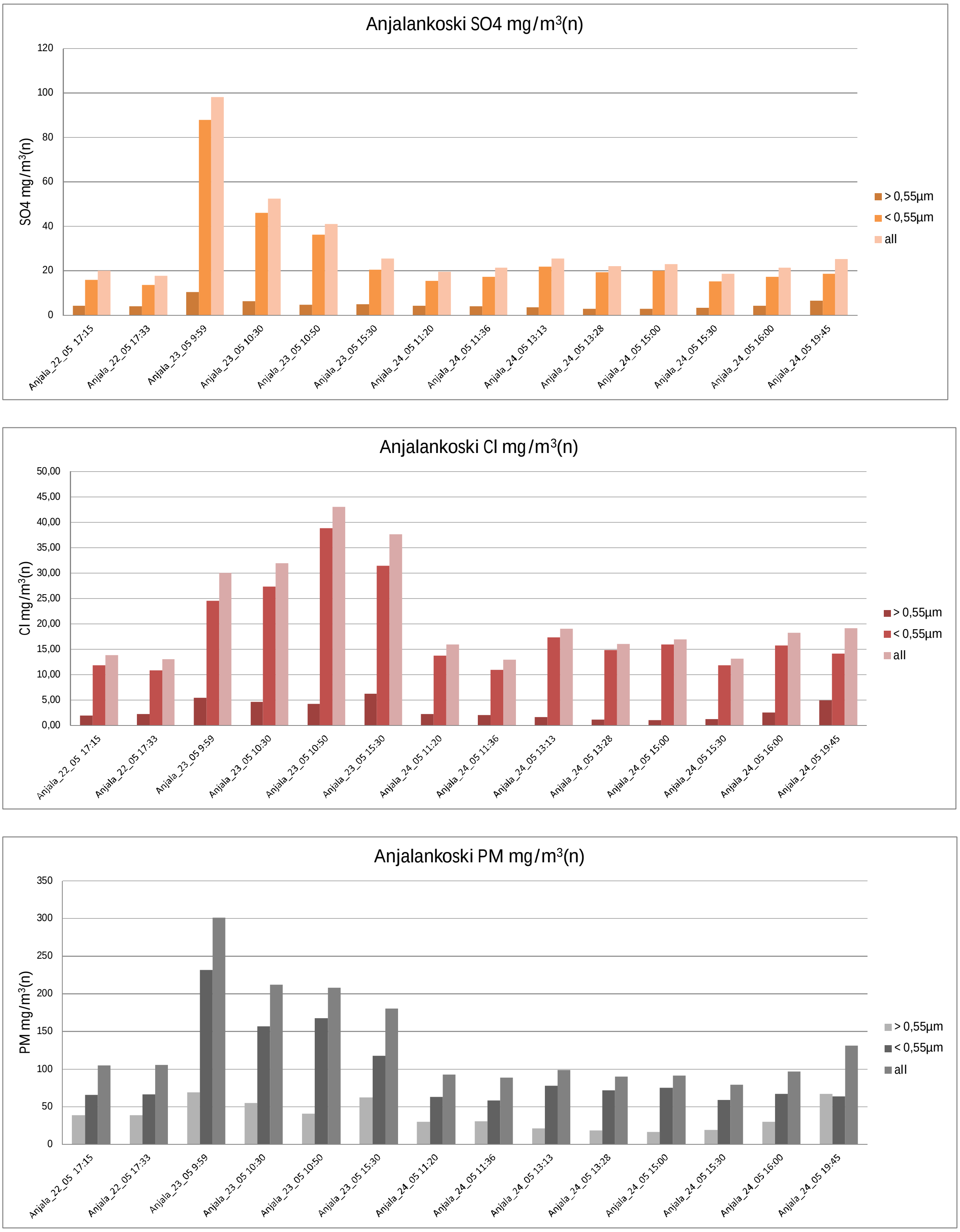
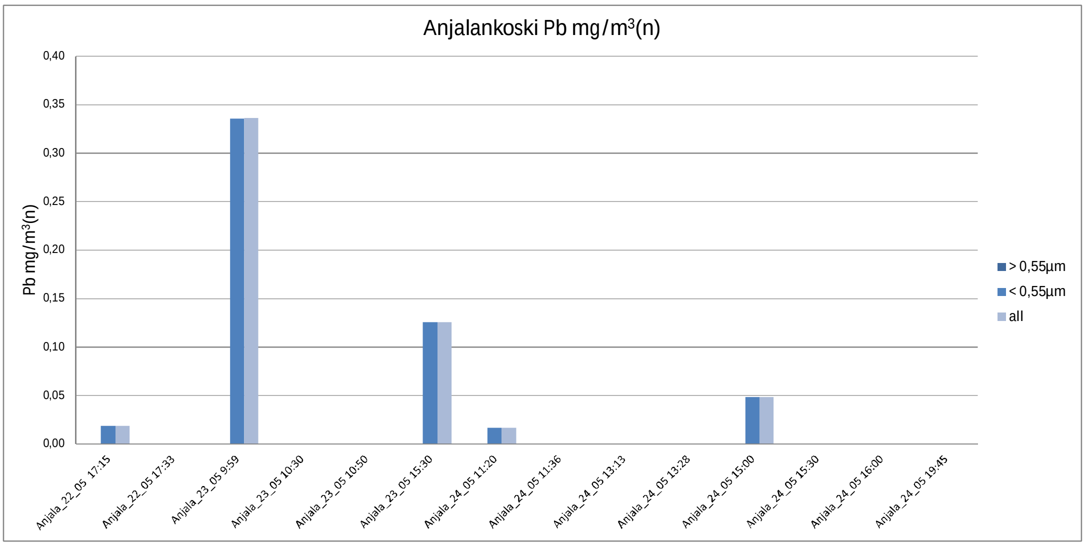


Figure 7. The results of the 5-stage impactor measurements, Anjalankoski power plant, 22.-24.5.2012

In these experiments Ca is mainly in the larger particle size class as previously in Rauma experiments. Furthermore, K and Na are in the smaller particle size class. The concentrations of K and Na are significantly larger in the 23.5. results than in the 24.5. results which can be expected by comparing the fuel analysis results in appendix 7.

The larger proportion of Cl in the fuel on the 23.5. in comparison to the 24.5. can be seen in these impactor results. Similarly the concentration of S is larger in the results of the 23.5. In these experiments Cl and S are mainly in the smaller particle size class.

Fig. 8 shows the impactor results for Pb and Zn. Both of these elements are only in the smaller particle size class. Concerning the concentration of Pb the impactor results correspond to the fuel analysis results or the concentration decreases to half on the 23.5. at 10-11 o´clock and at 15-17 o´clock. Furthermore, on the 24.5. the concentration of Pb remains on a low level in comparison to the results on the 23.5. The fuel analysis does not contain data on Zn concentration.



