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Comparison of fine particle emissions from a modern small-scale biomass boiler and from a large-scale coal-firing power plant

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As the small- and large-scale use of fossil fuels is reduced throughout Europe and gradually replaced with alternative fuels, there is a need to assess the effect on emissions of particulate and gaseous pollution. Previous studies indicate that wood burning for example is an important source of particulate pollution into the atmosphere (1).

In this study we focused on comparing the particle number and mass size distributions and concentrations from a modern small-scale (7MW) biomass power plant and from a coal-firing large scale (360 MW) power plant fulfilling the current emission regulations.

The particle measurements were conducted with the same instrument setup at both locations during winter of 2006 and 2007. Fine Particle Sampler (FPS-4000, Dekati Ltd.) was used to dilute and condition the combustion aerosol and Electrical Low Pressure Impactor (ELPI, Dekati Ltd.) (2), was used to measure the particle size distributions and concentrations in real-time. The biomass boiler was equipped with gasification of wood, re-circulation of flue gas and flue gas cyclones to reduce the particle emissions. The coal-firing power plant flue gas was cleaned with an electrostatic precipitator, and additionally equipped with a sulphur reduction facility using wet scrubbers and a baghouse filter. All measurements in both locations were conducted after the flue gas pollution control devices.

Biomass burning via fuel gasification differs from typical biomass firing in that the heating power is not generated directly by burning the fuel but by firing the products of the gasification of the fuel. Gasification of the fuel occurs in a stable thick layer of embers on a grate where the fuel turns slowly into ash. Grate movement removes the ashes from the bottom of the embers layer, but also causes some stirring of the embers layer. In flue gas re-circulation part of the flue gas is blown back from the stack into the boiler in an attempt to improve gas mixing and stabilize the embers layer.

The measured particle size from the coal-firing power plant was found to be significantly larger than what was measured from the biomass power plant, which is shown in Figure 1 as normalized particle number distributions. The emitted particle number concentration from the coal-firing power plant is lower than from the biomass plant. However, due to the larger particle size, the emitted particle mass is significantly higher from the coal-firing plant.

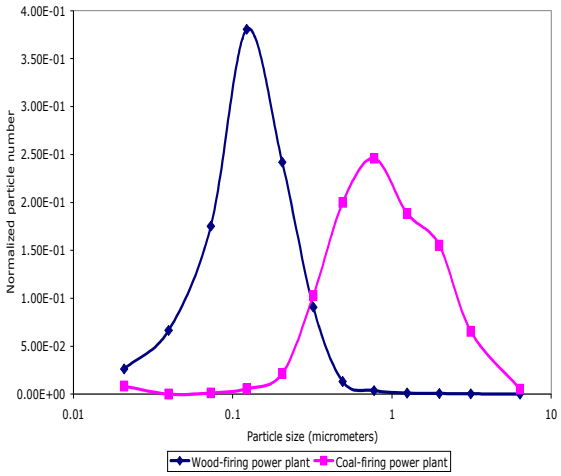

Figure 1. Measured normalized particle number distributions from a wood firing and from a coal firing power plant.

During emission peaks caused by grate movement in biomass plant and ESP rapping and baghouse cleaning in the coal-firing plant, particle size was found to increase due to re-entrainment of collected particles. In addition to these results, some considerations for performing particle measurements at sub-zero temperatures will be presented.

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