Ashes from biomass combustion: waste or resource? Characterization and utilization potential of ashes from different types of solid biofuels

Christoph Maschowski[1]

Reto Gieré[2]

[1]maschowski@minpet.uni-freiburg.de

[2]giere@uni-freiburg.de

The combustion of solid biomass to produce electrical power and heat has become an important factor in the aim to substitute fossil and nuclear fuels by renewable energy sources. Solid biomass fuels are mostly obtained from waste products from forestry (mainly wood) and agriculture (mainly straw), and thus do not have the problems associated with liquid biofuels, which due to rapid increase in demand lead to recognizable intrusion into acreages by energy crops. Nevertheless, the use of energy crops for solid biomass combustion, such as Miscanthus grass, has increased in the last decade.

Solid biomass contains various inorganic components in different amounts and speciation, depending on, e.g., plant type, soil, and harvest season. They remain as ashes after combustion, as they are non-combustible. One portion mostly stays at the combustion grate as bottom ash; the other is carried out of the boiler as fly ash with the flue gas. In modern combustion devices, various filter techniques (e.g. cyclones, electrostatic precipitators) remove a significant amount of this fly ash from the flue gas, with the remainder released into the atmosphere. The quantities, physical properties, and chemical composition of these fractions strongly depend on the combustion parameters, such as burning temperature, combustion scale, fuel type, which also determines the amount of unburned carbon left after the combustion process. Incomplete combustion often leads to the formation of soot and organic compounds such as dioxins or tar, which both can be hazardous for living organisms. The variety of possible particle types, which are generated during the combustion of biomass, is pronounced, as is the diversity of inorganic phases, which form from inorganic components.

Bottom ashes (in large-scale combustion devices fly ashes as well) usually are treated as waste products. Bottom ashes are considered to be unproblematic and sometimes are used as fertilizer additives, because thy also contain valuable nutrients and can act as a pollutant absorber, i.e. for heavy metals. Fly ashes, however, may be enriched in heavy metals and therefore have to be disposed as problematic waste. The suitability of bottom ashes for utilization heavily depends on the fuel type and quality. Characterization of a wide range of biomass ash types can help to assess the risk or potential, especially when it is crucial to return ashes from biomass combustion to the soil to avoid depletion of nutrients.

In this study, various bottom ashes from eight different wood types have been investigated in regard to their mineral composition by using X-Ray Diffraction Analysis and Rietveld-Refinement. From these data, the nutrient-supplying substances were assessed. Furthermore, heavy metal contents were determined by using Atomic Absorption Spectroscopy, to assess the maximum ratio of these ashes when used as fertilizer additives.