Study of a pilot electrostatic precipitator for various combustion conditions

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A pilot small scale electrostatic precipitator was designed and tested with wood-chips and wood-pellets boilers. Among the boilers, a stove was used for the combustion of wood-logs and coal briquettes. The pilot electrostatic precipitator was installed downstream the combustion unit, in-between the last one and the chimney (Fig.1).

Figure 1. Pilot electrostatic precipitator downstream the stove.

The electrostatic precipitator included a casing with corresponding gas input and output tube gas ducts. The ESP was equipped with an ash-box, which, being applied for collection of the precipitated fly ash, was used as a part of the particle ionizing stage. The high voltage electrodes were maintained at the high voltage rod, connected with the output of the high voltage power supply unit. The DC corona discharge was generated at the sharp points of the barbed high voltage electrodes installed inside the ash-box, which was grounded and served as an opposite electrode.

The experimental study were carried out for the positive and negative polarity of the applied voltage. The corresponding current-voltage characteristics were measured for various operation conditions with and without fuel combustion. The particle mass concentrations in the gas flow upstream and downstream the electrostatic precipitator were simultaneously measured using two analysers SM 500 (Fa. Wöhler).

The test were carried out not only for the variable operation conditions, but also for various design configurations of the high voltage electrode systems. The scope of the tests was the optimization of the ESP ionizing system and the improvement of the design of the high voltage insulator.

The negative polarity corona discharge allows higher mass collection efficiencies than the positive polarity corona. The ESP was operated at applied voltages up to 22 kV and corona current up to 2,1 mA what corresponds to corona discharge power consumption of ~45 W.

Tests 1 and 2 were carried out for variable geometry of the electrode system (wood logs combustion). The test 2 and 3 were carried for wood-logs and coal briquettes combustion (constant electrode geometry). The increase of the corona discharge power consumption results in enhancement of the mass collection efficiency (by operation without spark-over discharges).The ESP mean value collection efficiency is in-between 75-80%, reaching at higher corona discharge power consumption values >90%.

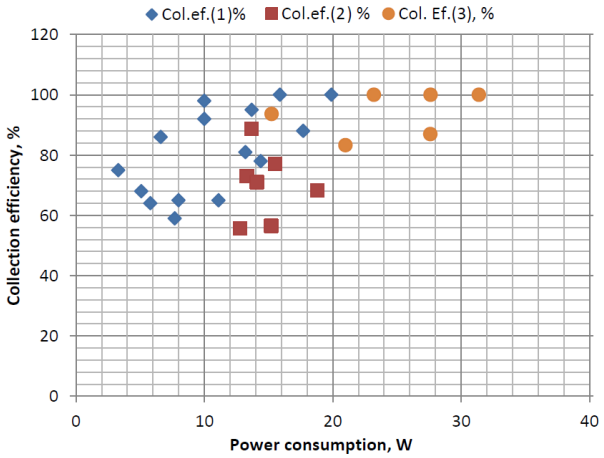

Figure 2. ESP mass collection efficiency for various fuels and electrode system configurations.

The tests with pilot electrostatic precipitator were also carried out with wood-chips and wood-pellets boilers. The data for the mean mass collection efficiency are similar to the measurements with logwood combustion.

The results of the study are recommended to be used for the design of the novel compact ESP for small scale biomass combustion facilities.