WP4.2.2 Furnace measurements

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Confidentiality: Confidential

MMEA research program, WP4.2.2 Furnace measurements

Report name : Measurements in BFB-furnace

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Summary report

This report summarizes the main results of the first field experiment of the WP4.2.2 Furnace measurements –project. The experiment was carried out at Ristiina power plant owned by Järvi-Suomen Voima Oy. The BFB-boiler manufactured by Metso Power Oy produces electricity and steam at 74 MW thermal power.

The aim of the experiment was to study the sampling technology of particles and gases at 700-1000°C temperature range at the boiler´s superheater section. The experiment was planned to find out the effects of heating of the sampling probe and the effects of the dilution ratio to the size-distribution and the alteration of particles. This information is needed for the construction of the sampling probe and its usage. Moreover, we compared the sampling results of 13-stage Dekati® Low Pressure Impactor (DLPI) and 5-stage Dekati® Gravimetric Impactor (DGI).

The increase of the temperature of the primary dilutor from 260°C to 420°C did not cause any significant changes in the observed concentrations of SO_4, Ca, K or Na (mg/m^3(NTP)) in the sampling gas. As the primary dilution was decreased from 7 to 2.5, it was observed that the concentrations decreased in the range 0.2-0.6 μm and in the range > 0.6 μm. The use of a cyclone with 2.3 μm cutoff limit decreases significantly the observed Ca concentration in the sampling gas.

The comparison of DLPI and DGI impactors in the size ranges <0.2 μm, 0.2-0.6 μm and > 0.6 μm indicated that there are some differences in element concentrations between these ranges but the total concentrations agree well. There are no significant differences between these two impactor types in the observed sampling gas concentrations of SO_4, Ca, K or Na (mg/m^3(NTP)). The concentration of Cl in the fuel was too low to be used in the comparison of the impactors.

This field experiment was planned and implemented by Tuula Kajolinna, Juho Kauppinen, Harri Mustikkamäki, Raili Taipale and Hannu Vesala from VTT, and Marko Räsänen from Emipromea Oy. The representative of Metso Power Oy was Merja Hedman.

The following pictures and tables describe the measurement site, the experimental arrangements, the measurement parameters and the results.

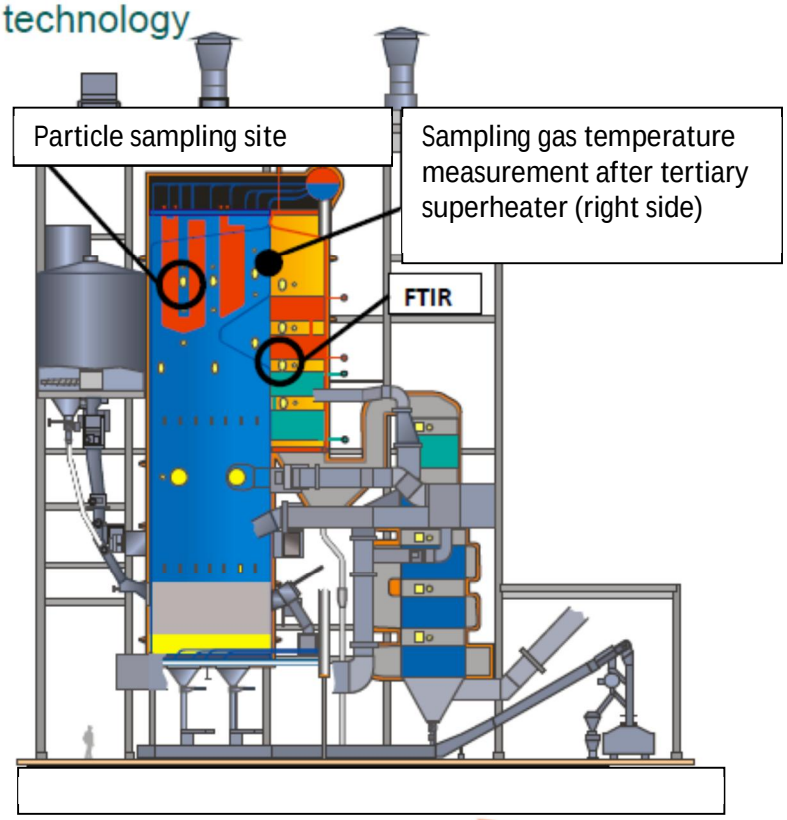
Fig 1. The field test site and the sampling position

HYBEX boiler

Bubbling Fluidized Bed (BFB) technology

Järvi-Suomen Voima,
Ristiina,
Finland

Steam	74 MW_{th} 30 kg/s 84 bar 482 °C
Fuels residue,	Spruce bark, plywood grinding dust,
Start-up	2002



metso

Fig. 2 Measurement arrangements at the superheater section of the power plant.

