

MECHANICAL–BIOLOGICAL PRETREATMENT OF MSW

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1. ABSTRACT

The process of mechanical-biological pretreatment (MBP) of municipal solid waste (MSW) was developed and optimized by the engineering team of the Trienekens group in close cooperation with the German Federal Environmental Agency. It is based on experience from similar treatment plants, which have been operated by Trienekens since the early 1980s.

Mechanical-biological pretreatment can be used first, in combination with a landfill, and second, in combination with an incinerator.

Pretreatment of MSW prior to landfilling substantially enhances the quality of the landfill material (leachate quality, gas potential, stability) and significantly reduces the required landfill space.

Pretreatment prior to incineration has other advantages: MBP makes it easy to separate recyclable material (metal, paper, plastic, RDF, etc.), reduces incinerator input and homogenizes the waste material in terms of water content, calorific value and particle size.

The two methods cannot only be used alternatively, but can also be developed on a step-by-step basis. You can start with MBP on a small scale to improve your landfill. To comply with tightening environmental protection standards, MBP can later be developed into a full-scale pretreatment facility. Trienekens AG and its subsidiaries are now running three large-scale MBP plants in Germany. An MBP pilot plant is being planned abroad.

2. INTRODUCTION

The MBP technology has originated from the recycling plants of the late 70s. The aim of these plants was to convert a fraction of the mixed municipal solid waste into useable compost.

In combination with other treatment and disposal facilities, such as refuse incinerators and landfills, the MBP technology is aimed to achieve the optimum in terms of environmental protection and cost effectiveness.

3. REQUIREMENTS OF MODERN WASTE TREATMENT SYSTEMS

The experience gathered from the dumping of municipal waste in landfill sites has shown that the deposition of waste that is neither presorted nor treated can lead to considerable environmental pollution through both leachate and gas.

Another important point is the high demand on areas used as disposal sites. The use of these areas is not only limited during the active life of the landfill, but will remain limited for many decades after its closure, thus preventing, or making more difficult, any urban planning measures desired. Moreover, disposal sites require regular maintenance and monitoring after depositing has ended. The costs associated with these measures are left to future generations.

There is a consensus today that this negative impact on the environment can be and has to be limited by the pretreatment of the materials to be deposited and by adequate sealing of the landfill base and surface. Thus, present-day waste generators will have to bear the arising overall costs today without shifting them to future generations.

One way of effectively pretreating waste that cannot be avoided is through thermal processes. If, however, the waste has a very high moisture content, low homogeneity and consequently a very low calorific value, problems may arise during the incineration process that affect the quality of the ashes and the flue gases (dioxins). The thermal treatment of waste is therefore a very controversial subject in political and public discussions, not least because of its high costs. There are various approaches to solving the above-mentioned problems.

Another possibility of treating municipal wastes before depositing them in the land is mechanical-biological treatment. Under certain circumstances, this treatment method can be used alone or in combination with thermal waste treatment plants. This will be explained in greater detail below.

Experience has shown that a technical facility can only be operated economically over many years if

- it is optimally coordinated with stable market conditions or
- it can flexibly react to changing market conditions.

The waste management market cannot at all be regarded as a market with a stable framework. Demands on the quality of the recycled products and residues, on permissible emissions, on the safety of employees, on landfill design, etc. will quite certainly undergo substantial changes in the coming years.

There is always a time lag between developments in public awareness and their implementation into laws and regulations. This especially applies to the environment/waste area which will receive increased attention worldwide in the future. In this connection, the mechanical/biological process offers a particular advantage due to its high flexibility.

In order to really find out which treatment process is the better one, it is necessary to take a broader view and take into consideration not only the individual process, but also the effects of preceding and following ones.

4. THE MBP TECHNOLOGY

4.1 General preliminary remarks

4.2.1 Mechanical Treatment

Dry processes are used for mechanical treatment. Reusable materials and contaminants are separated from the waste stream, which is to be biologically treated, by means of transport

and sorting facilities, e.g. wheel loaders, poly-grabs, conveyor belts, screening drums, magnetic separators, sophisticated automatic sorting facilities and even manual sorting.

