Umwelt Bundesamt

MECHANICAL-BIOLOGICAL WASTE TREATMENT/STABILISATION

APPLICATION OBJECTIVE	Mechanical biological waste treatment (MBT) is applied on mixed, organic/carbon rich waste with the aim to achieve - a stabilisation and minimisation of the risk potential together with a significant weight and volume reduction thru biological decomposition which could count towards the diversion of biodegradable waste from landfill, and in conjunction therewith - the processing of the waste in order to generate separate material streams, recover recyclable materials and improve the suitability for subsequent treatment processes.

OUTLINE ON APPLICATION FRAMEWORK

PARTICULARLY APPLICABLE FOR WASTE TYPES

Glass		Light-weight packaging		Biowaste	
Paper / paperboard		Mixed household waste	X	Bulky waste	
Lamps		Textiles		Electrical and electronic waste	
Scrap metal		Waste wood	X[1]	C&D waste	
Waste oil		Old paint & lacquer		Waste tyres	
Hazardous waste					
Branch specific waste	X	as far as they comprise biodegradable material and do not contain dangerous components or contaminations			
Other waste material	X	any biodegradable material of non-hazardous nature			

SPECIAL CHARACTERISTICS AND REQUIREMENTS OF THE APPLICATION

Pre-treatment of the input material: not required.

Options for the utilisation of the generated output:
Separated metals are returned to metal production, the high calorific material fractions can be processed and used as refuse-derived fuel (RDF) for energy recovery (see also the fact sheet on "Industrial co-incineration").
Following appropriate treatment such as an additional screening or biological stabilisation, rotting residues may also be used as landfill cover and for site remediation purposes.

Options for the disposal of process output and/or residues:
The biologically treated and stabilised material can be safely landfilled or incinerated.

Aftercare requirements:
Reduction and aftercare measures should be applied to the emissions which occur during treatment (exhaust air, wastewater). Aftercare in the frame of the usual procedures of landfill aftercare is also required in conjunction with the disposal of the process residues on landfills.

Protective needs:
Exhaust air and wastewater have to be collected and appropriately treated to protect the environment from the negative impacts that may otherwise cause to it, in addition technical and organizational measures for the avoidance and minimisation of emissions and nuisances (odours in particular) have to be undertaken. Particular precaution is required to prevent overheating and self-ignition of the waste, intense fire protection is a must.

Potential health risks:
Within the processing chain a higher risk of air contaminations with germs and spores must be observed, especially where non-encapsulated processes are taking place. Technical and personal protection measures (wearing of mouth masks) in the exposed places are highly recommended to avoid potential health risks.

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[1] in small quantities only, e.g. residues from sorting without contaminations of dangerous nature, generally wood recycling or the utilisation in special energy generating facilities should be preferred

RESTRICTIONS OR INFLUENCE OF EXTERNALITIES ON THE APPLICATION

Infrastructural conditions:
MBT facilities can basically be set up in any places; it will be an advantage however to erect them at locations that have access to the road and transportation network and close to the places where the relevant wastes are generated or where process residuals will be deposited. As with any treatment facility for mixed, organic rich waste, a minimum distance to the nearest residential area should be maintained to avoid any potential nuisances by odours, rodents or other unwanted vermine.

Climatic conditions:
MBT facilities can be operated under any climatic conditions provided that specific local constrains are considered in the technical settings. Exposure to temperature or moisture extremes puts some limitations to the employment of open rotting techniques for the biological treatment. Simple coverage by semipermeable membranes can be a solution, however. Insulation and/or additional heating systems might be applied to run anaerobic digestion reactors for the biological treatment under such temperature extremes.

Employment potentials:
MBT offers good opportunities for the employment of both, unskilled and higher qualified personnel.

