Loading of ESP electrode system with fly ash and its influence on corona discharge stability

A. Bologa and K. Woletz

Institute for Technical Chemistry, Karlsruhe Institute of Technology,
76344, Eggenstein - Leopoldshafen, Germany
Keywords: electrostatic precipitator, corona discharge, fly ash, electrode system, spark-over discharges
Associated conference topics: 1.5, 1.7
Presenting author email: andrei.bologa@kit.edu

Electrostatic precipitators (ESPs) are widely used for reduction of particle emissions from exhausted gases. The current work reflects the results of the study of loading of the ESP electrode system with fly ash and its influence on the stability of corona discharge, which defines the ESP collection efficiency.

The study focuses on the electrostatic precipitator, applied for cleaning of exhaust gases from small-scale biomass combustion. In the ESP, the electrode system consists of a grounded tube electrode and high voltage (HV) star-form electrode installed on a HV rod, which is maintained axially inside the tube. The HV electrodes has multiple sharp points, on which corona discharge is generated.

The loading of the grounded electrode with fly ash reduces electrode gap width, what results in increase in the number of spark-over discharges. The loading provokes the generation of back corona, which strongly disturbs the corona discharge stability, enhancing spark-over discharges in the electrode system. Back corona decreases the ESP collection efficiency.

Until the HV electrodes sharp points remain free from fly ash, the loading of the lateral surface of HV electrode (Fig. 1, upper) does not disturb the corona discharge stability.

The exhaust gas properties such temperature and humidity, as well as strong electric field and electrohydrodynamic phenomena, provoke the growing of "ball" form (Fig. 1, right up) or "rod" form (Fig. 1, right down) solid "caps" on the sharp points of HV star-form electrodes. The formation of solid "caps" reduces the width of electrode gap, what strongly disturbs corona discharge.

Until solid "caps" are dry, they "isolate" sharp points, reducing corona discharge current at the same value of applied voltage. When humid exhaust gas flows through the ESP, for example, during the start-up combustion phase, corona discharge takes place on the top of solid "caps", provoking spark-over discharges in the electrode gap.

The analysis of SEM micrographs of the solid °cap" (see Fig. 2) permits the assumption that the formation of layer-form structure of fly ash "caps" takes place during the stop-and-go operation of the combustion facility. The sedimentation of wetted fly ash particles on the surface

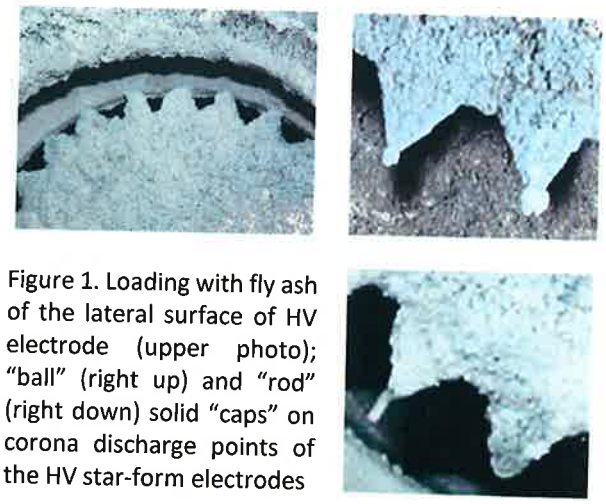

Figure 1. Loading with fly ash of the lateral surface of HV electrode (upper photo); "ball" (right up) and "rod" (right down) solid "caps" on corona discharge points of the HV star-form electrodes

Figure 2. View of the SEM micrograph of the "rod" solid fly ash loading

of "caps" in the corona discharge field results in the growing of the layers, which are further dried in a hot exhaust gas.

The analysis of fly ash composition from the lateral surface of HV electrodes and solid "caps" shows, that in fly ash from the surface of HV electrodes, the Ca, C and O dominate in the statistic percentage, what is characteristic for calcium carbonate. Inside the solid "caps", the K, C and O show their statistic percentage priority, what is characteristic for potassium carbonate.

The results of the study are used for optimisation and further development of the ESP electrode system.