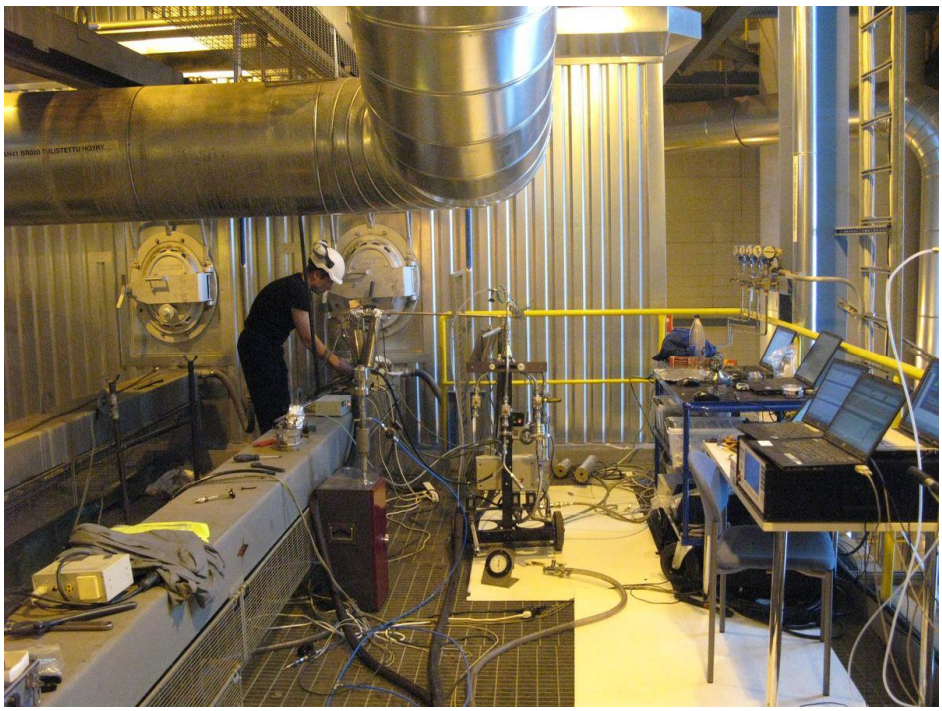
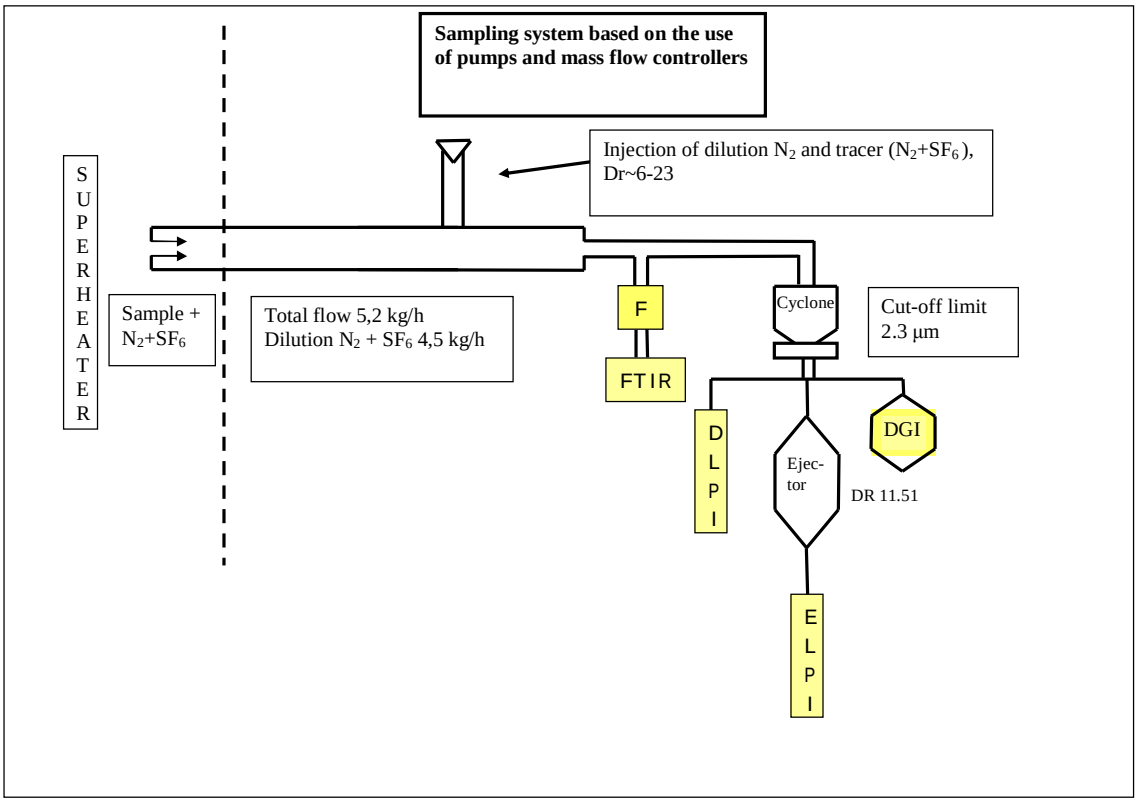