TECHNICAL DETAILS

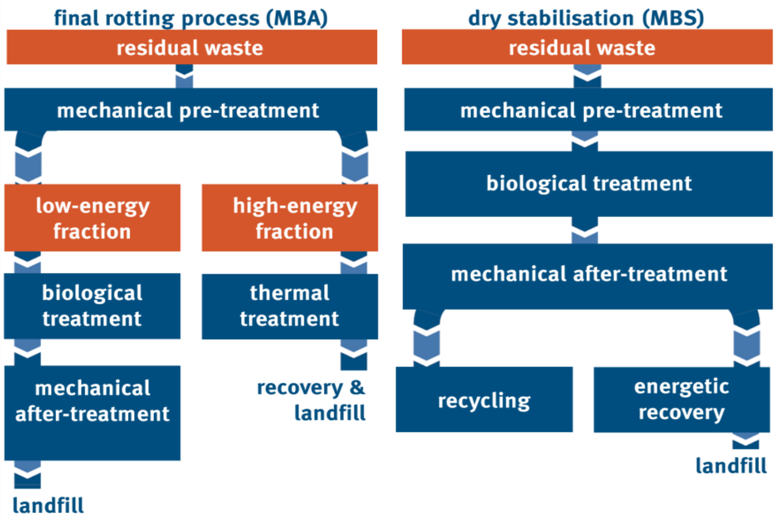
GENERAL OVERVIEW

ABSTRACT

Mechanical biological treatment comprises a combination of mechanical and biological processes that further treat mixed residual waste before disposal. The aim of this combination is to minimise the environmental impacts of deposited waste and to gain some further value from the waste through the recovery of recyclables and, in some cases, energy. The possible process configurations are numerous although consisting always of mechanical processes and a core biological treatment. Integrated systems have been developed that combine the two stages as an integrated entity and include emissions and odour control facets within a closed cycle. They can offer a reasonably flexible approach to the management of different waste materials due to their high tolerance of variation in waste composition and can even function without any additional collection infrastructure, means they are also suited to the unsegregated household waste stream.

The main distinction between the different concepts is made on the basis of the order of the technical processes and the aim of the biological treatment. The differences lie either in a “splitting” of the waste prior to the biological treatment (so as to obtain a high calorific fraction suitable for energy generation and a low calorific fraction undergoing a final rotting before landfill disposal) or a “dry stabilisation” of the entire waste with subsequent processing.

Figure 1: Simplified schemes to distinguish the basic concepts for mechanical-biological treatment (modified illustration based on a graphic provided by Nelles, Morascheck, Grünes)



	In "splitting" (or mechanical-biological treatment = **MBT**), a derived fraction of material is treated biologically. The core biological process used in such system can be anaerobic digestion or composting or elements of both. When anaerobic digestion is used, the process is usually configured to optimise biogas production. When composting is the core technology to biologically treat the derived waste material, no biogas is produced and the rotting process used to convert the mixed waste into stabilised matter for landfill disposal. In "dry stabilisation" (or mechanical-biological stabilisation = **MBS**) the entire waste is subject to a drying process facilitated by heat generated during biodegradation. In subsequent steps recyclables and refuse derived fuel (RDF) are won from the stabilised material, meaning that only the residuals are landfilled. Principal objective of the treatment is to generate a material which can be used for energy recovery or further processed by gasification.
BASIC REQUIREMENTS	- Input must be an organic rich solid waste without hazardous components - A certain standard of emission control and treatment and other protective measures (preferably fixed in a specific regulation) should be guaranteed - Power supply
EXPECTED RESULTS	Output: - High-calorific coarse material (MBT) or combustible dry stabilate (MBS) - Stabilised rotting material (MBT) or fine fraction (MBS) that can be deposited on landfills - Recyclable materials (mainly metals) - Process residues, dust, liquor and exhaust air Quality requirements for the output: - Material which has undergone mechanical-biological treatment should be marked by a low moisture content and respiration index value when deposited at landfills (coming from biological treatment material moisture level is usually <50% and the respiration index value less than 40 mg /kg dry matter – the German landfill ordinance requires the respiration index value AT4 to be below 5 mg/kg dry matter for materials accepted at landfills). - The liquor from anaerobic digestion processes shall be suitably treated to comply with the requirements for safe release into surface waters (e.g. Directive 91/271/EEC)
SPECIFIC ADVANTAGES	- reduces the volume and reaction potential of waste that must go to landfills and therewith the landfill void space taken, the emissions of gas, leachate and odour at the landfill site - combines material specific treatment and material recovery and generates various material fractions for further use - allows for energy recovery (from generated RDF and/or from biogas generated in biological processes) - simple and little capital intensive installations can be possible
SPECIFIC DISADVANTAGES	- for the parts of the waste not completely mineralized during the process further aftercare or treatment measures must be applied, including continued aftercare for the landfills - incomplete exploitation of the energy content of the waste
APPLICATION DETAILS	
TECHNICAL SCHEME	The core technology used in any mechanical-biological waste treatment is the biological process. Biological processes can only treat the biodegradable fraction of the MSW, however. Depending on the final disposal option and the material quality they require, mechanical processes of different intensity do either precede the biological treatment stage in order to separate the non-biodegradable (recyclable/combustible) from the biodegradable material (MBS), or they follow the biological treatment and further process the output so that a use as substitute fuel or other utilisations become possible (MBS). *Mechanical treatment* Mechanical treatment usually consists of several mechanical operations. They are adapted to or applied to change the physical properties and composition of the waste input in order to facilitate its further processing and valuable materials to be possibly recovered. The minimum technical requirements for an efficient treatment comprise of installations for:

