MBT CONCEPTS FOR A SUSTAINABLE WASTE MANAGEMENT

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SUMMARY: Mechanical-Biological Treatment (MBT) today is not the ultimate answer to a modern waste management. In waste management the idea of sustainability is represented and most recently in the European Waste Framework Directive with its proposed five step waste hierarchy. Accordingly, in Germany the material cycle is to be closed completely in 2020 at the latest. This can only be achieved by high-grade utilization of secondary products and by recycling, making landfills dispensable. However, discharge of pollutants will still be necessary; a 100 % recovery is not yet technically feasible. We present a new, modular Waste Treatment Technology, meeting the standards for sustainable development, already implemented on industrial scale. By using a stepwise wet separation process (NMT-Process) the waste is separated into unpolluted inert and organic fractions (BioFluff) while the process water contains easily biodegradable matter as well as salts and heavy metals. Biogas is produced from anaerobic digestion of the process water and the remaining sludge serves as pollutant sink for the process.

1. INTRODUCTION

In waste management the idea of sustainability is represented in the "Vision 2020" and most recently in the European Waste Framework Directive with its proposed five step waste hierarchy. Accordingly, in Germany the material cycle is to be closed completely in 2020 at the latest. This can only be achieved by high-grade utilization of secondary products and by recycling, making landfills dispensable. However, discharge of pollutants will still be necessary; a 100 % recovery is not yet technically feasible.

Originally, MBT-concepts have been developed for separation of waste into a wet fine fraction and a dry coarse fraction. Until the beginning of the 80s, the wet fine fraction was intended for the production of compost. The dry coarse fraction on the other hand was to be processed into refuse-derived fuels for industrial plants and was then called BRAM (BRennstoffAusMüll - fuel from waste). This concept was thought to allow a high-grade utilization of all waste components. The original motivation of MBT-technology was highly modern. The wet fine fraction was used for the production of optically clean waste compost which outwardly did not differ from biological waste compost. However, the content of pollutants, in particular of heavy metals (Hg, Pb, Cd etc.) was too high for a long-term agricultural utilization in food production.

By mechanical treatment, pollutants could not be sufficiently eliminated from the dry coarse fraction to allow a co-incineration in industrial power plants which complied with technical requirements and legal regulations regarding emission protection on a long-term basis.

Furthermore, as the costs of primary energy sources sank considerably in the mid-80s, the profitability of the BRAM-concept was not given anymore.

With the separate collection of recyclables and biowaste and because of the failure of the domestic waste compost and BRAM-concept, the MBT-idea was reduced to a mere pre-treatment prior to landfill storage. Closing of material cycles, energy efficiency and with them the idea of sustainability was pushed into the background.

The idea of waste separation for sustainable waste management is basically right, but the concept of MBT as pre-treatment plant prior to a landfill has failed, because neither the sustainability idea fully comes to effect nor will a long-term operation be possible. Furthermore, several MBT-plants still have difficulties with fully complying with the current legal requirements. Additionally, a conventional MBT-plant is facing the challenge that waste management is increasingly considered as raw material producer for high-grade secondary products („urban mining").

2. SUSTAINABLE WASTE TREATMENT CONCEPT

Mechanical-Biological Treatment today is not the ultimate answer to a modern waste management. We therefore propose a new, modular Waste Treatment Technology meeting the standards for a sustainable development and already implemented on industrial scale. By using a stepwise wet separation process (NMT-Process) the waste is separated into unpolluted inert and organic fractions (BioFluff) while the process water contains the easily biodegradable matter as well as salts and heavy metals. Biogas is produced from AD of the process water and the remaining sludge serves as pollutant sink for the process.