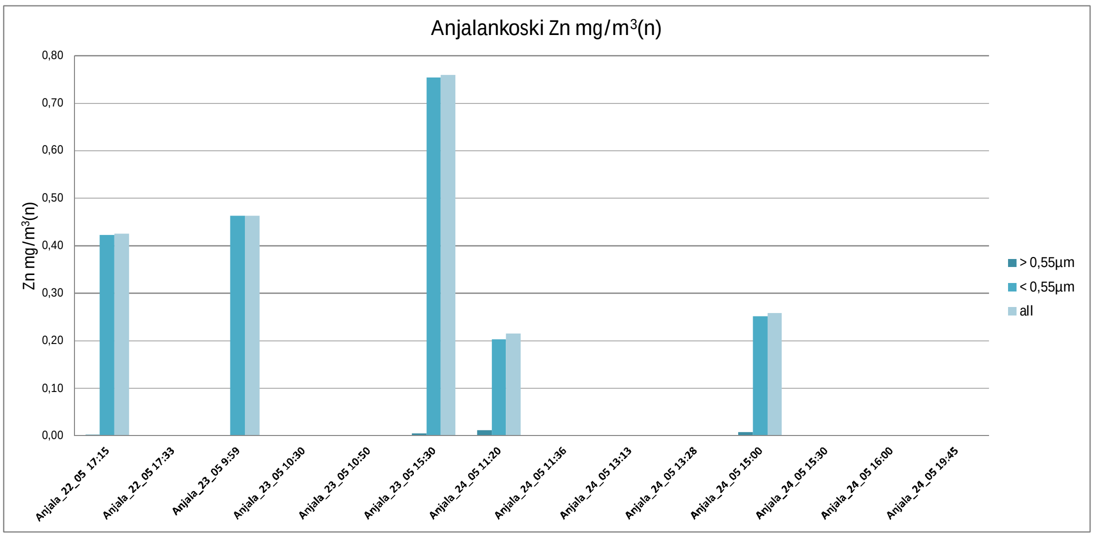


Figure 8. Pb and Zn results of the impactor measurements, Anjalankoski power plant, 22.-24.5.2012.

The FTIR results of the gas phase are shown in Table 4. and in Fig. 9. The results on SO_2 and HCl show that their concentrations in the second draw decrease by a factor 1/3 between the experiments on 23.5. and 24.5. This result corresponds to the changes of S and Cl concentrations in the fuel as shown in Anjalankoski power plant data in appendix 7.

Table 4. FTIR results at Anjalankoski power plant, 22.-24.5.2012

Summary: Anjalankoski May 2012																
Second draw		date	22.5.		23.5.				24.5.							
concentration in dry gas		start at	17:15	17:33	9:59	10:30	10:50	15:30	11:20	11:36	13:13	13:28	15:00	15:30	16:00	19:45
		stop at	17:25	17:43	10:09	10:40	11:00	15:40	11:30	11:46	13:23	13:38	15:10	15:40	16:10	19:55
Water vapor H2O	%		17	17	17	17	19	18	20	20	19	19	19	19	18	19
Carbon dioxide CO2	%	dry gas	14	14	12	13	14	14	15	14	14	14	14	15	14	14
Sulfur dioxide SO2	ppm	dry gas	37	40	167	110	131	87	50	44	40	43	50	45	39	54
HCl	ppm	dry gas	100	111	244	211	243	219	84	75	70	76	88	70	69	112
Furnace																
concentration in dry gas																
Sulfur dioxide SO2	ppm	dry gas	58	36	190	115	140	90	61	78	70	57	75	48	75	135
HCl	ppm	dry gas	77	75	172	168	199	201	67	63	68	71	80	63	64	91

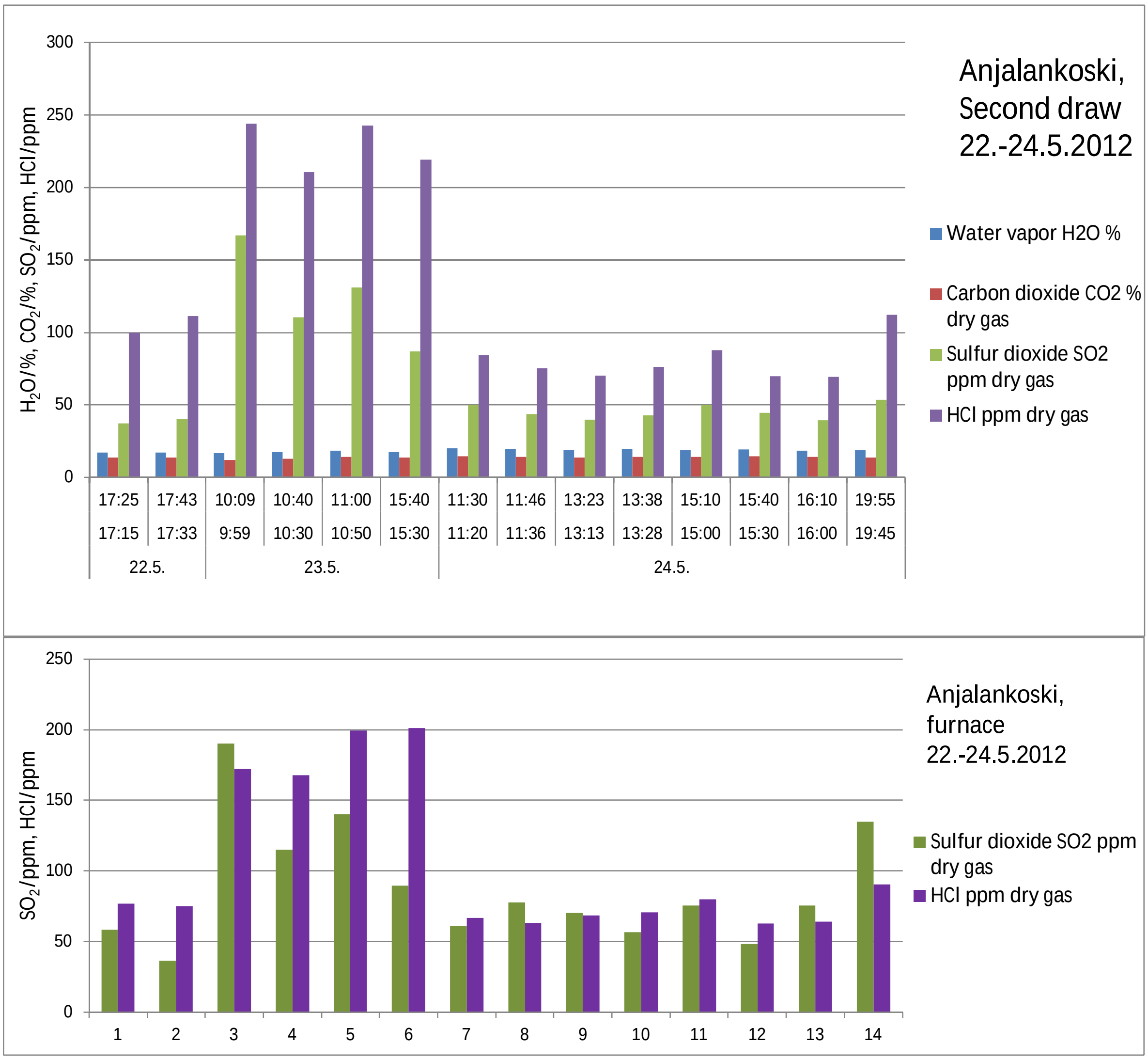


Figure 9. The measurement results of the gas phase by FTIR in the second draw and in the furnace, Anjalankoski power plant, 22.-24.5.2012

3.3 The comparison of impactor results with Corrored and KCl-analyzer results

The comparison of the results of Corrored and KCl-laser analyzers to the results of the 5-stage impactor experiments are shown in Fig. 10 and 11. This comparison is provided by Metso Oyj.