- storage and feeding
- removal of disturbing material and contaminants
- size reduction

A mechanical treatment prior to the biological stage (MBT scheme) can have the following process features:

i. Storage and feeding installations

Flat or deep bunkers are used to store the delivered waste. Flat bunkers allow disturbing bulky materials to be roughly separated by grabbing with wheel loaders or special gripper equipment. Apart from that, the delivered waste can be easily controlled any problematic deliveries can be rejected from treatment if necessary. Storing different fractions separately (e.g. dry commercial waste, bulky waste, and wet household waste) is rather easy in flat bunkers. Flat bunkers are cheaper than deep bunkers, but need more area.

In deep bunkers the waste can easily be mixed. It is however difficult to sort disturbing materials out of bulky and commercial waste in these bunkers. Deep bunkers are especially suited to store wet household waste. All dry waste should be stored in flat bunkers. Flat bunkers in this case are more suitable for combined mechanical-biological waste treatment processes.

ii. Separation of foreign matter and contaminants

In case a flat bunker is available the disturbing bulky materials[1] can be separated quite easily with a special gripper equipment (e.g. grap dredger) or wheel loader. Other disturbing materials[2] are separated at the feeding units or on the conveyor belt. In case of the dry bulky and commercial waste, a manual separation of disturbing materials in aerated cabins is acceptable. Due to potential health risks for the workers, such procedures are not applicable to wet household waste. Here separation by a grab dredger is the only suitable solution.

iii. Size reduction

To make packed materials accessible to further processing, generate a more homogenous waste mix and increases the reaction surface, screening of the waste and a size reduction of the overflow are undertaken. As size reduction is the most energy consuming step in the mechanical treatment process, applications only to the bulky parts of waste are also known. Bulky and commercial waste must at least be pre-shredded before reaching subsequent processes. For pre-shredding (up to a size between 250-500 mm) shearing units (rotors and in some cases guillotine shearing units), shredder and screw crusher are used. The main shredding (100 to 250mm) is done with rotor shear crushers, shredders and cascade mills. Fine shredding (< 25mm) is performed with cutting and hammer mills.

Additional steps/equipment for the mechanical pre-treatment may include:

iv. Metal separation

Large-sized metal parts are separated at the storage area, whereas small parts remain in the waste. Small iron parts are collected from overhead magnets from the waste stream passing through on a conveyor belt. Due to the easy removal and good recycling potential, metal separation should always be part of the process design.

v. Separation of non-ferrous metals

Also possible is the separation of non-ferrous metal, preferably from the material flow < 80 mm. Usable non-ferrous metals can be sold for high prices.

vi. Separation of the overflow by screening

Where substantial amounts of plastics and wood are in the waste, a separation can be useful together with paper/cardboard in a sieving drum. Screening at a mesh size of about 100 to 150 mm usually generates a high calorific fraction (paper/cardboard, plastics and wood) in the overflow. In the screening pass flow the biodegradable waste material is concentrated.

