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Characterization of biomass fly ashes from different flue gas treatments

CHRISTOPH MASCHOWSKI[1], RETO GIERÉ[1], GWÉNAËLLE TROUVE[2], PATXI GARRA[2], GONTRAND LEYSSENS[2], CORNELIUS SCHNÖNNENBECK[2], PETER KRUSPAN[3]

[1] Albert-Ludwigs-Universität Freiburg, Germany (maschowski@minpet.uni-freiburg.de)
[2] Université de Haute-Alsace, Mulhouse, France
[3] Holcim Europe Services Ltd., Allschwil, Switzerland

The combustion of solid biomass for the production of heat and electricity in central Europe is in heavy demand for the last years. In medium-scale facilities, e.g. district-heating power plants, the fuel type consists of wood chips and forest residues, which are not standardized materials. Therefore, the quality is variable depending on the supplying conditions. During combustion, many chemical, ash-transforming reactions take place and a portion of the ash is transported along with the flue gas. This fraction is enriched in sulfates, chlorides, and particles that contain heavy metals, known as fly ash, dust, or particulate matter. To reduce emission of dust into the environment, the flue gas passes through various types of air-pollution control (APC) devices (cyclones, electrostatic precipitators, and baghouse filters). The trapped fly ashes have to be disposed of at high cost.

In this study, fly ash samples from six district-heating biomass combustion plants with three different filter types were investigated by using scanning electron microscopy and size distributions measurements on suspended solutions and in air medium to characterize the morphology and size distribution of the ash particles. Furthermore, X-ray fluorescence and atomic absorption spectroscopy were performed to gather bulk chemical compositions, and X-ray diffraction with subsequent Rietveld refinement was applied to determine crystalline phases. The results were compared with the compositions of the corresponding bottom ashes and inorganic constituents in the fuel. The chemical composition as well as the shape and structure of the particles trapped are variable and depend on the APC type. Because the bulk chemical composition of the fly ashes strongly depends on the particle size distribution, the main controlling factor seems to be the cut-off diameter of the different filter types. Secondary particles, such as CaO (lime) and K_2SO_4 (arcanite) are abundant in the fine fraction of the fly ashes and are beeing trapped most efficiently by electrostatic precipitators, whereas primary particles auch as $CaCO_3$ (calcite) have larger sizes and are trapped by each APC type in comparable amounts. The data can be used to assess the utilization potential of the fly ashes, e.g. as a secondary raw material for the cement industry.