WASTE INCINERATION BOTTOM ASH AS CONSTRUCTION MATERIAL: BUILDING APPLICATIONS AND IMPACTS ON SUBSTANCE FLOWS

David Laner* and Iveta Vateva*

**University of Kassel, Faculty of Civil and Environmental Engineering, Research Centre for Resource Management and Solid Waste Engineering, Mönchebergstraße 7, 34125 Kassel, Germany*

The incineration of municipal solid waste (MSW) in waste-to-energy plants is a central element of modern waste management. In Germany around 20 million tons of municipal waste were incinerated in 2016, which resulted in 5 million tons of municipal solid waste incineration (MSWI) bottom ash (ITAD 2019, DESTATIS 2018). This residue is subsequently treated to separate ferrous and non-ferrous metals and direct them to recycling (cf. Figure 1). The remaining predominantly mineral material is mostly recycled as road construction and landfill construction material (together 90%) or otherwise landfilled (around 10%). Before treatment, the MSWI bottom ash is usually stored and different reactions occur, which lead to higher physical stability and lower chemical reactivity of the MSWI bottom ash. With regard to the use of mineral MSWI bottom ash fractions as building material, in particular salts (chlorides, sulfates), increased residual contents of metallic Al (hydrogen gas formation, swelling) and increasing heavy metal contents in the finer grain fractions (e.g. Zn) represent major challenges for high quality applications. The use as building materials also holds the potential to dissipate unwanted substances (especially heavy metals) in the built environment. Therefore, further treatment of the mineral residue of the MSWI bottom ash is necessary to utilize the material in high quality building materials (e.g. concrete bricks). This requires additional effort (materials, energy) and is associated with losses (e.g. fines to sludge in wet treatment processes). As a consequence, the actually recycled material per mass of input is lower for high quality applications such as concrete aggregates or cement additives than for already established utilization options such as (non-binding) road construction material or equilibration layers for landfill construction. Hence, identifying suitable MSWI bottom ash materials and employing the right pre-treatment technique for the highest value application is the key to attaining a circular economy (cf. Joseph et al. 2018).

The aim of the present study is to investigate the relationship between intensified treatment of MSWI bottom ash, consequent building material applications (including markets and substitution effects), and the fate of environmentally relevant substances for different treatment and utilization options. Therefore, several processing routes (i.e. conventional vs. advanced metal separation with/without further treatment of the mineral residue) are defined and substance flows are modeled based on data for MSWI in Germany. Established utilization options for pre-treated MSWI bottom ash are compared to high-quality applications in concrete, where MSWI bottom ash can be used as recycled aggregates (instead of sand and gravel) and/or as cement additive

(instead of binder or cement raw meal). Based on material and substance flow analyses for each processing route and utilization option (via different scenarios), trade-offs between the quantity and quality of MSWI bottom ash utilization in building products are explored and material efficient and clean recycling options are identified from a German perspective. Thereby, the mass-level of recycling is investigated against the level of contaminant cycling (cf. Pivnenko et al. 2016). Finally, the effect of large-scale implementation of promising recycling routes with respect to environmental impacts (screening LCA) and substance flow patterns (direction to suitable sinks) are roughly evaluated for the national MSWI system in Germany and recommendations on future research are provided.

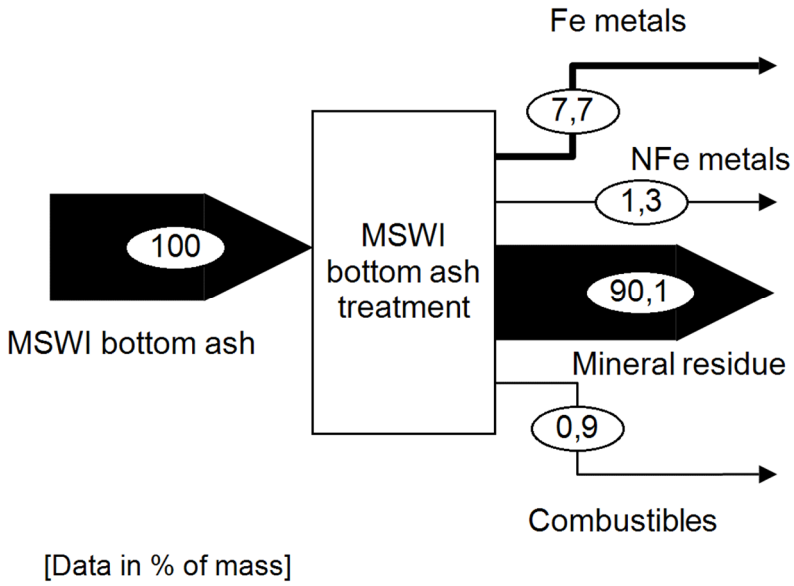

Figure 1: Average output flows from MSWI processing in Germany (based on Kuchta and Enzner 2015)

References

DESTATIS (2018). „Abfallentsorgung“. Statistisches Bundesamt, Fachserie 19(1), 2016.

ITAD (2019). “Reststoffe”. https://www.itad.de/ITAD/reststoffe, accessed on April 10th 2019.

Joseph, A. M., R. Snellings, P. Van den Heede, S. Matthys and N. De Belie (2018). "The Use of Municipal Solid Waste Incineration Ash in Various Building Materials: A Belgian Point of View." 11(1): 141.

Kuchta, K., Enzner, V. (2015). „Metallrückgewinnung aus Rostaschen aus Abfallverbrennungsanlagen - Bewertung der Ressourceneffizienz“. Entsorgergemeinschaft der Deutschen Entsorgungswirtschaft e.V.

Pivnenko, K., D. Laner and T. F. Astrup (2016). "Material Cycles and Chemicals: Dynamic Material Flow Analysis of Contaminants in Paper Recycling." Environmental Science & Technology 50(22): 12302-12311.