Resources from Waste

The global demand on resources is continuously increasing.

Countermeasures to mitigate the consumption of resources are usage of secondary raw materials, substitution or recycling.

At first glance recycling stands for the return of glass, paper, plastics or different metals in the material flow.

However, mineral aggregates for construction purposes are recovered from demolition waste as well as industrial and incineration residues.

Waste incineration served originally for reduction of volume and inertisation, especially for germ destruction. Today, the recovery of waste heat and energy from waste becomes more and more important.

Around two hundred and fifty kilograms bottom ash remains after incineration of one thousand kilograms municipal solid waste. In Germany about five million tons of such bottom ashes are generated annually.

Bottom ash is an inhomogeneous mixture consisting of mineral aggregates and metals as well as small amounts of unburnt materials like stones, glass cullet, ceramics and organic residues.

The share of metals in bottom ash is around ten percent whereby ferrous metals are prevailing. A smaller amount of nonferrous metals consists especially of aluminum and copper as well as the alloys brass and stainless steel.

About eighty percent of bottom ash is represented by mineral aggregates comprising ash and slag particles in equal shares. Slags are vitreous or crystalline melting products.

Bottom ashes are discharged in wet condition from the furnace chamber and have to be aged prior to subsequent utilization for chemical and physical stabilization. As a consequence, the contained pollutants will be immobilized or rather the tendency for their release is lowered. But, in doing so, the occurrence of valuable raw materials is influenced, too.

Mineral coatings are formed on nearly all surfaces of all particles. Moreover, due to agglomeration of different types of particles bottom ash will be cemented. In consequence, the recovery of metals is much more complicated.

Today, in some treatment plants bottom ashes are processed for metal recovery as early as possible after incineration and the stabilization process is carried out afterwards.

A few treatment plants operate in wet condition in order to minimize the content of salts, especially of chloride and sulfate, in the remaining mineral aggregates. But generally the mechanical treatment of bottom ashes is processed dry.
Magnetic separators and eddy current separators are typical devices for the metal recovery. They are implemented in each plant for bottom ash treatment. Eddy current separators induce in electric conductive particles magnetic fields, which are contrary to the alternately arranged permanent magnets located in a rotating magnet wheel.

While non-conductible particles fall from the conveyor belt in correspondence to the forces of gravity and velocity, conductible particles are extracted by the repulsive forces.

Sensor based classifiers are rarely used for bottom ash treatment. Impact, hammer and jaw crushers are used in various manners and in different positions of the treatment train.

The implementation of every additional process step leads to a different extend to a considerably higher amount of fine particles in the remaining mineral aggregates.

The Bundesanstalt für Materialforschung und –prüfung, BAM, represented by the department „Contaminant Transfer and Environmental Technologies“ is focusing on these fine particles in cooperation with different partners. Today, the fraction of fine particles is generally landfilled, therefore a high potential for saving of landfill space and for recovery of valuable raw materials is given here.

The project partner Heidemann Recycling puts emphasis on a dry treatment train without crushing.

This is obtained by an optimized eddy current separation. The devices were developed by the operator itself and are being continuously adjusted in the process.

The minimization of an additional fine portion to gain recyclable grain size distributions of the mineral aggregates and high recovery rates for all sorts of pure metals above 0 point five millimeters are the objectives.

The project partner TARTECH Mineralkaufbereitung applies another treatment concept.

The bottom ash is crushed after ageing by different devices in order to increase the recovery rates and quality of extracted metals.

High speed rotation accelerators were developed to uncover metals as much as possible, to singularize agglomerates and to limit the size reduction of the mineral residues at the same time.

In the framework of a joint project the treatment of the fraction below two millimeters was investigated.

Scientists of BAM experiment with different methods to refine this portion of bottom ash in order to generate ecologically harmless and marketable secondary raw materials.
Therefore treatment devices such as a centrifugal classifier, hydrocyclones or a jig in technical scale are tested.

The procedures may be optimized to a high recovery rate of valuable metals as well as to improve the quality of the remaining mineral aggregates.

In the technical center of BAM four point three large batches of solids and colloidal suspensions may be treated and processed. Precise analytical methods are the basis for reliable mass balances of the different procedures.

Therefore BAM promotes the project partners representing mainly small and medium-sized enterprises with its activities and assesses the benefits and the limitations of the various methodological approaches.

BAM also supports the project partners in the context of assessment of environmental impacts. Above all the fine fraction of granular materials is highly relevant for the in the environmental behavior.

For instance the leaching behavior is investigated using laboratory lysimeters, batch tests and in particular automated column percolation tests. The treatment of ash, slag and dust for recovery of mineral raw materials is going to be more and more important in the future.

There is an increasing interest in the business of construction materials for the utilization of alternative raw materials, especially for the production of asphalt, concrete and cement.

The objective of research activities of BAM is to enable the usage of the fine fraction from demolition waste as well as industrial and incineration residues in different applications.

Closed-loop recycling is still a vision in waste management. However, in the future it is necessary to recover secondary raw materials from waste. Moreover recovered resources have to be as good as primary resources with respect to the requirements on the environmental compatibility as well as to the performance of the materials. In our research projects we cooperate with partners from science and industry. This allows an integrated approach to the waste and recycling topic.

Comprehensive investigations with respect to environmental impacts of secondary raw materials were carried out at BAM in addition to technical approaches for the improvement of the treatment procedures.

Results of such investigations are going to be proposed in the preparation of engineering standards and regulations. In doing so, the Bundesanstalt für Materialforschung und –prüfung supplies a substantial contribution to the protection of primary and secondary mineral resources and therefore for the environmental health.