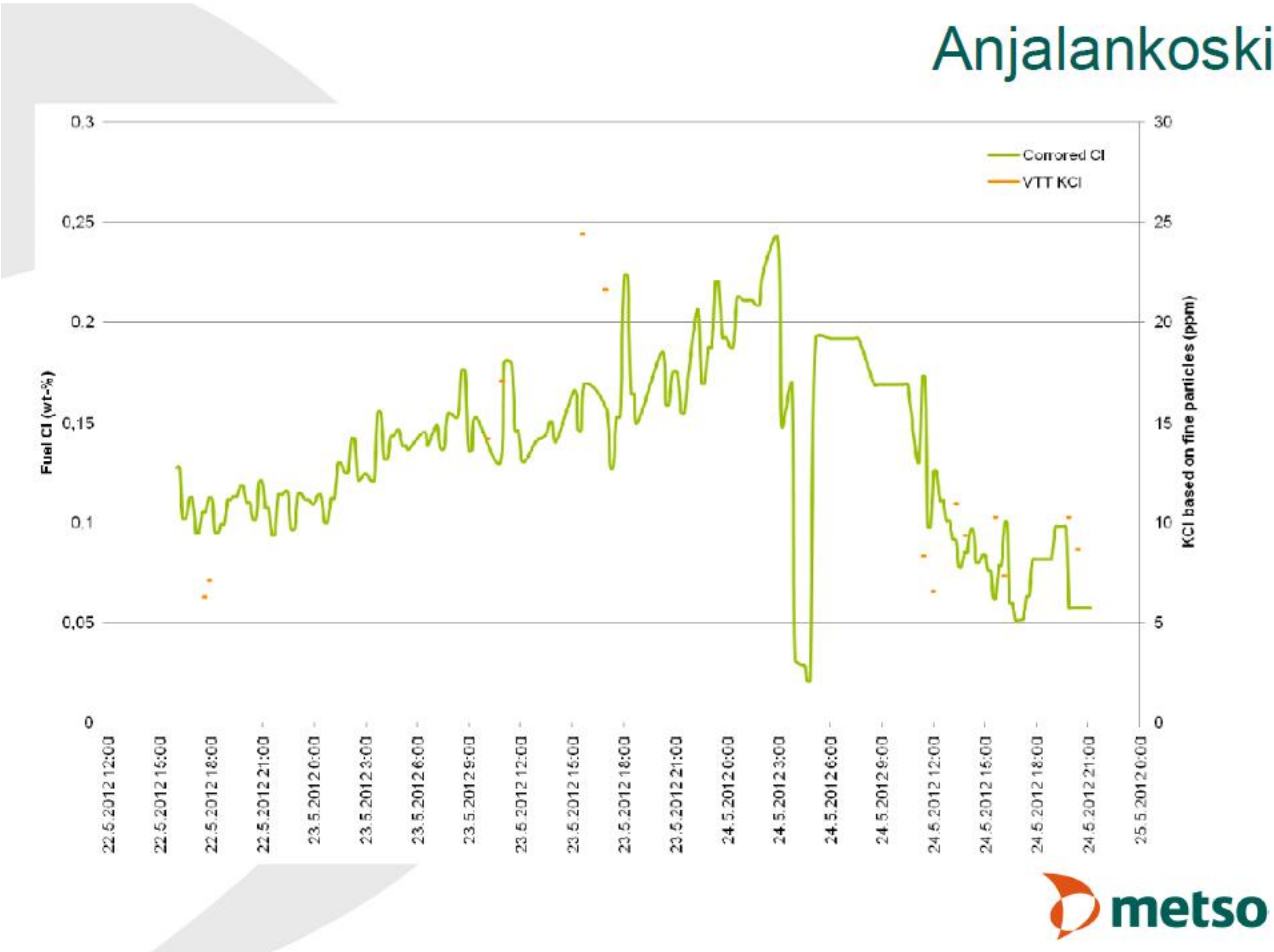


Figure 10. The comparison of Corrored and the impactor results, Anjalankoski power plant, 22.-24.5.2012

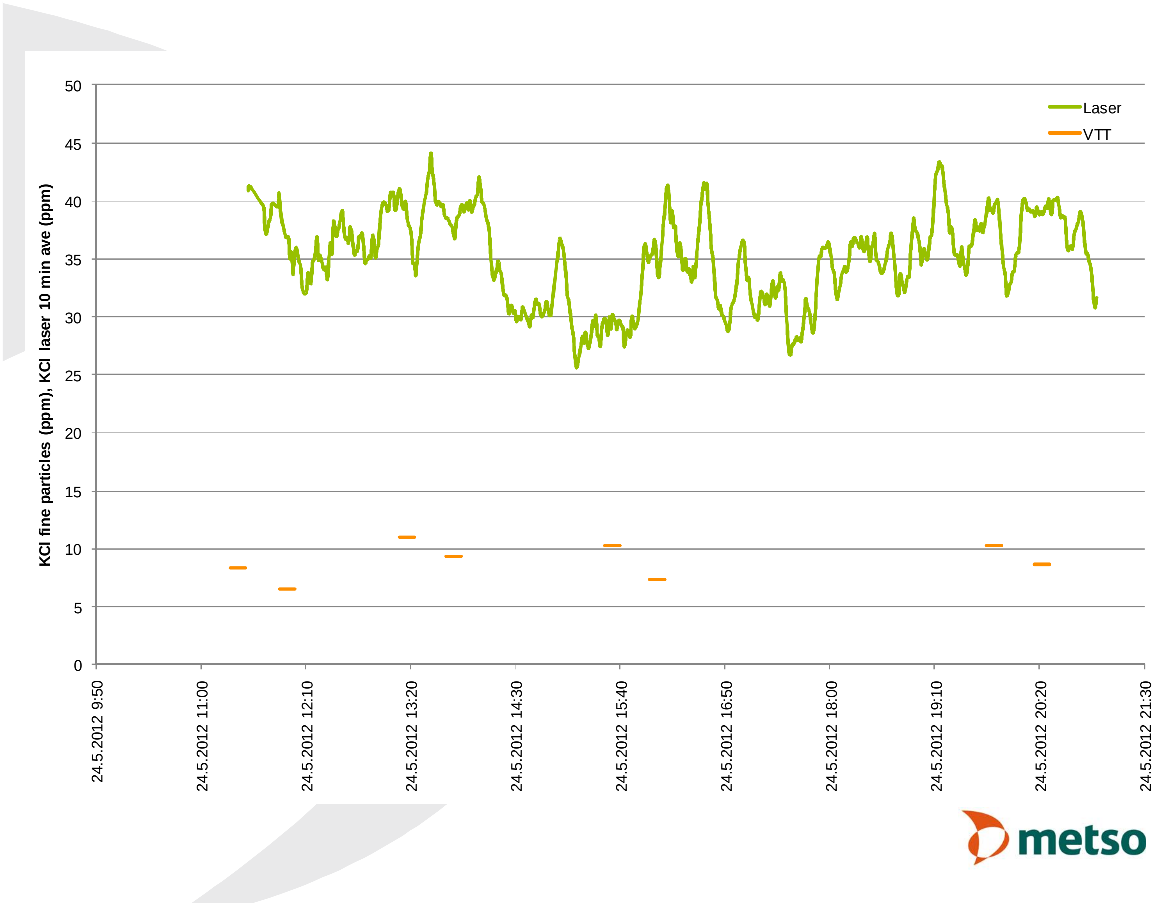


Figure 11. The comparison of KCl-laser analyzer results and the impactor results, Anjalankoski power plant, 22.-24.5.2012

The calculation of the KCl concentration is based on the assumption that all K in particles with the size < 0.55 µm is chemically KCl /7./. According to Fig. 10 the results of the impactor measurement correspond well to the results by Corrored analyzer. However, the concentration of KCl by the KCl-laser analyzer is 3-4 times larger than the concentration obtained by the impactor measurement. This deviation in KCl concentration will be studied in forthcoming experiments.

4. The tests of ICP-AES in laboratory and the sampling test at Anjalankoski power plant

The aim of this task is to develop the sampling system in such a way that a reliable and continuous flow of particulate sample from a furnace can be produced for a real-time analyzer.