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[1] e.g. mattresses, container boxes, larger concrete or metal parts

[2] e.g. containers, big plastic foils, ropes, cables, tyres, accumulators, furniture parts

An overflow that will be used to generate refuse derived fuel (RDF) need to be shredded and possibly conditioned and compacted in subsequent operations.

vii. Separation of light and heavy fractions by classification

A classification, for example with the help of an air classifier, to separate the high calorific fraction is less important than the screening, although with air classifying glass and stones may be discharged.

viii. Separation by sorting

Where dry waste contains a high amount of recyclable materials (applies mostly to commercial, C&D and bulky waste), a manual separation can be appropriate. Sorting stages are often attached to screening operations. Air classification helps segregating the waste mix and generates a separate RDF-fraction.

ix. Further comminution

In order to use the high calorific fraction as a fuel (see the fact sheet on "Industrial co-incineration") a further comminution is often done. High-speed crusher giver the best results here. Such installations can chop the material into pieces of 60-80 mm in size. For further comminution the waste has to be pelletised first which is very expensive.

x. Baling

For better storage and transportation of recovered recyclables and generated RDF-fractions (mostly consisting of plastics and paper) a press is often used for compaction/baling.

In a MBS-scheme with mechanical processing after biological stabilisation, the mechanical process comprise mainly of the steps:

- metal separation (iv),
- screening to separate the mineral fine fraction (vi),
- comminution (ix) and pelletising.

Before the biological process a separation of disturbing matter and size reduction may be necessary.

Biological treatment

Different technologies are applied for the biological treatment. Usually these are either intensive rotting/composting or anaerobic digestion methods. They are detailed in separate factsheets, namely these are the fact sheets on "Composting" and "Anaerobic digestion". Only major adjustments of these methods towards the realisation of a mechanical-biological waste treatment will be explained here.

As ***MBT-schemes*** are concerned, they are as follows:

Rotting method

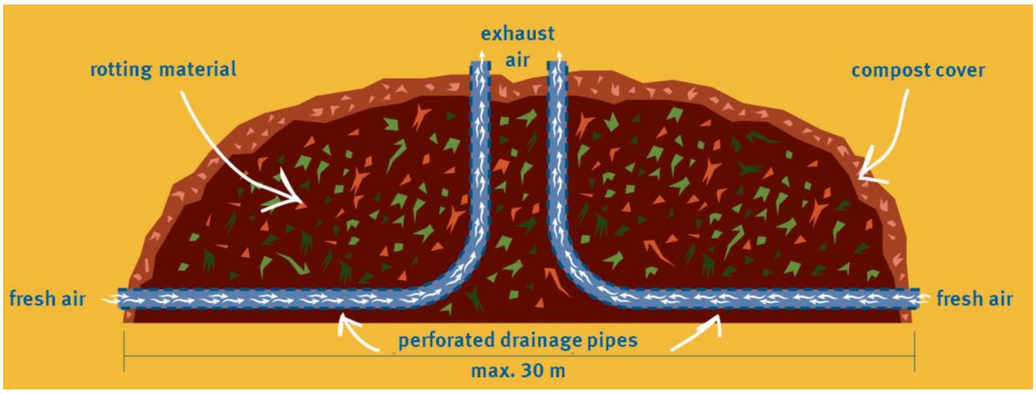
As in composting, static and dynamic methods can be used for the rotting of waste. *Static techniques* are the simplest methods for rotting. In this case the material is not turned during the process of biological degradation. For this the homogenized waste is piled into simple rotting heaps, triangle-shaped or flat-top windrows. The waste heaps are kept on an impermeable ground to avoid contamination of the ground water, proper ventilation must however be ensured to keep the heaps rotting in an aerobic state.

A simple practical method and one that already suits in areas with moderate requirements on exhaust air treatment (less fierce than is the case in Germany by now) is the Chimney draught process. In this process the perforated drainage pipes are laid tangential to the windrows. The distance between the pipes is about 3 to 4 m. The outlets of drainage pipes are laid chimney-like in the middle of the windrows. Through the biological self-heating of the rotting materials an air stream is produced. It provides for an oxygen flow through the digested material. A semipermeable cover membrane can help to keep the water content at the required level. Through the static operation 2.5 m high flat top windrows are possible.