Fig. 3 The sampling systems : VTT Minisampling system



Ejector sampling

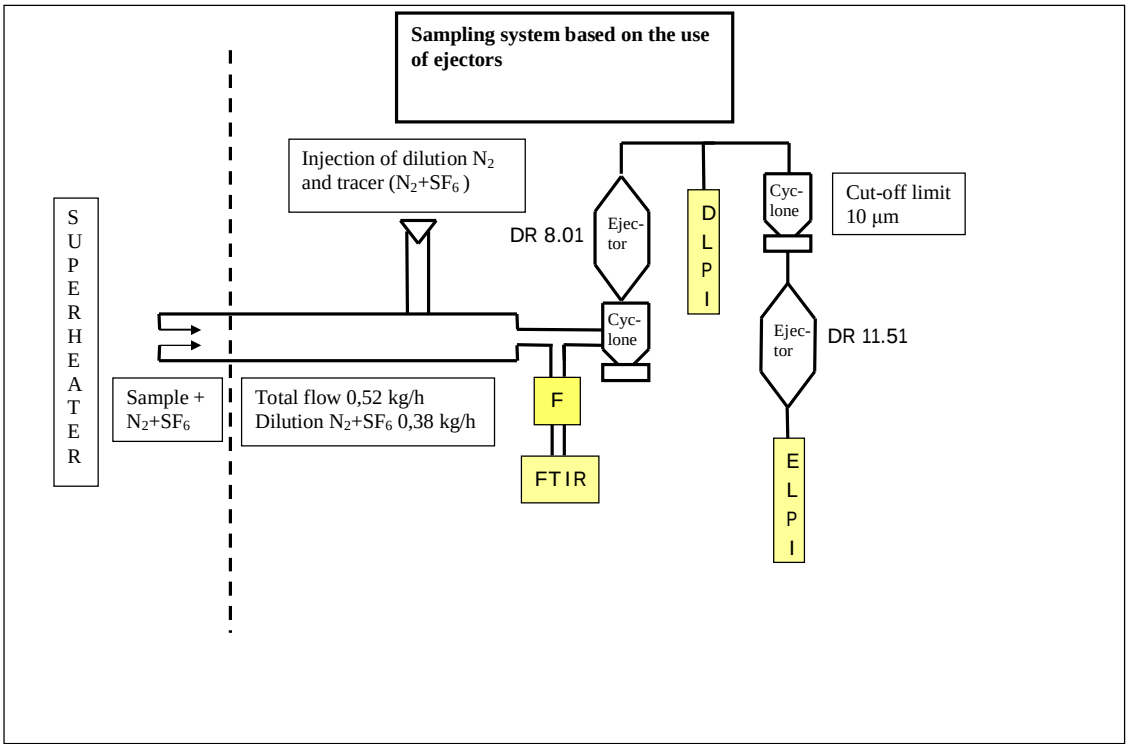


Table 1. The temperature of the primary dilutor, primary dilution factors based on different gases, and mass flow in the sampling probe for the DLPI sampling periods 1-7