The connection of VTT`s ICP-AES device to the sampling system in a power plant was not yet done in this task. We tested first the coupling of particulate sample flow and external reference flow in gas phase to the ICP-AES device in laboratory conditions. The vaporization of external reference liquid to gas phase was not, however, reliable. After this the reference liquid could be successfully injected to ICP-AES device by using a nebulizer unit. This test was continued at Anjalankoski power plant where a suitable sample gas flow was provided by the Minisampling device. In this test we observed that a suitable sample gas flow for ICP-AES device can be provided by injecting first the sample gas flow to the reference liquid and then to the nebulizer unit.

During the field experiment the Minisampling device was used to produce a particulate sample gas flow for ICP-AES device as shown in Fig. 12.

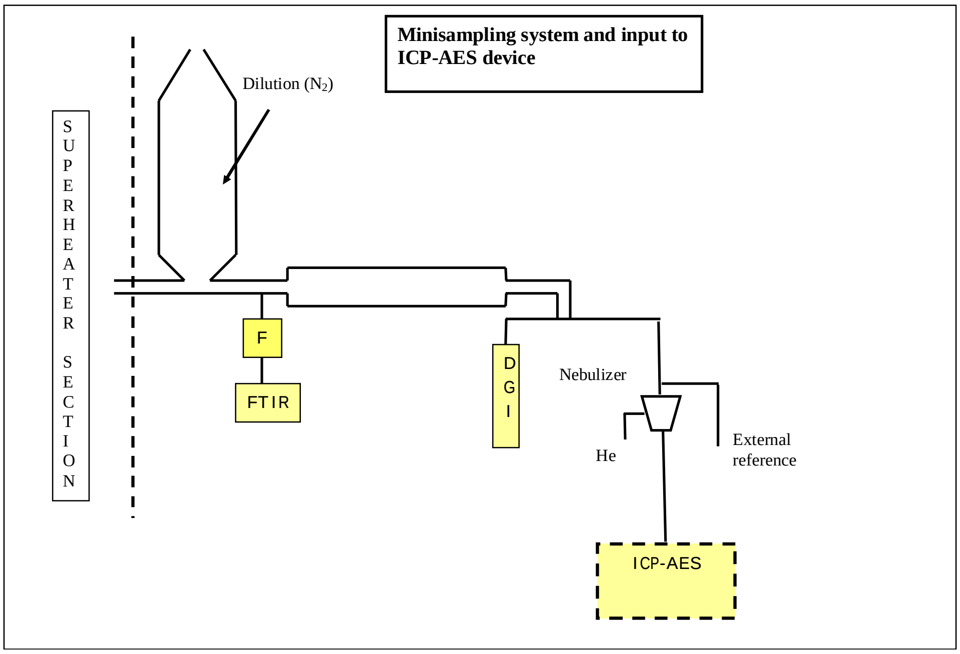


Figure 12. Sampling arrangement for producing a continuous particulate sample flow from furnace to ICP-AES device. F=Hastelloy particle filter, FTIR=Fourier transformation infrared analyzer, DGI=Dekati Oy`s gravimetric 5-stage impactor, Nebulizer=converts a liquid sample to mist, He=He-gas feed for ICP-AES device, External reference=standard sample for ICP-AES device in liquid form, ICP-AES=inductively coupled plasma-atomic emission spectrometer.

5. Summary

During FP2 of Cleen Oy´s MMEA research program new information has been produced by field experiments at Rauma and Anjalankoski power plants on element concentrations in the particle and gas phase in furnace. The experiments have been focused to determine corrosive species in the superheater section. During these experiments the changes in the burning process have been continuously measured by FTIR analyzers.

The studies aim to simplify the sampling of particles, to decrease analysis costs, and to develop a reliable sampling method. A long term goal in MMEA research program is to develop cost-effective methods and devices for in-furnace real-time particle analysis.

Concerning the measurement in Anjalankoski power plant the results of particle measurement by an impactor have now been compared to continuously operating Corrored and KCl-laser analyzers.

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APPENDICES

Appendix 1

RaVo mittausjakso HK6

	Ke 14.3.	To 15.3.	Pe 16.3.	La 17.3.	Su 18.3.	Ma 19.3.	Ti 20.3.	Ke 21.3.
Polttoaine:	Torstain poltoaineet aumaan	Kuori+metsähake+liete+REF	Varapäivä torstaille			Turvetoimitukset SEIS	Kuori+metsähake+liete+REF	Varapäivä tiistaille
		Turve 15 energia-%					Turve EI	
		Lihaluujauho EI					Lihaluujauho EI	
							Liete minimillä - ei kauhalla lisää	
Kuorma		HK6 30-35 kg/s					HK6 30-35 kg/s	
		HK5 säätää					HK5 säätää	
Nuohous		Ei nuohota mittausten aikana					Ei nuohota mittausten aikana	
		Nuohous ennen mittausjaksoa					Nuohous ennen mittausjaksoa	
Lisäaineet		Kalkki KYLLÄ - vasten päästörajaa					Kalkki KYLLÄ - sama annostus kuin torstaina	
		Ammoniakki KYLLÄ - vakiovirtauksella					Ammoniakki EI	

Aamu		Polttoainenäytteenotto hihnalta alkaa n. 2 h viive hihnalta pesään				Polttoainenäytteenotto hihnalta alkaa n. 2 h viive hihnalta pesään	
10:00		**Mittausjakso alkaa** VTT mittaa kerroksissa 5 - 8				**Mittausjakso alkaa** VTT mittaa kerroksissa 5 - 8	
10:30	VTT ja Metso saapuu	Mittausjärjestys päätetään myöhemmin				Mittausjärjestys päätetään myöhemmin	
	voimalaitokselle					Lämpötilamittaukset alkaa	
	Turvallisuuden yleisperehdytys						
	pääportilla				VTT ja Metso saapuu		
12:00					voimalaitokselle		
Päivä	Mittauslaitteiston pystytys						
	Laitteiston testaus				Laitteiston testaus		Laitteiston purku

14:00	Kuorman ennuste torstai ja tiistai	Lämpötilamittaukset alkaa	VTT Poistuu laitokselta				
Ilta							
20:00		**Mittausjakso loppuu**				**Mittausjakso loppuu**	
Huom.		REF määrää ajetaan vasten HCl päästörajaa				REF määrää ajetaan vasten HCl päästörajaa	

Appendix 2.

