



Emissions Measurement and Reduction as Applied to Fine Particles from Wood Combustion

Stephan Michael¹, Josef Wüest¹, Tom Strebel¹, Donato Rubinetti², Beat Müller³, Daniel Jud³, Karin Vetsch³

¹Institute of Biomass and Resource Efficiency, FHNW and ²Institute of Thermo and Fluid Engineering, FHNW, 5210 Windisch, Switzerland

³OekoSolve AG, 8889 Mels-Plons, Switzerland

Fine Particle Emissions

Biomass-fired power plants can supply electrical and thermal energy at the location where demand exists. This ability – combined with virtually CO₂-neutral combustion – makes biomass an important pillar in the energy mix of the future. However, its use is also associated with a number of challenges – including potentially higher particulate emissions, which can be responsible for pulmonary disease. The Institute of Biomass and Resource Efficiency (IBRE) utilizes different measurement devices to quantify both the amount and size of combustion-generated particles in laboratory and field environments. IBRE also works closely with standardization bodies and lawmakers to establish and enforce regulations that improve air quality and collaborates with its industrial partners on the development of clean biomass furnaces and effective exhaust gas cleanup treatments.



STS 0396

Test Laboratory for Wood Firing Systems

- Modern test facilities for initial type testing of boilers for solid fuels and residential solid fuel burning appliances
- Gravimetric measurement of total amount of particles → relevant for type approval testing
- Measurement of particle size distribution and average diameter → assessment of toxicity is possible

Standards and Directives

- Collaboration with national and international standardization bodies on “Ecodesign Directives” (EU), “Swiss Ordinance on Air Pollution Control” (CH), and “Federal Immission Control Act” (D)
- Comparison of established and new measuring methods
- Consulting for federal departments and private associations

Primary and secondary measures to limit emissions

- Optimization of furnace design, on air staging and ash disposal
- Development and improvement of exhaust gas clean up technology such as electrostatic precipitators (ESP)
- Simulation of ESPs (geometry, field intensity, varying temperatures)



Figure 1: Deposits of particulate matter around ESP in a chimney

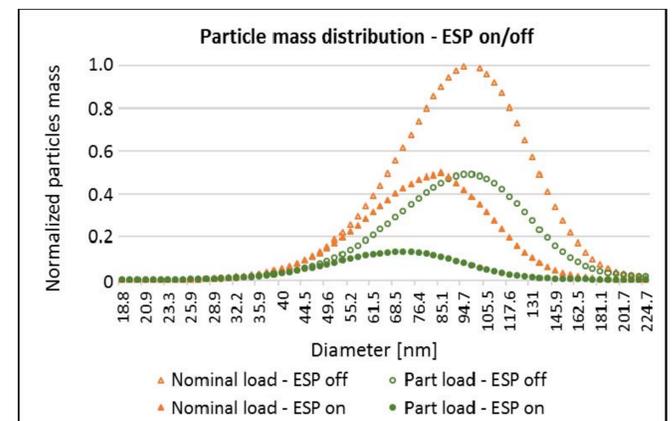


Figure 2: Reduction of particulate matter with/without ESP

Innovative discharge electrode as an integrated particle separator for wood boilers

A project funded by KTI (Commission of Technology and Innovation) in cooperation with OekoSolve AG

ESPs are well developed exhaust gas treatment systems that, however, increase system size, which is an important issue for small scale boilers. The project is focused on integrating an ESP into the appliance itself. This effort will significantly reduce costs and space requirements to further spread implementation in wood combustion systems.

Project goals

- Integration of an high voltage electrode inside a standard boiler
- < 20 mg/m³ fine particles and a particle removal rate of at least 60 %
- Establishment of design rules to find the best electrode position independent of furnace type

Current status

- Development of an electrostatic precipitation model using Comsol Multiphysics is completed
- Validation of the model in defined setups is ongoing

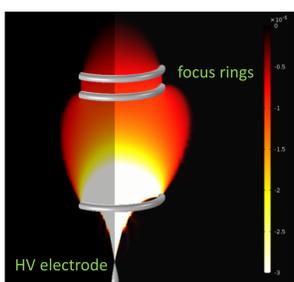


Figure 3: 2D numerical simulation of Corona discharging (colorbar correlates with the strength of the electric field); focus rings are able to constrain the electric field and are therefore able to guide the generated ions

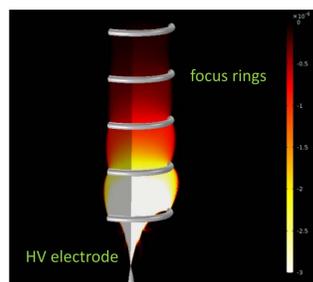


Figure 4: ESP on a rooftop in Saas-Fee

Real-world emissions from wood combustion after treatment by an electrostatic precipitator

A project funded by BAFU/FOEN (Federal Office for the Environment)

The "car-free" community of Saas-Fee installed 2012 over 100 ESPs to provide clean, wood-fired heating systems. IBRE will perform measurements in this unique field laboratory to test the efficiency of particle precipitation in different appliances.

Project goals

- Development of a mobile measuring device, that is within a 20 % range of a standard gravimetric measurement
- Determination of ESP particle precipitation efficiency rates in the field
- Recommendation for lawmakers on an accurate and easy to handle field method for the measurement of fine particles

Current status

- Comparison of different measuring devices at laboratory conditions
- Definition and validation of the new field measuring set-up is ongoing
- Measurements in Saas-Fee are scheduled for winter 2018/2019