Modelling of industrial solid waste treatment processes

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With more than 240 million tons in 2013, municipal solid waste (MSW) is one of the biggest waste streams in Europe (eurostat 2015). Looking at the route from mixed waste to secondary raw materials, part of the waste stream is treated in mechanical-biological treatment plants (MBT) and material recovery facilities (MRF). Within these facilities, the waste is separated into material groups, such as metals, plastics and high calorific material. The resulting concentrates are sold as secondary raw materials or used in energy recovery. To exploit the inherent potential of resources and to run the treatment facilities in an economically viable way, it is vital to adapt the settings of the treatment processes to changing boundary conditions. These boundary conditions are a.o. the secondary raw material market prices, the composition of the waste, properties of the waste and the particle size distribution of the different material groups. As waste is known to be heterogeneous, the range of each of those boundary conditions can be immense. In addition, the design of process chains is complex, making the optimization of treatment plants an intricate task.

Optimization of a process chain typically relies on experimental trials. In an industrial plant, experimental trials, however, often disturbs the normal operation and are time and man power consuming. Furthermore, the results of these trials always have to be interpreted with regard to the input material which was used during the trial. To make the optimization of process chains more efficient, this PhD project aims to develop an integrated set of waste separation process models that can complement experimental optimization trials. The PhD project started in December 2015 and lasts four years. The developed models will enable the simulation of process chains for waste treatment and thereby enable the user to perform “virtual” trials. The application possibilities reach from testing the feasibility of a planned process chain design to anticipating alterations in the process or determining necessary adaptions due to alterations of the waste stream. The project will focus on two main challenges: (i) characterisation of the physical properties of the waste stream (single particle level) and (ii) modelling of separation processes using the physical properties of the waste particles.

The characterisation of the waste stream will be done on single particle level with sensor-based technologies (3D laser triangulation, NIR, colour detection) (instead of bulk level which is commonly done). The main challenge of single waste particle characterisation is the development of an abstract description of the shape of a particle. This is essential for the modelling because the shape, beside the density and the size of a particle, is needed to describe the behaviour of a particle in separation processes.

The modelling of the waste separation processes will be based on the physical properties of the waste particles, e.g. size, shape, density. During the project three different separation processes will be studied: sieving, metal separation and wind sifting. The wind sifting process will be modelled using a phenomenological approach. Based on the operating principle of a wind sifter, particle classes with similar behaviour will be defined and their behaviour in the wind sifter described. The influence of input composition, feed rate and particle size distribution will be determined experimentally and taken into account in the model. The wind sifting experiments will be done with both idealised material and real waste streams. The sieving and the metal separation models will be developed using data mining of existing data.

Within the full paper the project idea, results from preliminary studies and later application possibilities will be presented.

References

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