Mittauspöytäkirja Mini samling													
Rauman tulipesämittaukset													
date	time	mini samling_ID	test_ID	Filter_ID	G_tot	G_dil	side flow	dilution	temp	meas_time	Yhde	O2	huom
					kg/h	kg/h	kg/h	dr		s		%	
15.3.2012	10:30	Rauma_15_03_2012	Rauma 01	set 1	3,5	3,45	0,2	12,47	40	600	6		Taso 8 oikea kauinmainen eli neljäs
	10:46			set 2	3,5	3,45	0,2	12,61	40	600	6		Taso 8 oikea kauinmainen eli neljäs
	11:58			set 3	3,5	3,45	0,2	12,57	40	600	5		Taso 8 oikea keskellä ylhäällä
	12:15			set 4	3,5	3,45	0,2	12,74	40	600	5		Taso 8 oikea keskellä ylhäällä
	13:28			set 5	3,5	3,45	0,2	12,63	47	600	4		Taso 8 oikea etummainen
	13:44			set 6	3,5	3,45	0,2	12,57	47	600	4		Taso 8 oikea etummainen
	15:50	Rauma_15_03_2012_ilta		set 7	3,5	3,45	0,2	12,59	50	600	3		Taso 8 Vasen etummainen
	16:06			set 8	3,5	3,45	0,2	12,7	50	600	3		Taso 8 Vasen etummainen
	17:10			set 9	3,5	3,45	0,2	12,67	50	600	2		Taso 7 Etuseinä keskellä
	17:26			set 10	3,5	3,45	0,2	19,36	50	600	2		Taso 7 Etuseinä keskellä
	19:27			set 11	3,5	3,45	0,2	14,3	50	320	1		Taso 5 Oikea keskimmäinen näkölasi
	19:49			set 12	3,50	3,50	0,20	21,08	50	180	1		Taso 5 Oikea keskimmäinen näkölasi
20.3.2012	10:43	Rauma_20_03_2012		set 13	3,5	3,45	0,2			600	6	0.28-0.35	Taso 8 oikea kauinmainen eli neljäs
	10:58			set 14	3,5	3,45	0,2			600	6	0,23	Taso 8 oikea kauinmainen eli neljäs
	11:54			set 15	3,5	3,45	0,2			600	5	0.26-0.3	Taso 8 oikea keskellä ylhäällä
	12:10			set 16	3,5	3,45	0,2			600	5	0.19-0.25	Taso 8 oikea keskellä ylhäällä
	12:56			set 17	3,5	3,45	0,2			600	4	0,2	Taso 8 oikea etummainen
	13:12			set 18	3,5	3,45	0,2			600	4	0,3	Taso 8 oikea etummainen
	13:38			set 19	3,5	3,45	0,2			600	4	0,28	Taso 8 oikea etummainen käänetty jäähdytysvirtaus
	13:53			set 20	3,5	3,45	0,2			600	4	0,28	Taso 8 oikea etummainen käänetty jäähdytysvirtaus
	15:30	Rauma_20_03_2012_ilta		set 21	3,5	3,45	0,2			600	3	0,24	Taso 8 Vasen etummainen käänetty jäähdytys
	15:46			set 22	3,5	3,45	0,2			600	3	0,15	Taso 8 Vasen etummainen käänetty jäähdytys
	16:51			set 23	3,5	3,45	0,2			600	2	0.23-0.20	Taso 7 Etuseinä keskellä
	17:13			set 24	3,5	3,45	0,2			600	2	0.13-0.26	Taso 7 Etuseinä keskellä
	18:20			set 25	3,5	3,45	0,2			300	1	0,01	Taso 5 Oikea keskimmäinen näkölasi
	19:04			set 27	3,5	3,45	0,2			600	1	0	Taso 5 Oikea keskimmäinen näkölasi nostettu laimenussuhdetta

Appendix 3.

Mittauspöytäkirja Mini samling											
Anjalakosken tulipesämittaukset											
date	time	mini samling_ID	test_ID	Filter_ID	G_tot	G_dil	side flow	meas_time	Yhde	O2	huom
					kg/h	kg/h	kg/h	s		%	
22.5.2012	17:15	Anjala_22_05_2012		set 28	3,5	3,25	0,2	600			Alussa noin 300s, ehkä pieni ilmavuoto
	17:33			set 29	3,5	3,25	0,2	600			
	17:50			set 30	3,5	3,25	0,2	600			
23.5.2012	9:59	Anjala_23_05_2012		set 31	3,5	3,25	0,2	600			
	10:30			set 32	3,5	3,25	0,2	600			
	10:50			set 33	3,5	3,25	0,2	600			
	15:30	Anjala_23_05_2012_ilta		set 34	3,5	3,3	0,25	600			nebulazer kokeet samalla, lisävirtaus 0.05kg/h
	16:01			set 35	3,5	3,3	0,25	600			nebulazer kokeet samalla, lisävirtaus 0.05kg/h
	16:50			set 36	3,5	3,3	0,25	600			nebulazer kokeet samalla, lisävirtaus 0.05kg/h, impaktori tukkoon
24.5.2012	11:20	Anjala_24_05_2012		set 37	3,5	3,3	0,2	600			
	11:36			set 38	3,5	3,3	0,2	600			
	11:53			set 39	3,5	3,3	0,2	600			
	13:13			set 40	3,5	3,3	0,2	600			
	13:28			set 41	3,5	3,3	0,2	600			
	13:44			set 42	3,5	3,3	0,2	600			
	15:00	Anjala_24_05_2012_ilta		set 43	3,5	3,3	0,2	600			
	15:30			set 44	3,5	3,3	0,2	600			
	16:00			set 45	3,5	3,3	0,2	600			
	19:45			set 46	3,5	3,3	0,2	600			
	20:17			set 47	3,5	3,3	0,2	600			

Appendix 4.

Mittauspöytäkirja nebulizer						
Date	mini samling_ID	time	flow l/min	dr	huom.	
23.5.2011	Anjala_23_05_2012_nebu	12:27	1	7,5	ei nebulizer	
		12:40	0,51	7,5	vanha nebulizer	kaasupuoli
		12:43	0,54			kaasupuoli
		12:49	0		tukossa	kaasupuoli
		12:58	0,49		uusi nebulizer	kaasupuoli
		13:04	0,29			kaasupuoli
		13:06	0,41		avattu hanaa	kaasupuoli
		13:11	0,37			kaasupuoli
		13:15	0,24			kaasupuoli
		13:17	0,53		avattu hanaa	kaasupuoli
		13:20			tukossa	kaasupuoli
		13:22	0,35			nestepuoli
		13:29	0,15			nestepuoli
		13:31	1		avattu hanaa	nestepuoli
		13:33	0,6			nestepuoli
		13:40	0,33			nestepuoli
		13:49	1,66		avattu hanaa	nestepuoli
		14:01	0,88			nestepuoli
		14:10	2,1		avattu hanaa	nestepuoli
		14:15	1,8			
		14:23	1		ei nebua	
		14:37			uusi nebu	nestepuoli lisätty vesi sp 1mL
		14:45	1,2		ei nebua	
	Anjala_23_05_2012_ilta	15:30	1		uusi nebu	nestepuoli lisätty vesi sp 1mL
		17:07	0,8		ei nebua	
		17:09	0,7		uusi nebu	ei vettä vain virtaus

Appendix 5. The analysis results by Labtium Oy, 26.11.2012

LABTIUM

23.11.2012 13:27:57

Teknologian tutkimuskeskus VTT — Espoo

Vesala Hannu
PL 1000
02044 VTT
FINLAND

ANALYYSITULOKSIA

TILAUSNUMERO:	113708	VIITE:	531446

NÄYTTEITÄ: 130

MENETELMÄKOODI	NÄYTTEITÄ	MÄÄRITYKSIÄ
095M	130	382
206	130	
206Rs	130	260

Labtium Oy

Marjo Lauren
Kemisti

Labtium Oy

Tekniikantie 2
02150 ESPOO
Puh. 01065 38000

MENETELMÄKUVAUKSET JA HUOMAUTUKSET

Tilausnumero:	113708
Raportointipäivä:	23.11.2012 13:27:57

TULOS PÄTEE VAIN TESTATUILLE NÄYTTEILLE.
TESTAUSSELOSTEEN SAA KOPIOIDA VAIN KOKONAAN.

TULOKSET VALMISTUNEET: 22.10.2012 - 23.11.2012

VAIN NE TESTIMENETELMÄT, JOISSA TÄSSÄ SELOSTEESSA ON MERKINTÄ
+ MENETELMÄKOODIN EDESSÄ, KUULUVAT AKKREDITOINNIN PIIRIIN.

Näytteet impaktorinäytteitä, joista Set_1 merkityt olivat halkaisijaltaan 72mm kvartsisuodattimia ja muut näytteet (Set_2 - Set_5) halkaisijaltaan 47mm alumiinikalvoja. Asiakkaan pyynnöstä Set_4 ja Set_5 näytteet yhdistettiin ja uutettiin yhtenä näytteenä.

