INTEGRATED MODEL TO OPTMIZE THE PERFORMANCE OF MECHANICAL BIOLOGICAL TREATMENT OF MUNICIPAL SOLID WASTE

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In 2021, 2,2 billion tons of waste were generated in Europe, and although only 10 percent is municipal waste, it is a very complex fraction to process because of its high heterogeneity. Specifically in Italy, the percentage of separate collection is still too low: 57,5% in southern Italy (ISPRA, 2023) and it determines a great quantity of unsorted waste that has to be managed. In this context, mechanical-biological treatment (MBT) plants assume a strategic relevance as one of the *best practices* for the management of undifferentiated waste.

In accordance with environmental regulations, achieving circular economy goals requires optimization of MBT plants, to make them more efficient and sustainable, maximizing material and energy recovery from the undifferentiated fraction.

This study concerns the implementation of a model to optimize the performance of MBT plants of municipal solid waste (MSW). The flow chart of this kind of plant is in figure 1.

For the modeling, the case-study of the AMIU Puglia MBT plant in Bari, was investigated. The plant treats around 150000 tons per year of residual waste from separate collection of the municipality of Bari and of the amount leaving the plant: 56,6% is Stabilized Disposable Waste (SDW) to be landfilled and 43,4% is Combustible Dry Fraction (CDF) to be further treated to produce Secondary Solid Fuels (SSFs).

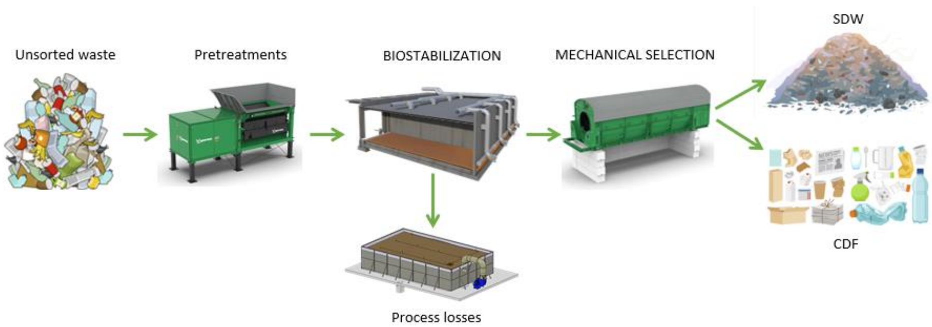

Figure 1 – Flow chart of the MBT plant processes

Through the use of mathematical formulations, the model wants to simulate the biological and mechanical processes that occur in MBT plants to estimate the characteristics of these two outflows, knowing the incoming waste and the plant operational parameters (figure 2).

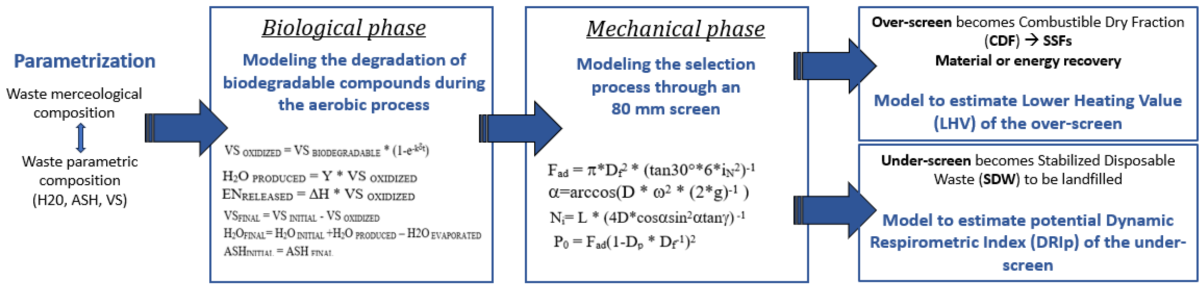

Figure 2 – Flow diagram of the forecasting model of the MBT plant

The input data, provided by the specific company, concern: quantitative information about the unsorted waste (i), its merceological composition (ii), the duration of the biological phase (iii), the operational parameters of the selection phase (iv). The model is made up of several steps which have the purpose of representing individual treatment phases.

Thanks to the study carried out by Consonni and Viganò (2011) it was possible to obtain, from the merceological composition of the incoming waste, the characterization in terms of water content, ash, volatile solids and calorific value of each category constituting the undifferentiated waste. This parametrization has been very helpful to obtain, with a weighted average of the merceological composition, the parametric composition of the entire unsorted waste.

The modeling of the biological phase simulates the degradation, during the aerobic process, of the biodegradable organic substance contained in the undifferentiated waste and allows to obtain the qualitative and quantitative characteristics of the waste entering into the next stage; a kinetic degradation constant k – typically varying between 0.043 and 0.082 d^{-1} (Baptista et al., 2010) – was used.

For modeling the mechanical selection phase, a probabilistic theory was applied to the case study to predict the behavior of a material subjected to a rotating screen (Stessel I. et al., 1992) and the model was implemented with the determination of the particle size distribution of the unsorted waste (Tanguay-Rioux et al., 2020).

After this phase there are two waste flows: the under-screen, which represents the stabilized disposable waste (SDW) to be landfilled, and the over-screen, which represents the combustible dry fraction (CDF) to be energetically valorized.

Once the over-screen is known, it’s possible to estimate its Lower Heating Value (LHV), which is important for classifying it as waste used as Secondary Solid Fuel or to declare its *end of waste*; after characterizing the under-screen, its potential Dynamic Respirometric Index (DRIp) can be determined.

The model allows the optimization of processes according to the characteristics of the waste to be treated; furthermore, this tool enables the MBT plants to be designed or modified, ensuring greater efficiency and sustainability.

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