A bio filter which consists of wood chips or already stabilised organic material or compost is spread on the top of each pile. It helps in reducing the emission of harmful substances and odour development.

In the heaps the biologically active material partly decomposes to CO_2, water and humic substances, water evaporates and leaves a biologically inactive substrate. Rotting without turning the material and without technical aid for aeration and irrigation is only used for the passively aerated biological post rotting (open air post rotting). To use the technique for the main rotting, an actively aerated method with control of water content and oxygen supply should be adopted.

Figure 2: Chimney draught process of Spillmann/ Collins



Another static method is that of *rotting boxes and containers*.

The rotting boxes are made out of reinforced concrete or steel. They have a driveable perforated bottom. They are operated in a batch mode. The boxes are supplied with air from the perforated bottom, and exhaust air is then sucked on top of the rotting material for further treatment. The intensive rotting is completed after 8 to 10 days. The technology is simple and more durable. However, rotting boxes require an input which has been intensively mechanically pre-treated. Also the rotting material tends to dry easily.

As *dynamic or quasi-dynamic methods*, rotting drums, tunnel reactors and windrow techniques with regular turning can be applied (see fact sheet on "Composting"). These suites best for the intensive rotting of the waste.

Intensive rotting technologies are the choice to implement MBS-schemes. They are applied on the entire input stream in order to biologically dry and sterilise the material and to produce in this way an output which is largely suitable for thermal treatment and combustion processes. Given the unsorted input and the high rate of emissions and leachate it produces in the early phase of treatment, fully encapsulated systems are used for the rotting process.

The calorific composition of the output material will be relatively high as both the liquid content is being reduced thru biological degradation and non-combustible materials (e.g. metals and inert materials) are separated afterwards. The calorific value of the so derived RDF type material can range between 12-16MJ/kg dependent on waste input and achieved moisture levels. There is much scope for different ways of recovering the energy from this material. These range from RDF-type combustion or co-incineration through to gasification. Most suitable is a co-incineration in an industrial plant which can readily handle fuels with higher calorific values (see fact sheets on "Industrial co-incineration")

Anaerobic digestion method

Not applicable for MBS but another option to realise the biological stage in a MBT-scheme is the method of Anaerobic digestion.

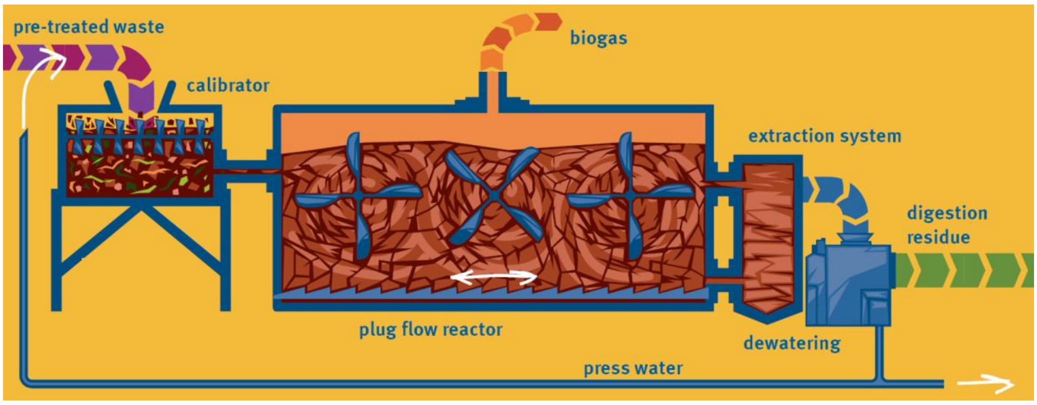
When anaerobic digestion is incorporated into the MBT, the process is usually configured to optimise biogas production. However, in some instances the technology has been configured to optimise the production of biogas and RDF. In the anaerobic digestion process biological degradation takes place in closed reactors without air supply. A difference can be made between wet and dry processes. Both process schemes are described in a separate factsheet (see the fact sheet on "Anaerobic digestion").