	Start	Stop	Temperature of the primary dilutor °C	Primary dilution based on H_2O (wet)	Primary dilution based on CO_2 (dry)	Primary dilution based on SF_6	Mass flow in the sampling probe kg/h
Period 1 : REFERENCE	14:08 14:37	14:22 14:52	230	6,3 6,6	7,5 7,8	7,8 8,0	5,2
Period 2 : large dilution	15:19 16:01	15:59 16:41	190	17,8 18,1	18,8 19,4	22,2 21,8	5,2
Period 3 : two stage dilution	17:17 18:20	17:39 18:37	400	2,7 2,6	2,3 2,1	2,4 2,2	2,5
Period 4 : REFERENCE	12.33 12:50	12:48 13:05	260	5,5 5,6	6,1 6,2	6,3 6,6	5,2
Period 5 : high temperature	14:19 14:42	14.39 15:02	420	5,9 5,9	6,8 7,0	5,9 6,0	5,2
Period 6 : Cyclone	15:30 15:47	15:45 16:02	300	5,4 5,7	6,2 6,5	6,6 7,2	5,2
Period 7 : Ejector	17:12	19:28	270	3,4	3,6	3,9	0,52

Fig. 3 Comparison between DLPI and DGI, element concentrations in particles (mg/m^3(NTP)) in size ranges <0.2 µm, 0.2-0.6 µm and >0.6 µm : results obtained on 1.2.2011

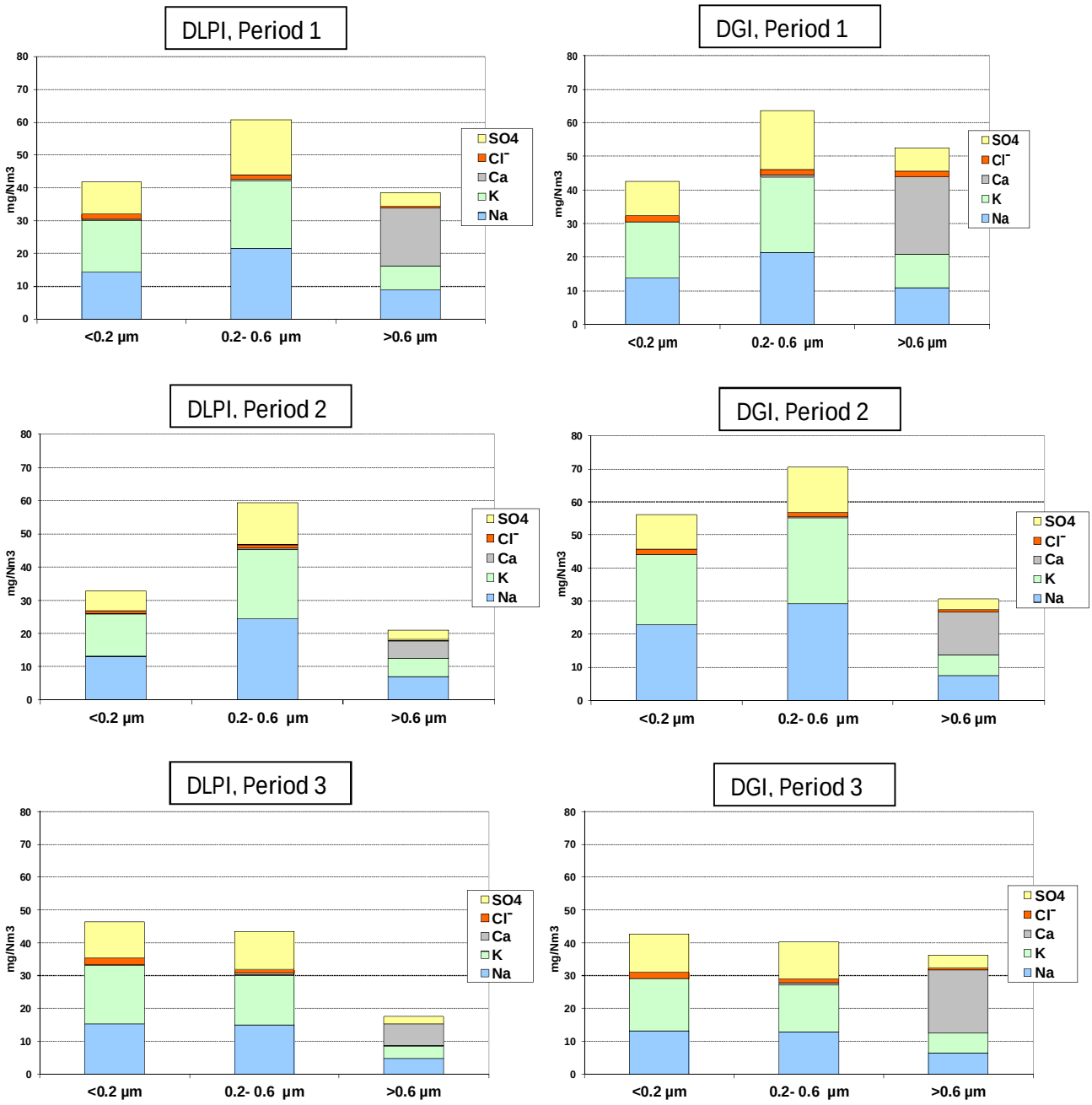


Fig. 4 Comparison between DLPI and DGI, element concentrations in particles (mg/m^3(NTP)) in size ranges <0.2 µm, 0.2-0.6 µm and >0.6 µm : results obtained on 2.2.2011

