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Measures in the Wood Combustion Process for Particle Emission Control

Particulate matter (PM) is the key emission to be reduced in wood combustion processes. The aim of the project was to achieve low particulate emission from biomass fired boilers by measures in the combustion process. Additi-on-ally the requirement was a robust combustion for fuel variation in terms of water content and fines in the fuel.

Design and Process Features

To achieve process flexibility to burn fuels with varying density and humidity, flue gas recirculation (FGR) was selectively employed. The FGR system connects the boiler exhausts with the primary combustion chamber.

The main element of innovation in the primary combustion chamber is the inclined grate in combination with the stoker. Small air inlets causing increased pressure drop providing an even air distribution in the ember bed.

To reduce the nucleation of particles the gasification process in the ember has to be kept at modest temperatures and at substoechiometric air/fuel ratios. This measure prevents potassium and calcium from oxidation and thus from evap-oration. Test series have been performed at air/fuel ratios of 1.0, 0.8, 0.6 and 0.45 in the primary chamber.

Analysis

A scanning mobility particle sizer (SMPS) was applied to analyze size distributions and total number concentrations of particles in the range from 0.008 to 0.6 µm (PM0.6). The characteristic data of the nanoparticles is given by the MODE diameter as the most frequent size of a particle population and the total number concentration (TNC). In addition to the nanoparticle analysis total particle emission (TPE) have been measured by gravimetric filter system.

Conclusion

It could be shown that a significant reduction of physiologically relevant PM0.6 emissions as well as the total particle emissions (TPE) is possible when applying exhaust gas recirculation when burning dry fuels. At higher heat loads TPE emissions increase when high gas flow velocity in the primary chamber causes entrained fly ash particles whereas PM0.6 emissions remain at low level. The combination of the high ember bed and an even air distribution results in a low particle emission for a broad range of wood fuels from high to low water content.

Acknowledgement

The project was funded by the Swiss Agency for the Environment, Forests and Landscape (BUWAL).

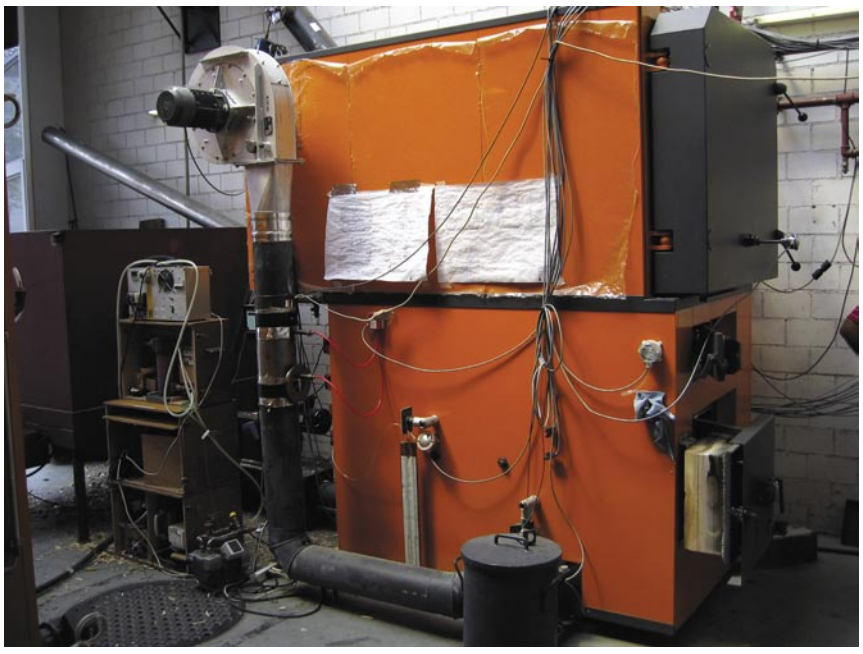

Fig. 1: *Boiler prototype with two-stage combustion applying flue gas recirculation (FGR) with 240 kW nominal heat output.*

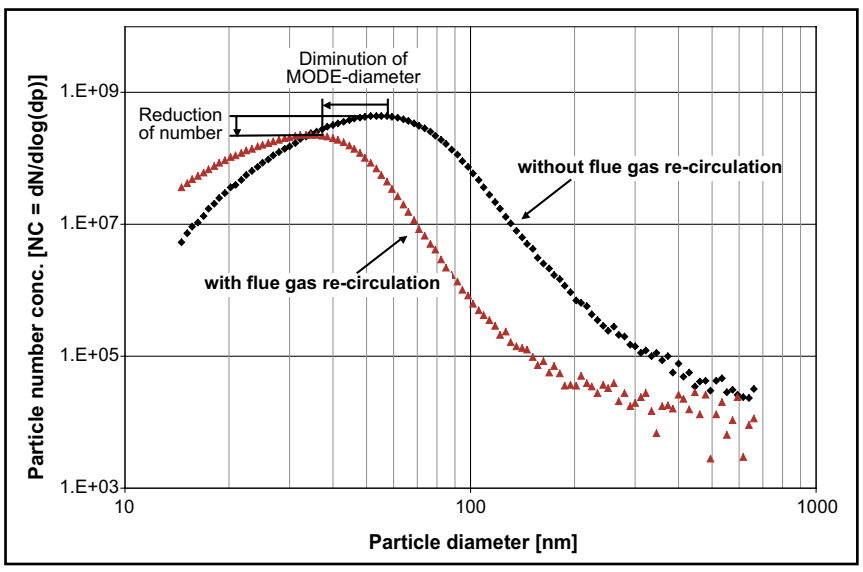

Fig. 2: *SMPS-plot of nanoparticle (PM0.6) number concentration with and without flue gas recirculation.*

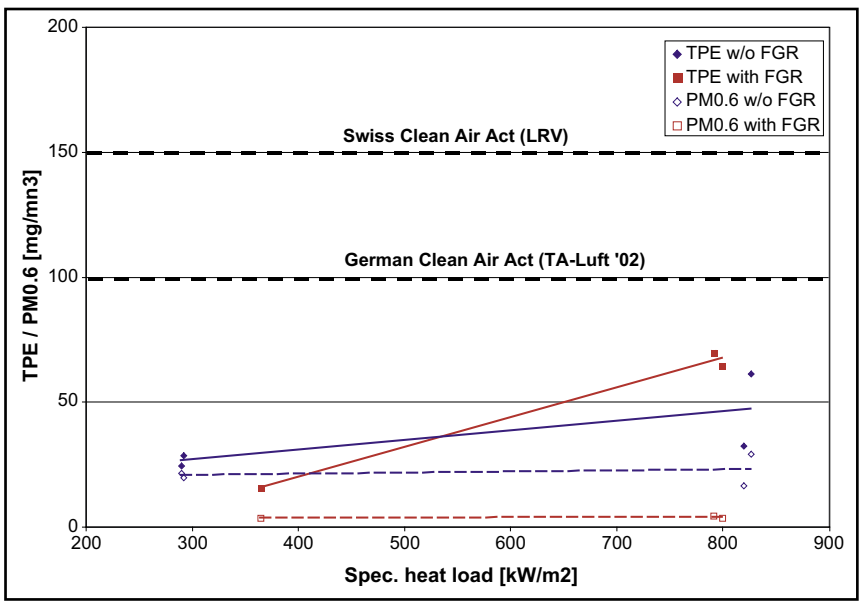

Fig. 3: *Total particle (TPE) and PM0.6 emissions at different heat loads and application of flue gas recirculation (FGR). The Swiss and German emission threshold values are indicated in the graph.*

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