Physical characteristics of particles in a large CHP plant boiler during co-combustion of coal and biomass pellets

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Need for the reduction of CO_2 emissions drives the energy companies to develop new ways to increase their renewable fuel based energy production. In coal-fired power plant one possibility for that is to substitute part of the coal with biofuel pellets. In principle, this kind of changes in fuels can lead to changes in flue gas and thus has potential to affect also the characteristics of particle emissions of power production.

The studied power plant was 363 MW_{th} reheater equipped natural circulation cylinder boiler. The boiler was equipped with 12 low-NOx technology burners (Tampella/Babcock-Hitachi HTNR low NOx) which situated at the front wall. The power plant is designed to combust pulverized coal, which is grinded in ball grinders. In this study 6-13% of the coal was substituted with wood pellets; roasted pellets or industrial pellets (rp or ip).

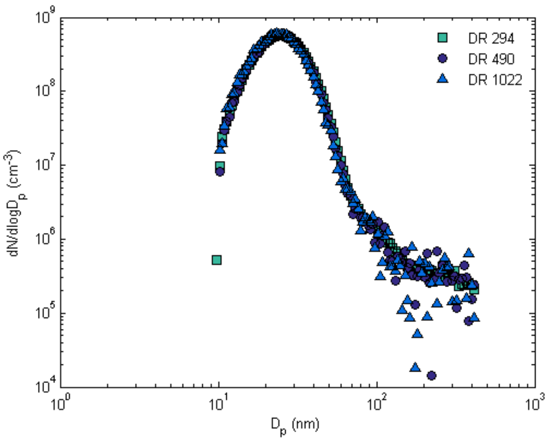

Figure 1. Effect of primary dilution ratio to the particle size distribution measured for coal+rp7.7%

The particle measurements were made from the boiler super heater area, where the temperature ranged 900-1000 °C. Primary dilution of the flue gas sample was performed with porous tube type diluter using 200 °C nitrogen (Aho *et al.*, 2008) as diluting gas. Secondary and tertiary dilution, again with nitrogen, was performed with ejector diluters (Dekati Ltd.). The primary dilution ratio was calculated based on CO_2. Particle number size distribution was measured with Scanning mobility particle sizer (DMA 3071, CPC 3025; both from TSI Ltd.) and Electrical low pressure impactor (ELPI, Dekati Ltd.). The gaseous emissions were measured with FTIR gas analyser (Gasmet DX-4000) after the primary dilution. The CO_2 concentration was also measured after tertiary dilution.

In addition to particle size distribution measurements the charging state of the particles were studied. This was made using a self-made electrostatic precipitator for the flue gas sample to remove periodically the electrically charged particle fraction before the SMPS measurement.

Figure 1 shows that the primary dilution ratio did not affect the particle size distribution. This indicates that the most significant particle formation processes happens at the boiler, not in the flue gas sampling system. This indication was strongly supported by the results related to electric charge of particles. Particle number size distribution measurements showed that the ip-substitution (10.4%) changed the particle size distribution from unimodal to bimodal (see Table 1). Although the observed changes were relatively small, those may have effect e.g. on the loading of electrostatic precipitators in power plants or, in principle on emissions.

Table 1. Characteristic values for particle number size distributions with coal and coal + 10.4% industrial pellet

	Modes	GMD (nm)	GSD	Ntot (1/cm^3)
Coal	1	25	1.4	$246\cdot10^6$
Coal+ 10.4% ip	2	25	1.4	$208\cdot10^6$
		120	1.6	$1.01\cdot10^6$

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