Because of the inhomogeneity of the input material (sediments on the one hand and fibrous components on the other hand) the dry single-step process is considered as one of the most suitable treatment methods (see Figure 3).

Advantages of the dry digestion process are:

- lower water demand
- because of the higher dry matter content sedimenting components are better integrated in the digestion material than in the wet processes.

Figure 3: Technical scheme of a dry process for anaerobic digestion (component configuration according to Linde-KCA plug flow scheme)



Digestion processes are completed after about 18–21 days and the remains dewatered in a press. The solid matter can then be further cured by composting and deposited at landfills whereas the waste water has to undergo further treatment. Due to the high COD, expensive methods for the treatment of the waste water have to be employed, however.

The treatment of residual waste by anaerobic digestion also causes specific requirements concerning equipment, personnel and plant safety. Evacuating the biogas from digestion containers operated in batch mode must be done with utmost care to avoid explosive mixtures to develop. In plug- flow operated plants corrosion-provoking compounds (e.g. chlorine, sulphur, acids) and abrasive components (e.g. minerals, metals) contribute to higher wear.

The typical problems of the treatment of residual waste by anaerobic digestion can be minimized with the following technical solutions:

- use of biogas nozzles instead of agitators (in wet process) to circulate the feedstock in the digesting vessel, this helps minimizing surface scums and wrappings on the agitators,
- prior segregation (e.g. ballistic classifier) and discharge of heavy components (sedimenting materials) and light materials (e.g. textiles and foils to avoid wrapping, occlusions and surface scum),
- adjusting to a dry matter content of 20–40 % before digestion (eliminating a demixing in the vessel), or
- a washing of the fine fraction that has been obtained after the mechanical pre-treatment to remove light materials, sand and other abrasive materials such as glass from the feedstock. The remaining material which consists mainly of biodegradable substances can be digested then in a wet process.

Generally it is necessary that exhaust air from MBT and MBS be collected and treated. Depending on the applied biological processes, the air stream and the legal provisions suitable solutions can range from simple biofilters up to processes involving the so-called regenerative thermal oxidation (RTO). Thermal processes have the advantage that organic compounds are significantly reduced. A disadvantage is the energy demand (especially if no biogas is generated in the plant itself) and the fact that the technology has still high maintenance needs.

QUANTITY ASPECTS	Input: - 100% MSW - water (if digestion is applied for biological treatment) Output (taking the average waste composition in Europe as a reference): - 2–5 % disturbing material - 2–4 % metals (Fe and non-ferrous) - 30–45 % high calorific material suitable for RDF production 45–65 % fine fraction subject to biological degradation of which: 10–25% of weight get lost due to biodegradation up to 20% of weight get lost as water 5% are converted to biogas 30–50% remain to be landfilled. The changed order of separation and biological activity in MBS-schemes improves the recovery of non-degradable materials and therefore leads to a reduced amount of residues going to landfill.
SCALE OF APPLICATION	Mechanical-biological treatment installations operate in the following range: - Minimum throughput: 25,000 tons/a (with simple rotting method) - Minimum throughput: 60,000 tons/a (with anaerobic digestion) - Upper range of throughput: 300,000 tons/a
INTEROPERABILITY	Mechanical-biological waste treatment is a complementary measure to waste disposal operations and permits the recovery of waste materials for recycling and the processing of waste in order to avail of more beneficial ways for their disposal (e.g. RDF generation). The process can thus be well combined with any other waste disposal operations above all the possibility to integrate it as a pre-treatment stage on landfills.

OPERATIONAL BENCHMARKS: RESOURCE CONSUMPTION

ENERGY BALANCE

- The overall energy demand lies between 20–70 kWh/t whereby mechanical pre-treatment normally takes the greatest share with about 10–30 kWh/t.