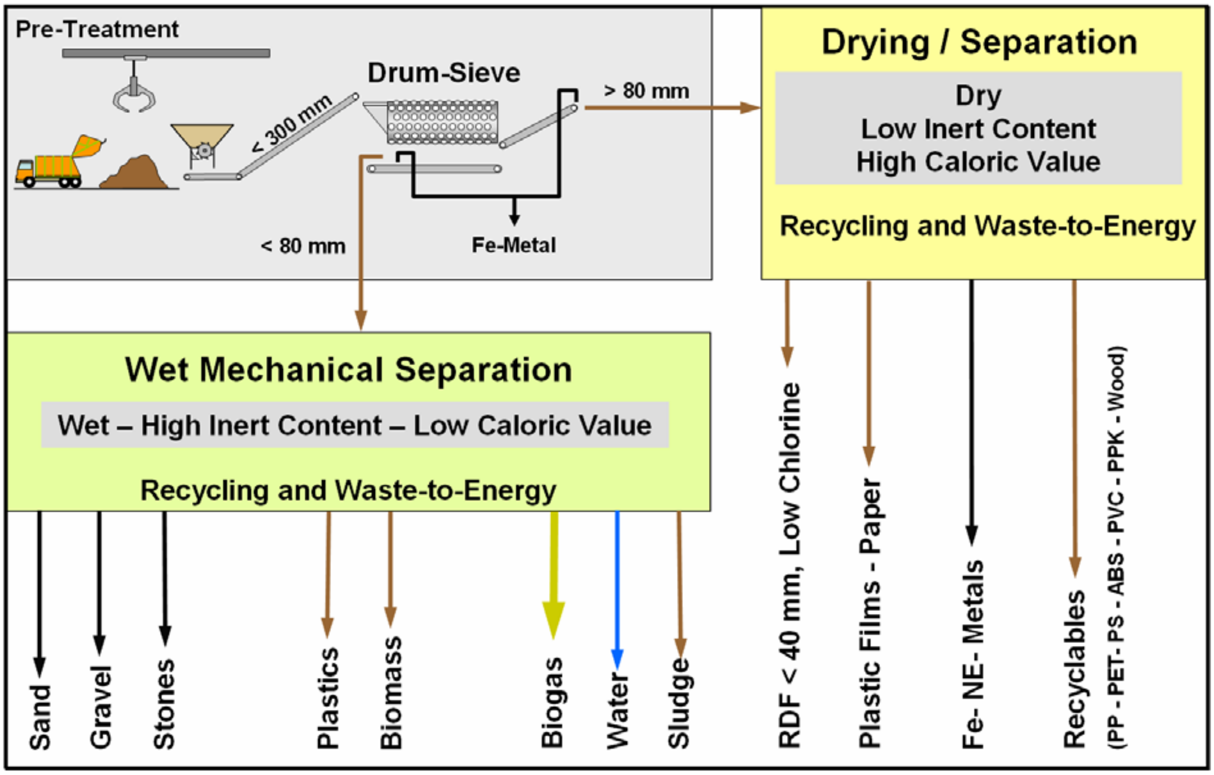

Figure 1: Sustainable MBT-concept – Process Flow Diagram with Products

The proposed treatment technology is suitable for household waste, bio waste and other mixed materials and fulfils the high requirements for a sustainable waste management. Our concept represents the technical answer to a landfill-independent waste management.

The MBT-concept developed by EcoEnergy is based on modules and can easily be adapted to improve the performance of existing MBT- and composting plants. The modules are:

- Module 1: mechanical pre-treatment
- Module 2: Tunnel-Dryer and recycling
- Module 3: wet mechanical separation (Nass-Mechanische Trennung, NMT-Process)
- Module 4: waste water treatment and biogas utilization
- Module 5: BioFluff drying
- Module 6: BioFluff conditioning and utilization