206	Vesiuutto Kvartsisuodattimet (Set_1) uutettiin 50ml ja alumiinisuodattimet (Set_2, Set_3 ja Set_4_5) 40 ml ionivaihdettua vettä.
095M	Monialkuainemääritys ICP-MS-tekniikalla Ca, K, Na, Pb ja Zn määritettiin vesiuutteesta ICP-MS tekniikalla. Tulokset on raportoitu yksiköissä ug/näyte.
206Rs	Anionien määritys IC-tekniikalla Cl ja SO4 määritettiin vesiuutteesta ionikromatografilla. Tulokset on raportoitu yksiköissä ug/näyte.

Laboratorion näytetunnus	Tilaajan näytetunnus	Ca µg 095M	K µg 095M	Na µg 095M	Pb µg 095M	Zn µg 095M	Cl µg 206Rs	SO4 µg 206Rs
L12119194	Set 1_1	3,64	10,7	7,44	-	-	16,4	24,6
L12119195	Set 1_2	13,4	2,74	1,13	-	-	5,01	12,2
L12119196	Set 1_3	112	4,28	2,00	-	-	37,4	103
L12119197	Set 1_4_5	349	7,51	4,41	-	-	92,3	241
L12119198	Set 4_1	<2	<2	1,95	-	-	<5	9,6
L12119199	Set 4_2	8,32	<2	<1	-	-	<4	7,3
L12119200	Set 4_3	86,2	<2	1,00	-	-	21,5	81,7
L12119201	Set 4_4_5	272	2,04	1,85	-	-	48	185
L12119202	Set 6_1	<2	<2	1,45	-	-	5,96	7,1
L12119203	Set 6_2	20,1	<2	<1	-	-	12,5	14,1
L12119204	Set 6_3	197	<2	<1	-	-	62	144
L12119205	Set 6_4_5	711	3,24	1,93	-	-	210	398
L12119206	Set 7_1	<2	<2	2,37	-	-	6,03	13,3
L12119207	Set 7_2	9,81	<2	<1	-	-	4,46	6,7
L12119208	Set 7_3	79,5	<2	<1	-	-	25	60,7
L12119209	Set 7_4_5	329	2,85	2,16	-	-	92,6	183
L12119210	Set 8_1	-	2,88	3,28	-	-	6,13	17,8
L12119211	Set 8_2	-	<2	<1	-	-	5,02	7,6
L12119212	Set 8_3	-	<2	1,2	-	-	35,7	61,3
L12119213	Set 8_4_5	-	3,06	2,37	-	-	102	171
L12119214	Set 9_1	4,21	20	2,87	-	-	62,5	6,5
L12119215	Set 9_2	24,4	<2	<1	-	-	8,78	11
L12119216	Set 9_3	204	2,54	<1	-	-	32,9	102
L12119217	Set 9_4_5	871	10,4	3,63	-	-	110	293
L12119218	Set 10_1	-	10,3	2,04	-	-	41	<5
L12119219	Set 10_2	-	<2	<1	-	-	15,2	8,6
L12119220	Set 10_3	-	<2	<1	-	-	18,5	26,1
L12119221	Set 10_4_5	-	7,81	2,74	-	-	91,3	269
L12119222	Set 11_1	<2	82,3	16,7	-	-	137	6,92
L12119223	Set 11_2	7,57	2,56	1,14	-	-	<4	<4
L12119224	Set 11_3	32,4	5,2	1,26	-	-	5,52	4,2
L12119225	Set 11_4_5	260	24,8	9,92	-	-	35,3	58,3
L12119226	Set 12_1	-	16,4	5,91	-	-	38,1	7,4
L12119227	Set 12_2	-	3,06	1,46	-	-	<4	<4
L12119228	Set 12_3	-	3,09	1,21	-	-	4,09	<4
L12119229	Set 12_4_5	-	12,6	5,34	-	-	25,9	59
L12119230	Set 14_1	18	174	60,2	-	-	254	112
L12119231	Set 14_2	23,4	84,9	35,8	-	-	107	44,8
L12119232	Set 14_3	115	27,1	10,6	-	-	59,2	97,9
L12119233	Set 14_4_5	353	39,1	15	-	-	122	227
L12119234	Set 16_1	12,6	26,6	11,8	-	-	45,5	37,5
L12119235	Set 16_2	19	4,15	1,8	-	-	8,94	14
L12119236	Set 16_3	121	3,49	1,9	-	-	38,2	97,5
L12119237	Set 16_4_5	343	5,71	3,46	-	-	93,9	185

L12119238	Set 18_1	7,12	5,17	4,41	-	-	17,3	16,4
L12119239	Set 18_2	24,7	<2	<1	-	-	6,65	14,8
L12119240	Set 18_3	178	2,54	1,36	-	-	38,5	105
L12119241	Set 18_4_5	413	3,76	2,07	-	-	84,3	185
L12119242	Set 20_1	14,4	183	48,0	-	-	286	50,1
L12119243	Set 20_2	25,7	7,58	3,22	-	-	10,1	24
L12119244	Set 20_3	181	7,12	3,27	-	-	19,3	153
L12119245	Set 20_4_5	413	9,68	4,26	-	-	69,9	278
L12119246	Set 21_1	5,41	8,98	4,96	-	-	27,9	14,6
L12119247	Set 21_2	16,6	<2	<1	-	-	5,18	12,3
L12119248	Set 21_3	136	3,22	1,33	-	-	29,1	99,9
L12119249	Set 21_4_5	308	4,25	2,08	-	-	60,8	166
L12119250	Set 22_1	-	8,17	4,26	-	-	27	14,4
L12119251	Set 22_2	-	2,54	<1	-	-	6,98	13,7
L12119252	Set 22_3	-	3,2	1,49	-	-	44,6	111
L12119253	Set 22_4_5	-	4,8	2,5	-	-	100	208
L12119254	Set 24_1	19,1	20,5	5,21	-	-	44,3	24,3
L12119255	Set 24_2	20,1	2,69	<1	-	-	5,35	7,8
L12119256	Set 24_3	130	3,59	1,23	-	-	27,9	62,1
L12119257	Set 24_4_5	691	23,8	8,79	-	-	166	300
L12119258	Set 25_1	12,5	30,9	7,01	-	-	54,3	12
L12119259	Set 25_2	12,3	2,71	<1	-	-	4,04	<4
L12119260	Set 25_3	74,8	3,37	1,11	-	-	9,33	17,1
L12119261	Set 25_4_5	455	19,8	7,27	-	-	91,9	142
L12119262	Set 27_1	-	27,8	9,5	-	-	55,2	8,2
L12119263	Set 27_2	-	2,51	<1	-	-	4,2	4,6
L12119264	Set 27_3	-	3,52	1,08	-	-	6,77	6,7
L12119265	Set 27_4_5	-	17,3	5,34	-	-	54,9	67,2
L12119266	Set 28_1	40	229	165	0,416	13,5	390	432
L12119267	Set 28_2	39,8	203	203	0,542	8,21	207	340
L12119268	Set 28_3	74,7	22,8	23,8	0,053	1,12	43,5	80,1
L12119269	Set 28_4_5	359	27,4	24,4	0,008	0,124	103	229
L12119270	Set 29_1	-	248	174	-	-	412	425
L12119271	Set 29_2	-	247	251	-	-	260	387
L12119272	Set 29_3	-	28,8	29,8	-	-	47,1	90,9
L12119273	Set 29_4_5	-	35,1	30	-	-	149	266
L12119274	Set 31_1	63	962	558	3,14	15,9	655	2040
L12119275	Set 31_2	43,6	1370	1010	15,7	9,08	682	2670
L12119276	Set 31_3	63,3	320	245	1,95	3,66	183	722
L12119277	Set 31_4_5	566	173	130	0,007	0,025	339	649
L12119278	Set 32_1	-	661	401	-	-	880	1150
L12119279	Set 32_2	-	870	770	-	-	736	1520
L12119280	Set 32_3	-	125	113	-	-	111	244
L12119281	Set 32_4_5	-	99,5	84,9	-	-	292	401
L12119282	Set 33_1	-	934	539	-	-	1610	1090
L12119283	Set 33_2	-	622	574	-	-	690	988
L12119284	Set 33_3	-	83,3	81,1	-	-	121	185
L12119285	Set 33_4_5	-	69,7	64,7	-	-	265	294