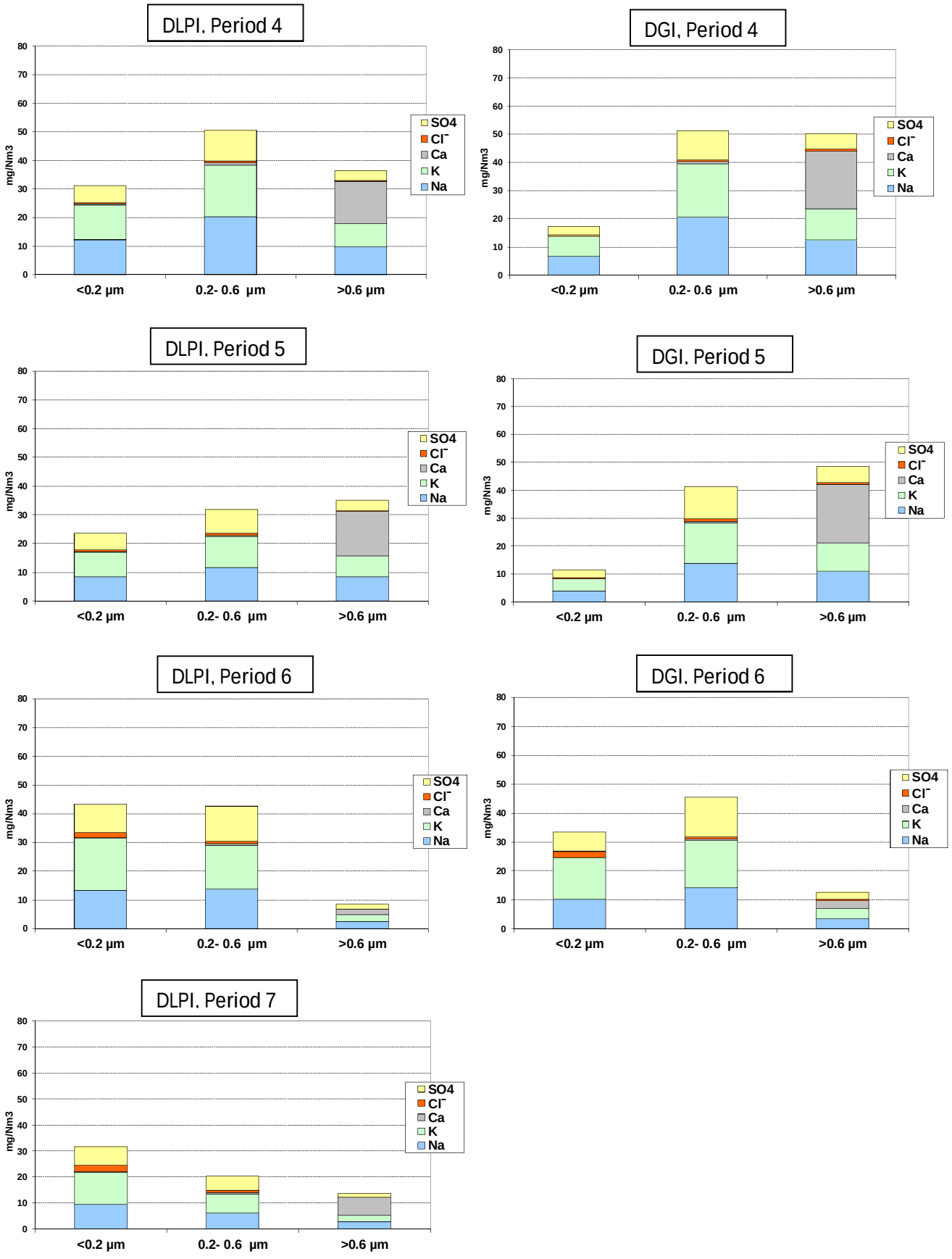


Fig. 5 Comparison between DLPI (■) and DGI(□), the total concentrations of water soluble Na, K, Ca, Cl and SO_4 (mg/m^3(NTP), calculated at 6% O_2) including all analyzed impactor samples.