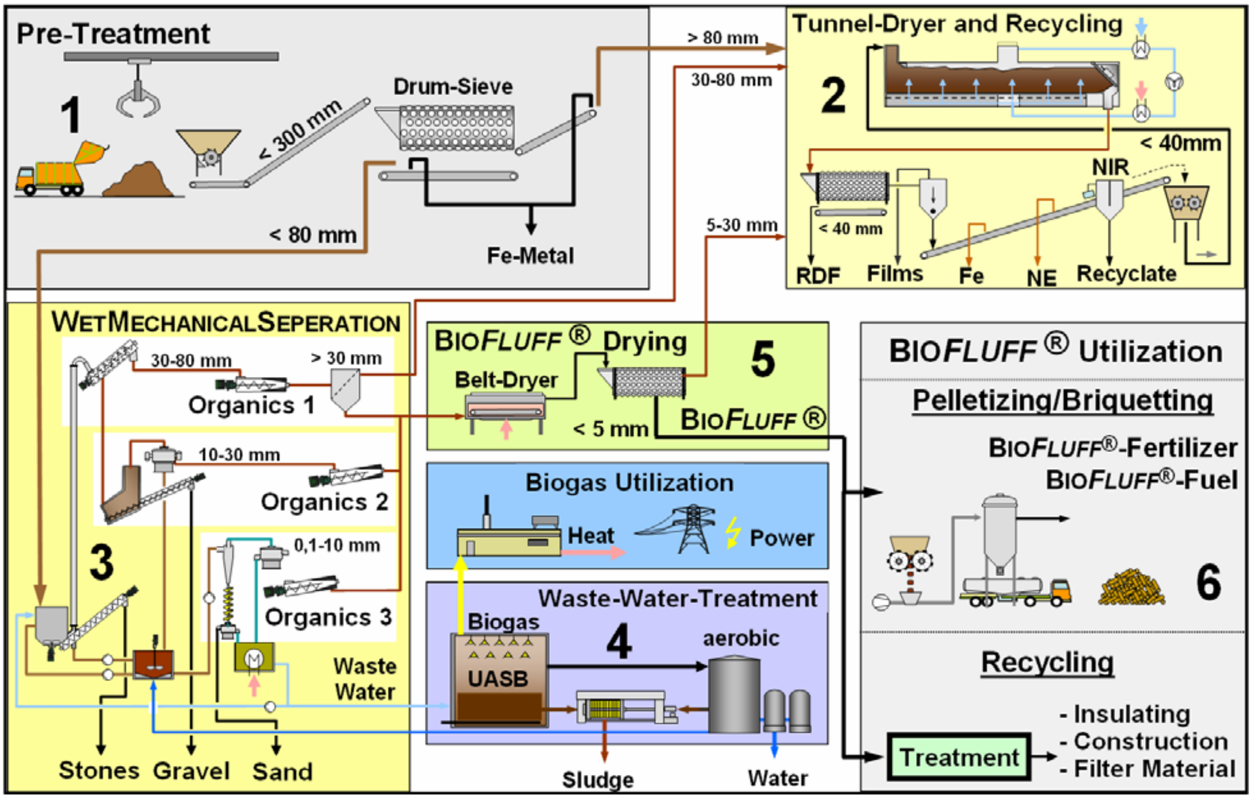

Figure 2: Sustainable MBT-concept – Process Flow Diagram detailed

Core component of the concept is Module 3, the wet mechanical separation of the fine fraction < 80 mm. This fraction can be described as a mixture of water, inert matter (sand, stones and glass) and native and fossil organic matter. Main purpose of the treatment is the production of materially recyclable inert fractions and materially and/or energetically recyclable organic fractions.

2.1 Module 1: Mechanical Pretreatment

The first step in mechanical treatemnt of waste is the selective shredding with subsequent classification into a high calorific, largely dry coarse fraction and a low calorific, largely wet fine fraction consisting of organic matter and inert substances. The waste is shredded and separated into fractions according to particle size, usually in a drum sieve. Inert material and coarse organic matter will be shredded to particle-sizes of < 80 mm. Deformable plastics, plastic films etc. are hardly shredded at all (selective shredding). When the sieve design is correctly adapted to the shredder performance (sieve perforation, sieve diameter, etc.), the fine fraction of < 80 mm contains 90 % to 95 % of the organic matter and inert substances while the hardly shredded plastics and PPK (paper, cardboard and carton) are collected in the coarse fraction.