L12119286	Set 34_1	84,5	845	456	2,15	34,9	1570	760
L12119287	Set 34_2	57,4	397	343	5,87	12,8	440	513
L12119288	Set 34_3	78,2	59,7	55,6	0,498	3,44	125	121
L12119289	Set 34_4_5	501	77,2	63,5	0,027	0,356	420	335
L12119290	Set 37_1	42,2	401	237	0,325	6,66	615	585
L12119291	Set 37_2	20,8	90,3	78,6	0,523	3,01	86,8	183
L12119292	Set 37_3	31,3	15,4	12,3	0,036	1,14	29,7	56,2
L12119293	Set 37_4_5	210	22,7	16,6	0,012	0,629	119	222
L12119294	Set 38_1	-	346	219	-	-	455	580
L12119295	Set 38_2	-	115	88,5	-	-	100	250
L12119296	Set 38_3	-	18,7	15	-	-	29,9	94,6
L12119297	Set 38_4_5	-	27,1	18,5	-	-	109	218
L12119298	Set 40_1	-	493	285	-	-	710	670
L12119299	Set 40_2	-	239	170	-	-	211	424
L12119300	Set 40_3	-	33,4	23,2	-	-	38,7	109
L12119301	Set 40_4_5	-	26,3	17,8	-	-	93	202
L12119302	Set 41_1	-	436	269	-	-	612	601
L12119303	Set 41_2	-	188	143	-	-	171	385
L12119304	Set 41_3	-	20	15,3	-	-	22,5	63,2
L12119305	Set 41_4_5	-	17,4	11,8	-	-	63,7	150
L12119306	Set 43_1	31,4	438	270	0,247	5,65	615	627
L12119307	Set 43_2	23,8	235	173	2,4	5,3	244	404
L12119308	Set 43_3	64,5	29,3	25,2	0,086	3,19	39,5	100
L12119309	Set 43_4_5	185	23,1	18,3	0,011	0,402	56,9	156
L12119310	Set 44_1	-	352	232	-	-	494	505
L12119311	Set 44_2	-	122	108	-	-	115	236
L12119312	Set 44_3	-	21,4	18,7	-	-	29,1	77,2
L12119313	Set 44_4_5	-	27	21,1	-	-	69,5	179
L12119314	Set 45_1	-	463	277	-	-	653	520
L12119315	Set 45_2	-	220	187	-	-	200	364
L12119316	Set 45_3	-	28,6	23,5	-	-	38,6	91,9
L12119317	Set 45_4_5	-	38,7	27,8	-	-	143	238
L12119318	Set 46_1	63,2	325	214	-	-	506	488
L12119319	Set 46_2	35,9	245	217	-	-	214	433
L12119320	Set 46_3	60,7	30	25,3	-	-	53,7	93,2
L12119321	Set 46_4_5	503	65,4	47,1	-	-	270	356
L12119322	Ref 1	3,94	<2	2,68	<0.002	0,0556	6,36	<5
L12119323	Ref 4 Al	<2	<2	<1	0,004	0,182	<4	<4

Liite 6. Alkuainepitoisuudet, Rauma ja Anjalankoski.

	Ca	K	Na	Pb	Zn	Cl	SO4	mass
	mg/Nm3	mg/Nm3	mg/Nm3	mg/Nm3	mg/Nm3	mg/Nm3	mg/Nm3	mg/Nm3
> 0,55µm								
yhde 6 15.03.	10,683	0,230	0,135			2,825	7,377	80,018
yhde 5 15.03.	11,893	0,089	0,081			2,099	8,089	89,150
yhde 4 15.03.	27,502	0,125	0,075			8,123	15,395	183,038
yhde 3 15.03.	12,003	0,104	0,079			3,378	6,676	94,893
yhde 3 15.03.		0,108	0,084			3,615	6,061	81,199
yhde 2 15.03.	32,598	0,389	0,136			4,117	10,966	186,047
yhde 2 15.03.		0,302	0,106			3,528	10,394	175,766
yhde 1 15.03.	35,301	3,367	1,347			4,793	7,916	561,964
yhde 1 15.03.		2,268	0,961			4,663	10,622	1235,887
yhde 6 20.03.	15,292	1,694	0,650			5,285	9,833	90,666
yhde 5 20.03.	14,899	0,248	0,150			4,079	8,036	70,672
yhde 4 20.03.	18,646	0,170	0,093			3,806	8,352	74,087
yhde 4 20.03._käänetty jääh	17,928	0,420	0,185			3,034	12,068	62,856
yhde 3 20.03.	14,955	0,206	0,101			2,952	8,060	63,220
yhde 3 20.03.		0,216	0,113			4,501	9,362	72,918
yhde 2 20.03.	29,844	1,028	0,380			7,169	12,957	267,645
yhde 1 20.03.	38,081	1,657	0,608			7,691	11,885	511,706
yhde 1 20.03.		1,116	0,344			3,542	4,335	215,524
Anjala_22_05 17:15	6,656	0,508	0,452	0,000	0,002	1,910	4,246	39,007
Anjala_22_05 17:33		0,529	0,452			2,245	4,008	38,528
Anjala_23_05 9:59	9,147	2,796	2,101	0,000	0,000	5,479	10,489	69,300
Anjala_23_05 10:30		1,574	1,343			4,619	6,343	55,176
Anjala_23_05 10:50		1,117	1,037			4,248	4,712	40,423
Anjala_23_05 15:30	7,384	1,138	0,936	0,000	0,005	6,190	4,938	62,463
Anjala_24_05 11:20	3,943	0,426	0,312	0,000	0,012	2,234	4,168	29,607
Anjala_24_05 11:36		0,507	0,346			2,039	4,079	30,290
Anjala_24_05 13:13		0,475	0,322			1,680	3,650	20,996
Anjala_24_05 13:28		0,321	0,218			1,174	2,765	18,618
Anjala_24_05 15:00	3,289	0,411	0,325	0,000	0,007	1,012	2,774	16,411
Anjala_24_05 15:30		0,503	0,393			1,294	3,333	19,623
Anjala_24_05 16:00		0,683	0,490			2,523	4,198	29,865
Anjala_24_05 19:45	9,224	1,199	0,864			4,951	6,528	67,153

