Aerosol-Size-Spectra of a Wood-Burning Furnace

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Wood is the most important carrier of solar / renewable energy. The fuel characteristics with low ash and low sulfur content challenges coal, oil, and gas heating systems.

The emitted particle inventory of a LogWIN 30kW solid fuel, wood heating systems was monitored during the start-up-, continuous phase and burnout- phase. The furnace is characterized by a discontinuous charging of roughly 50 cm long logs into combustion chamber.

Upon loading the feeder with beech-logs, the furnace was booted according to a strict protocol for either automatic or manual start-up routine. The aerosol inventory was sampled with a wide-range aerosol monitor consisting of an SMPS and an OPC operated in tandem mode. Besides a typical calorific value of around 15.3 MJ/kg, dry wood still contains up to 15% water (Strehler, 2000). Therefore, a condensation trap was placed inbetween the sample outlet and the measurement devices. Due to the extremely high aerosol concentrations during the start-up procedure, both instruments have been provided with a 1:100 dilution system. Once in normal combustion mode, the furnace's particle inventory is equivalent to a state-of-the-art pellet burner.

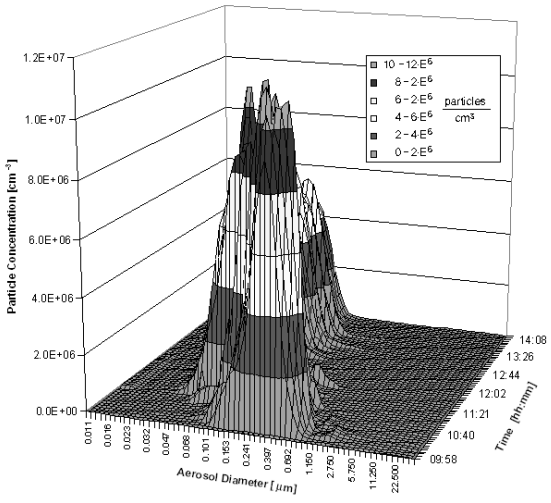

Figure 1. Time-resolved aerosol distribution during start-up and normal combustion mode.

Figure 1 displays the particle distribution for both the start-up and the continuous combustion mode measured at the exhaust outlet some 90 cm downstream the chimney. The continuous combustion mode is characterized by a drastic particle-size shift from a coarse range around 300 nm to a finer range of about 70 nm.

Once the furnace switched over into a continuous combustion mode, the generated aerosol was again monitored at the end-of-stack (roof-top) of the test-site. The slightly altered particle concentration emitted into the environment was gathered and used for particle deposition calculations with the stochastic lung deposition model developed by Koblinger & Hofmann (1990).

The model revealed deposition peaks past the 15th generation (Fig. 2), which belong to the pulmonary or alveolar region (Yeh & Schum, 1980). This alveolar deposition is common for combustion aerosols. It has been proposed that alveolar deposition is associated with increased cardio-circulatory problems, as the immune system is the primary organ to remove entrapped particles (Donaldson et al., 1988).

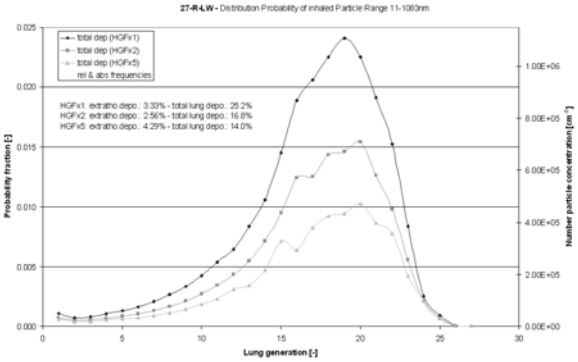

Figure 2. Modelled deposition pattern of the end-of-stack aerosol, using the Monte Carlo code IDEAL. Plotted are three individual simulations for various Hygroscopic Growth Factors (HGF).

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