A sieve cut of < 80 mm has been widely proven in this technical context. A screening which is considerably coarser than 80 mm will complicate the subsequent processing of the fine fraction.

2.2 Module 2: Treatment of coarse fraction

The coarse fraction > 80 mm, separated by drum sieve, usually has a much higher dry matter content than the fine fraction < 80 mm. As shown in figure 3, separation is most effective with either very dry or in wet material.

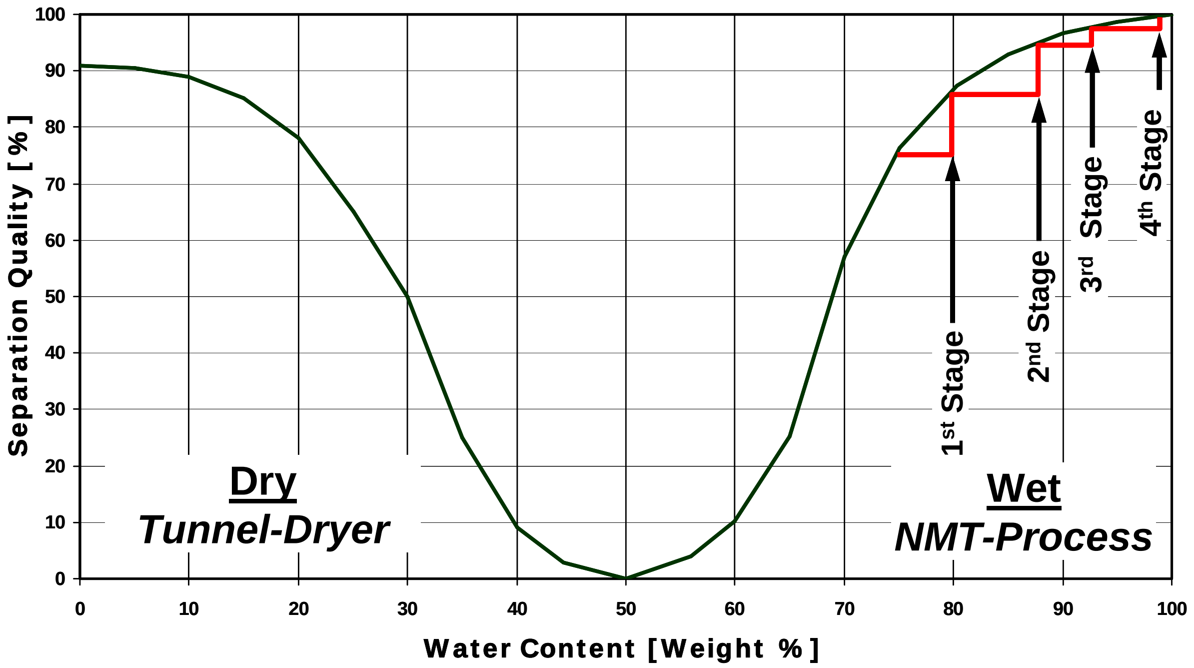

Figure 3: Separation Quality in relation to Water content

The coarse fraction of > 80 mm can be used for energy recovery without further treatment in a refuse-derived fuel processing plant (grate firing). This is reasonable for use in highly energy-efficient combined heat and power plants.

If a direct, energy-efficient utilization is not possible, further treatment of the coarse fraction for production of (materially) recyclable fractions is required. Drying improves the treatment quality and thereby the utilization possibilities. A sustainable drying technology has to meet the following requirements:

- Treatment of a wide grain-size range of up to 300 mm must be possible without making a further shredding of the material before drying necessary.
- Drying temperature should be less than 100 °C because of fire hazard. Low drying

temperatures prevent material changes in plastics, thus making a material recycling possible.

- As drying energy, low-temperature heat should be used e.g. from power or CHP stations.
- The dryer should be run in recirculation mode to minimize the amount of exhaust gas and to avoid extensive exhaust gas cleaning.