Table 1: Comparison of the energy consumption of different process options (source: Nagel, Nachhaltige Verfahrenstechnik, 2015)

Utility	MBT (rotting techniques)	MBT (anaerobic digestion)	MBS
Electricity	45 kWh/Mg	65 kWh/Mg	100 kWh/Mg
Heat	0	Self supply	0
Gas (share needed for RTO)	41 (39) kWh/Mg	58 (45) kWh/Mg	25 (25) kWh/Mg

MBT schemes with an integrated anaerobic digestion generate approx. 70–170 m³ biogas per $Mg_{\text{waste input to digester}}$

CO_2-BALANCE	- Studies to assess the environmental impact suggest that the landfill disposal of waste stabilized by mechanical-biological treatment results in the formation of only 10% of the landfill gases and 10 % of the leachate that a disposal of untreated waste would have caused. - Using closed systems (box reactors/halls and systems with a purification of the exhaust air) for the biological treatment stage helps significantly to minimize GHG emissions and such to escape uncontrolled to the atmosphere.
AIDS/ADDITIVES NEEDED	- No other than specified
HUMAN RESOURCES	The demand on labour force depends largely from the capacity of the plant. The average requirements are similar to that of composting installations (see also fact sheet on “Composting”). Integrating manual sorting stages naturally requires a larger workforce. For rather complex process arrangements specially trained and qualified staff is needed to take care for the facility management and operations control.

SPATIAL NEEDS

The minimum space demand depends from the planned treatment capacity. However, the need of additional space can be very low if the treatment is integrated into the operations of landfills. In that case it comprises the area where the windrows or rotting boxes are set up. Practically the figures provided for composting and anaerobic digestion could be used (see the fact sheets on "Composting" and "Anaerobic digestion").

OPERATIONAL BENCHMARKS: COST DIMENSIONS

INVESTMENT COSTS

The investment comprises in the main of the following cost positions

- Costs for area development: depend from the local conditions and planned capacity, above all the costs for the acquisition and preparation of the area (costs may be rather low if the treatment is part of the operations on a landfill)
- Equipment (price references as of the year 2008):

mechanical stage: constructional parts incl. storage bunker:40 EUR/ Mg*a
stationary machinery: 20–80 EUR/ Mg*a
mobile equipment (vehicles): 5–10 EUR/ Mg*a

biological stage:

- rotting method: constructional parts: 70 to 90 EUR/t*a
stationary machinery: 110–140 EUR/ t*a

- anaerobic digestion: constructional parts: 50 to 60 EUR/t*a
stationary machinery: 130–180 EUR/ t*a

Overall estimates for the capital needs of complete MBT installations are in a range from EUR 12 million for a facility of 50,000 Mg per annum to EUR 40 million for 220,000 Mg/a. Very simple MBT process installations for developing countries were investigated to cost a total of EUR 15-20 per Mg input (Source: GTZ, Sektorvorhaben Mechanisch-biologische Abfallbehandlung, 2003)

OPERATING COSTS

Running costs are incurred for

- Personnel (depending on the local labour market)
- Daily operations (consumption of fuel/electricity, insurances etc.)
- Repair and maintenance
- for each structural element approx. 1% of the initial investment
- machinery and electronic: 3–4% of the initial investment
- mobile equipment (e.g. wheel loader): 8–15% of the initial investment

The higher wear in digesting mixed residual waste results in higher costs for repair and maintenance of MBT installations with an anaerobic digestion as compared to digestion systems using pure biowaste.

A cost example (net costs) for a plant with an annual throughput capacity of 150,000 Mg is provided in the table below.

Table 2: Running costs EUR/Mg (source: Morgenstern: Restabfallentsorgung in Deutschland, Econum GmbH)

Cost position	Overall costs EUR/Mg	incl. variable share EUR/Mg
Personnel	6	
Repair, Maintenance	9	5
Energy, Fuels	7	7
Insurances and others	6	
RDF supply and transport (related to 50% of input)	30	30
Transport/landfill disposal residues (20% of input)	5	5
Transport/disposal other materials (7% of input)	5	5
Transport/disposal metals (3% of input)	-3	-3
Depreciation and capital services	25	
Total	90	48

POSSIBLE PROCEEDS

- Sale of recovered material, particularly metals.
- supplying RDF to the market and generating revenues this way is a highly uncertain procedure, in general no positive revenues are made up to this moment.