	Ca	K	Na	Pb	Zn	Cl	SO4	mass
	mg/Nm3	mg/Nm3	mg/Nm3	mg/Nm3	mg/Nm3	mg/Nm3	mg/Nm3	mg/Nm3
< 0,55µm								
yhde 6 15.03.	3,950	0,542	0,324			1,800	4,279	31,744
yhde 5 15.03.	4,133	0,000	0,129			0,940	4,311	54,362
yhde 4 15.03.	8,398	0,000	0,056			3,112	6,390	186,236
yhde 3 15.03.	3,258	0,000	0,086			1,295	2,944	94,783
yhde 3 15.03.		0,102	0,159			1,660	3,073	71,405
yhde 2 15.03.	8,706	0,844	0,107			3,899	4,472	536,682
yhde 2 15.03.		0,398	0,079			2,886	1,341	534,484
yhde 1 15.03.	5,427	12,228	2,593			19,350	1,510	205,334
yhde 1 15.03.		4,060	1,545			7,595	1,332	340,072
yhde 6 20.03.	6,775	12,389	4,618			18,203	11,033	116,917
yhde 5 20.03.	6,629	1,487	0,673			4,024	6,472	57,771
yhde 4 20.03.	9,473	0,348	0,261			2,819	6,149	62,183
yhde 4 20.03._käänetty jääh	9,598	8,582	2,365			13,691	9,858	86,282
yhde 3 20.03.	7,672	0,592	0,305			3,019	6,157	50,321
yhde 3 20.03.		0,626	0,259			3,537	6,261	50,922
yhde 2 20.03.	7,308	1,157	0,278			3,349	4,068	72,932
yhde 1 20.03.	8,336	3,095	0,680			5,664	2,436	135,947
yhde 1 20.03.		2,182	0,683			4,269	1,258	100,784
Anjala_22_05 17:15	2,864	8,432	7,264	0,019	0,423	11,874	15,797	65,543
Anjala_22_05 17:33		7,892	6,853			10,835	13,605	66,725
Anjala_23_05 9:59	2,746	42,860	29,301	0,336	0,463	24,565	87,789	231,506
Anjala_23_05 10:30		26,196	20,311			27,319	46,096	156,780
Anjala_23_05 10:50		26,275	19,139			38,805	36,272	167,908
Anjala_23_05 15:30	3,244	19,186	12,596	0,126	0,754	31,467	20,546	117,803
Anjala_24_05 11:20	1,770	9,513	6,156	0,017	0,203	13,733	15,474	62,831
Anjala_24_05 11:36		8,975	6,034			10,943	17,298	58,634
Anjala_24_05 13:13		13,830	8,640			17,340	21,737	78,051
Anjala_24_05 13:28		11,871	7,876			14,848	19,340	71,607
Anjala_24_05 15:00	2,128	12,487	8,325	0,049	0,251	15,976	20,110	75,092
Anjala_24_05 15:30		9,223	6,678			11,880	15,233	59,317
Anjala_24_05 16:00		12,553	8,600			15,728	17,215	67,045
Anjala_24_05 19:45	2,930	11,003	8,368			14,188	18,598	63,657

Appendix 7. The chemical analysis of fuel samples, Anjalankoski power plant

Ramboll Analytics

Date: 12.9.2012
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Certificate

Project: 82133560-01/26

Metso Power Oy/Tampere
Joni Maunula
Lentokentänkatu 11, PL 109
33101 TAMPERE

Sample information:	Metso Power, Biofuel samples, Anjalankoski		
Reference:	Anjalankoski/Joni Maunula	Date of sampling:	
		Date of arrival:	4.7.2012
Sampling by:		Research started:	4.7.2012

Fuel samples

				Unit	Method
Sampling point	TP2 23.5.12 11:10	TP3 23.5.12 17:12	TP4 24.5.12 12:05		
Sample ID	12YF 00707	12YF 00708	12YF 00709		
ANALYSIS					
Total moisture	35,1	50,0	54,6	m-%	SFS-EN 14774-2*
Bulk density,as received	290	270	230	kg/m3	SFS-EN 15103 mod.
Analysis moisture	4,0	5,4	6,0	m-%	SFS-EN 14774-3*
Esikäsittely, kokooman tekeminen	ok	ok	ok		RA1040
Pretreatment, fusion	ok	ok	ok		ASTM D6349, modif.
Ash 550 °C, dry basis	39,9≠	27,1≠		m-%	SFS-EN 14775*
Ash 550 °C, dry basis					
Ash 550 °C, dry basis			5,8	m-%	SFS-EN 14775*
Ash 815 °C, dry basis	40,7	19,7≠	5,3	m-%	ISO 1171 modif.*
Volatile matter, dry basis	58,0	62,3	74,4	m-%	SFS-EN 15148*
Carbon, C dry basis	36,1	45,5	49,8	m-%	SFS-EN 15104*
Hydrogen, H dry basis	4,6	5,7	6,1	m-%	SFS-EN 15104*
Nitrogen, N dry basis	0,73	0,85	0,62	m-%	SFS-EN 15104*
Oxygen, dry basis, calculated	18,2	20,5	37,5	m-%	ASTM D 3180, CEN/TS 15296 modif.
Pretreatment, oxygen bomb	ok	ok	ok		CEN/TS 15289, 15408 modif.
Fluoride, F dry basis	0,0055	0,0056	0,0062	m-%	SFS-EN 15289, 15408 modif.*
Chloride, Cl dry basis	0,10	0,073	0,031	m-%	SFS-EN 15289, 15408 modif.*
Sulfur, S dry basis	0,50	0,30	0,16	m-%	SFS-EN 15289, 15408 modif.*
Gross calorific value, dry basis	16,00	18,84	20,12	MJ/kg	SFS-EN 14918*
Net calorific value, dry basis	15,00	17,59	18,78	MJ/kg	SFS-EN 14918*
Net calorific value, as received	8,88	7,57	7,20	MJ/kg	SFS-EN 14918*
Pretreatment, microwave oven (HNO3/H2O2/ HF)	ok	ok	ok		RA3017
Metals 2	ok	ok	ok		

The results apply solely to the samples analyzed. The certificate may only be copied as whole.

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Date: 12.9.2012
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Certificate

Project: 82133560-01/26

	12YF 00707	12YF 00708	12YF 00709	Unit	Method
Aluminium Al	12000	7600	2700	mg/kg dw	RA3000
Aluminium Al	18000	13000	2100	mg/kg dw	SFS-EN ISO 11885 mod.
Phosphorus P	500	640	650	mg/kg dw	RA3000
Potassium K	9800	4900	2200	mg/kg dw	RA3000
Calcium Ca	28000	19000	13000	mg/kg dw	RA3000
Calcium Ca	21000	15000	11000	mg/kg dw	SFS-EN ISO 11885 mod.
Lead Pb	53	25	13	mg/kg dw	RA3000*
Magnesium Mg	2400	1700	1100	mg/kg dw	RA3000
Manganese Mn	270	350	400	mg/kg dw	RA3000*
Sodium Na	8200	4100	1700	mg/kg dw	RA3000
Silicon Si	100000	61000	10000	mg/kg dw	SFS-EN ISO 11885 mod.
Iron Fe	7000	3600	980	mg/kg dw	RA3000*
Titanium Ti	890	660	320	mg/kg dw	RA3000

* Method is accredited by the FINAS. Uncertainty of measurement is reported if requested.

Ramboll Analytics

Niina Nyman
Laboratory Engineer, B. Sc., +358 400 759 657

The certificate has been accepted electronically.

More info Samples are combined with massfraction 50:50 from part samples R1 and LE.
Methods RA3000 : Metals analysed from microwave oven dissolution (CEN/TS 15290),
Method SFS-EN ISO 11885 mod. metals analysed from fusion dissolution (ASTM D6349, modif.).
Particle size distrubution is carried out according to the standard SFS-EN 15149-1, >3,15 mm by Ramboll Finland Oy.
The dublicate results of the determination didn't fullfill the standard criteria. Three determinations were performed instead.

Delivery joni.maunula@metsopartners.com; merja.hedman@metso.com; jaani.silvennoinen@metso.com

The results apply solely to the samples analyzed. The certificate may only be copied as whole.