For this purpose we developed a process for low temperature drying of waste, using a waste adapted belt dryer with recirculating air. The dryer is heated with low temperature industrial waste heat. The dryer can process material with a particle size up to 400 mm. The drying air is recirculated, cooled down for condensation and reheated. The air is stripped off dust, pollutants and odors in the scrubber.

By drying we can produce a dry, odorless and clean material which can be used for materials recycling and / or energy recovery.

2.3 Module 3: Treatment of fine fraction (NMT-Process)

The fine fraction < 80 mm is separated by the NMT-Process into inert fractions, organic fractions and a liquid fraction which contains the soluble matter as well as the finest inert matter and organic particles.

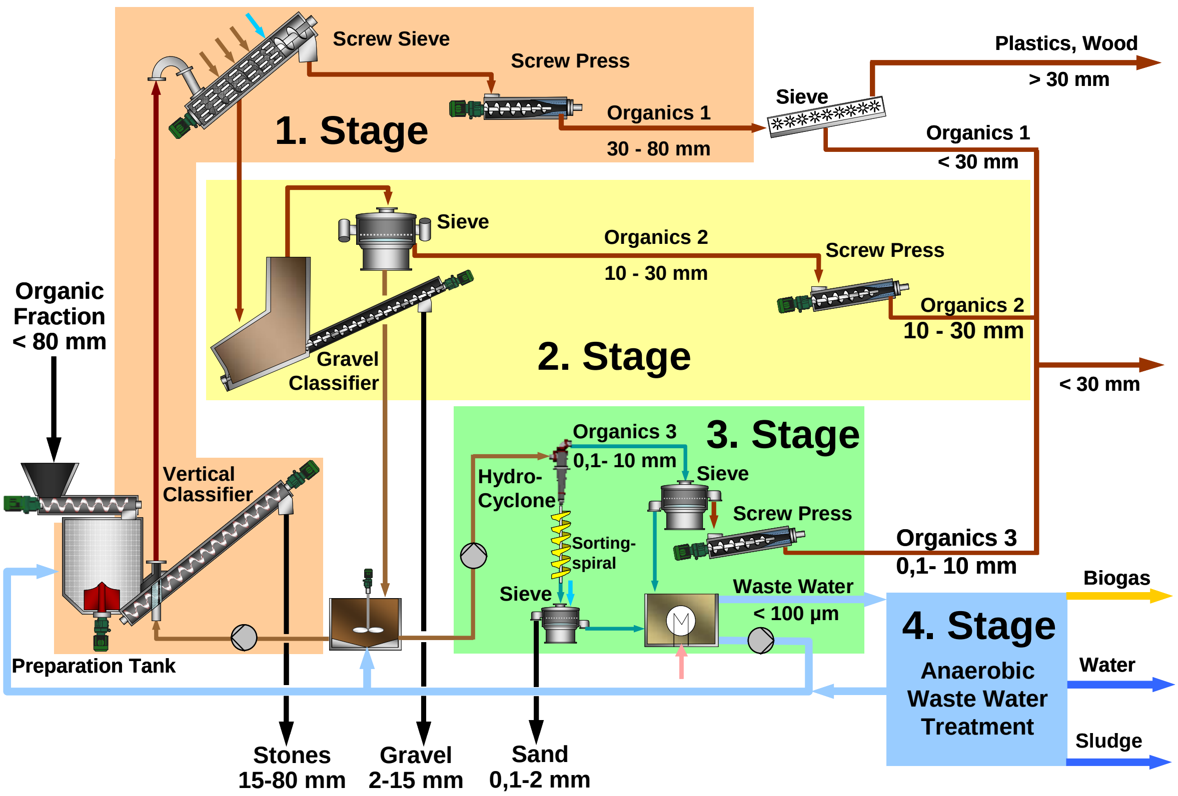

Figure 4: NMT-process – Process Flow Diagram

Sand-free organic fractions are produced by a three-stage inert separation and simultaneous production of three organic fractions, washed stepwise with process water. The organic fractions are further separated into particle sizes of 100 µm to 10 mm, 10 mm to 30 mm and 30 mm to 80 mm. The organic fractions are separately dewatered by screw presses to a residual water content of 40 % to 60 %. Thus the press force is applied evenly to the material, because no coarser particles are blocking off gaps where the dewatering is hindered. For separation, recirculation water heated up to about 65 °C is used. Heating of the process water reduces the viscosity of the water, thus improving the separation efficiency and the efficiency of the pressing.