MASS SPECIFIC OVERALL COSTS	- In the range of EUR 40–120 per Mg only for the treatment operations (possible proceeds and/or costs for the disposal of residues and supply of RDF to the incinerating industries not included). Lower waste volumes requiring landfill disposal on the other hand means a saving of costs, another benefit not expressed in monetary terms is longer landfill lifetime.

OTHER RELEVANT ASPECTS

MISCELLANEOUS

MARKET INFORMATION

REFERENCE FACILITIES *(Note: the list of sites and/or firms does not constitute a complete compilation)*	The technology has strongly evolved during the past two decades. Today, there are over 100 plants operating in Europe using some form of mechanical biological treatment on residual wastes. Germany alone has about 50 plants operating above a capacity of 20,000 Mg/a. The average capacity of such plant is 100,000 Mg/a, configurations up to 300,000 Mg annual throughput exist. Almost all large waste management providers undertake waste processing at different scale with this technology or have shares in operating plants doing such treatment. Reference facilities in Germany are for example: - MEAB mbH, Schöneiche www.meab.de - Zweckverband Abfallwirtschaft Saale-Orla, Pößneck www.zaso-online.de - MBA Lübeck www.entsorgung.luebeck.de/ueber_uns/unsere_anlagen/mba.html - MBA Neumünster GmbH, Neumünster www.mba-nms.de - WEV GmbH, Großpösna www.e-wev.de Large-scale applications which were established and set in operation under the integration of know-how or technical components from Germany can be found in many EU-countries and their neighborhood, inter alia in Italy, Bulgaria, Portugal, France, Finland or Croatia.
RECOGNIZED PRODUCER AND PROVIDER FIRMS *(Note: the list of firms does not constitute a complete compilation of companies)*	MBT technology in the past has been delivered by a vast array of producers and partial equipment providers in Germany. Meanwhile the number of firms engaging in turnkey solutions for MBT plants has decreased whereas many firms have specialized in providing components suitable for MBT solutions, such as *Shreeder/comminutor:* - HAMMEL Recyclingtechnik GmbH, Bad Salzungen www.hammel.de *Separators, classifier:* - EuRec Technology GmbH, Merkers www.eurec-technology.com - Mogensen GmbH & Co. KG, Wedel www.mogensen.de - Spaleck – Förder- und Separiertechnik www.spaleck.de *Metal separators (Fe, non-Fe):* - Steinert Elektromagnetbau GmbH, Köln www.steinertglobal.com - IMRO Maschinenbau GmbH, Uffenheim www.imro-maschinenbau.de - Wagner Magnete GmbH & Co. KG Spann- und Umwelttechnik, Heimertingen www.wagner-magnete.de *Air treatment systems:* - LTB Lufttechnik Bayreuth GmbH & Co. KG, Goldkronach www.ltb.de - Dürr Systems GmbH Environmental and Energy Systems, Stuttgart www.durr-cleantechnology.com/de The overall planning is done by specialised planning bureaus or the plant operators who often care for the complete erection of the facilities too. Recognized providers in the area of turnkey solutions are for example: - Strabag Umweltanlagen GmbH, Dresden www.strabag-umweltanlagen.com - Komptech Vertriebsgesellschaft Deutschland mbH, Oelde www.komptech.de - HAASE Energietechnik AG, Neumünster www.bmf-haase.de - Herhof GmbH (Tochtergesellschaft der Helector S.A). www.herhof.com - AMB Anlagen Maschinen Bau GmbH, Oschersleben www.amb-group.de

	Providers of plant concepts and components for more simple dry stabilization techniques are: - CONVAERO GmbH www.convaero.com - W.L. Gore & Associates GmbH www.gore.com/de_de/

ADDITIONAL REMARKS AND REFERENCE DOCUMENTS

Relevant organizations and contact points for further information about the application of MBT and the technical requirements are:

- Arbeitsgemeinschaft Stoffspezifische Abfallbehandlung: www.asa-ev.de
- Arbeitskreis für die Nutzbarmachung von Siedlungsabfälle: www.ans-ev.de
- Gütegemeinschaft Sekundärbrennstoffe und Recyclingholz e.V.: www.bgs-ev.de
- Fachverband Biogas e.V. www.biogas.org