Reduction of fine particle emissions from small scale biomass combustion by use of compact electrostatic precipitation module

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Keywords: combustion aerosol, particle charging, electrostatic precipitation
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The reduction of fine particle emissions from small scale biomass combustion is an actual problem. The electrostatic precipitators (ESPs) are well known apparatus which ensure effective particle collection by various operation conditions. The development of the ESPs for small scale biomass, especially wood, combustion needs the correspondence to the several demands, such compact design, low pressure drop and power consumption. The ESP should be characterized by low operation costs and high safety.

The current study is devoted to the development of compact electrostatic precipitation modules which could be applied for exhaust gas cleaning from small scale biomass, especially, wood chips and wood pellets boiler.

The results are obtained in the framework of the joint project by the partner consortium, which includes the Karlsruhe Institute of Technology, HDG Bavaria and CCA-Carola Clean Air GmbH. The study was carried out at the test facility of the first partner and the second partner provided the small scale wood chips boiler for the investigations and the third partner developed and manufactured the compact electrostatic precipitation modules.

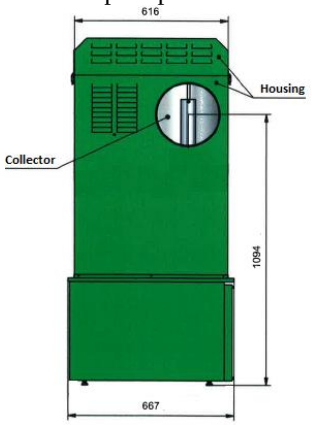

Figure 1 Compact CAROLA® -ESP for 50 kW boiler

The compact CAROLA®-ESPs were developed for exhaust gas cleaning from the boilers with heat capacity up to 50, 100 and 200 kW. The modules could be installed downstream the boilers ("Stand alone" units, Fig.1) and could be integrated into the housing of the boiler. The control of the ESP could be realized using the ESP control unit or the boiler could partly ("Adapted" unit) or completely ("Integrated" unit) overtake the control of the ESP operation parameters.

Among the study at the test facility, the ESPs were also operated in "field" conditions. In the report the authors discuss the results of the long-term operation stability of the ESPs. It is shown, that the stability of operation of the ESP depends on combustion conditions, e.g. gas temperature and composition. During the start-up combustion phase, the corresponding condensation phenomena could disturb the ESP operation stability, causing spark-over discharges and short-current. The gas temperature and fly ash composition are responsible for back corona discharge in the ESP ionizer and spark-over discharges. The loading of the ionizer with particles is responsible for spark-overs and high particle number concentrations are responsible for the corona discharge suppression.

In the report the authors present the technical solutions for the above mentioned problems, e.g. they discuss the approaches to the development of special high voltage insulators which ensure the stable ESP operation even in high temperature gases. The use of the special designed ionizer cleaning system ensures effective particles charging by various operation conditions. The corresponding approaches to the control of corona discharge parameters allow the reduction of spark-over discharges and improvement of the stability. It is shown, that there is a limit of power consumption P for particle charging for which the collection efficiency remains rather constant even with further increase of the P. In the report the authors also discuss the approaches to the design of the compact collector stage of the ESP in which the charged particles collection takes place under the influence of the aerosol space charge effects.

The tests were carried out both for a single-field and so called two-field ESPs, when the two of single-field compact modules were installed one after another. The last technical solution is useful for combustion not only pf high but also of low quality fuel. The compact ESP modules could be recommended for design of the ESP up to 1000 kW.

Acknowledgement: Acknowledgement: The authors thank Klaus Woletz, Wolfgang Aich and Damir Brand for their able technical assistance. Funding by the Fachagentur Nachwachsende Rohstoffe e.V. (FNR), Germany (FKZ 22017814)