Additionally, because of temperature interferences above 65°C and the shear effect in the screw presses, the effect of a thermo-mechanical cytolysis (TMZ) as well as hygienization of the native organic matter is achieved. After screening, the organic fractions are dewatered in screw presses. During this process, also the cell water is collected because of the special process conditions of the thermo-mechanical cytolysis.

Process-induced, the pollutant content of the biomass fraction is low. Chlorine is not contained as PVC because of the preceding separation of plastics and can only be contained as dissolved salt in the water. Because of the high dewatering degree without thermal drying, all dissolvable pollutants are washed out by 50 % to 90 % by the press and washer water depending on the water treatment and press concept.

Because of the low water-holding capacity, inert substances can be dewatered down to a residual water content of < 5 % without drying. The inert substances are cleaned with recirculation and fresh water. If required, the quality of the coarse inert fraction can be improved by construction waste processing.

The following products can be yielded from the inert fractions:

- Stones
- Gravel
- Sand

2.4 Module 4: Waste Water Treatment

Another objective of the NMT-Process is to transfer the digestible components of the waste into the recirculation water and to filter them according to the requirements of an anaerobic industrial water cleaning at about 100 pm. In this respect, most appropriate are high-performance procedures with anaerobic fixed-bed reactors or with biomass retention according to the UASB-process. The COD-degradation lies, depending on the anaerobic degradable COD-content, at 75 % to 95 % and the treatment duration at about 15 to 30 hours compared to 18 to 21 days in conventional biogas plants. The produced biogas is used in a CHP station, energy and heat are used for the waste treatment. Excess energy is fed into the grid.

The outflow of the UASB-process is post-treated in an aerobic fixed-bed reactor and can be recirculated as washing water for the NMT-Process or passed on as surplus water to the subsequent nitrification or denitrification stage of the aerobic wastewater treatment and then recirculated. If the salt content of the NMT-process products is too high, reverse osmosis can be applied.

The wastewater sludge, which is produced during the anaerobic and aerobic stage of the wastewater treatment, is used as pollution sink of the whole process.

2.4 Module 5 and 6: BioFluff processing

The organic fractions from the NMT-Process can be dried and processed to BioFluff.

After drying, the organic substances (raw BioFluff) are sieved at 5 mm while the residual plastics are separated in the screen overflow. The screen underflow consists of up to 100 % native organic material which will be referred to as BioFluff in the following.

The dried and screened BioFluff is conditioned in accordance with the intended processing. BioFluff is low contaminated, dry-stabilised, frayed biomass which can be put to various uses. It can be pelletized for the utilisation as dry fertilizer and pelletized or briquetted for direct energy recovery. If BioFluff is to be further processed e.g. digested into methane and ethanol or converted into insulating material, building material or filter material, pelletization and briquetting for transport may be necessary because of the low density.

3. CONCLUSION

In 2006 and 2007 tests with a pilot plant proved the large-scale feasibility of NMT and the quality of the fractions produced from MSW as well as from separately collected biowaste.

We could further verify by experiment, that 65 % to 80 % of the biogas production, generated with AD from the total material, is also yielded from AD of the process water. The process yields low polluted inert fractions for construction purposes as well as sand-free organic fractions, containing only unpolluted organic matter, separated in fossil and native organic matter.

Due to the very low pollution, the native organic fractions (BioFluff), even from MSW without separate collection, fulfill the requirements for the German compost application as a high quality fertilizer. The process also reduces the salt content of the BioFluff so that BioFluff also meets the specifications for use in coal fired boilers for CO_2-free energy utilization.

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