Homogenization is the last step in the mechanical treatment process. The material mixture is homogenized and, if desired, mixed with sludge from clarification, paper production or other production processes. The moisture content of the material is adjusted to be favorable for the biological process.

All the main units and conveyor transfer points in the mechanical pretreatment process are provided with source-specific suction removal systems and are connected to a central dust removal system.

4.2.2 Biological Treatment

Aerobic digestion is a form of biological decomposition and conversion of organic materials that can often be observed in nature. The main players in the aerobic process are microorganisms (bacteria, protozoa, fungi).

The following features are crucial for the digestion process:

- A stable temperature of approximately 50° C to provide optimum reproduction conditions for the microorganisms.
- Sufficient moisture at the surface to ensure the supply of nutrients to the microorganisms.
- An adequate volume of pores in the digesting material to ensure the supply of oxygen by forced aeration everywhere.

If these conditions are successfully optimized by technical means, the natural rotting process can occur at a great speed. The heat that is released in the process helps to remove any surplus water, together with forced aeration.

In the Trienekens AG system, tunnel reactors, which are closed on all sides, are used for intensive digestion. Sliding floors serve to slowly transport the waste through the tunnel without compressing it.

The oxygen content, temperature and water content can be checked and controlled by measurement and control equipment, thus accelerating the natural course of rotting.

The decomposition process typically begins with an adaptation phase of 12 to 24 hours, followed by a starting phase of approximately one day. Over the next seven days, biological conversion is most intense, accompanied by strong heat development. Cooling of the decaying material may become necessary in the process by aeration. The biological activity tapers off after two weeks at the latest, but is far from ending. With light, even aeration the biological process can be maintained for months and months. In this phase, conversion is low so that it can be regarded as insignificant from a technical point of view. The decomposition losses at the various levels are dependent on the mechanical pretreatment, the decomposition technique used, duration, the composition of the decaying material, the initial moisture level, etc. The total values vary between 20 and 40 percent

for one-week intensive degradation. The decomposition loss consists, on the one hand, of organic compounds that are actually decomposed; on the other hand, of the water losses mentioned above.

A natural side-effect of the decomposition process is the formation of odorous gases. They are drawn off both at the inlets and outlets of the tunnel reactors and, after running through a scrubber, are led into a biological filter where the odor components are biologically decomposed. It is necessary to use a decomposition system, which is closed to the highest extent possible in order to avoid undesirable negative effects on the environment. In this way, it can be assured that the odorous air is captured completely and is fed into the exhaust air cleaning system.

Biological filters have been used successfully in odor reduction for many years, attaining efficiencies of 95% and more.

4.2.3 MBP in combination with a landfill

If MBP is to be used as a pretreatment technique before dumping, its process technology must be oriented towards the improvement of landfill characteristics.

In order to achieve the greatest possible decomposition of organic carbon compounds, it is important to control the decomposition process. The water content should be such that the end-product can be easily compressed (not too dry). The portion of fine particles arising during biological conversion is very welcome as it will help to stabilize the disposal site substance later on.

This method has the following advantage:

- The required landfill capacity is reduced by approximately 40%.
- The concentration of rotted residual waste in the leachate is significantly lower in the initial operating years than at conventional disposal sites. The same applies to the toxicity of the leachate. Levels of ocher in the leachate collection system are significantly reduced.
- Waste containing pollutants are sorted out and do not reach the municipal waste landfill.
- Negative side-effects of landfill operation, such as paper and plastic being blown into the air, flocks of birds, odours and the development of dust are minimized or completely avoided.

4.2.5 MBP in combination with a refuse incineration plant

Requirements are different when the MBP is combined with a refuse incineration plant (RIP).

The objective of this method is to greatly reduce the waste volume, not just by biological decomposition but also by separating those fractions of the waste, which can be used for energy production. This energy may then be utilized to substitute the primary energy needed in industrial furnaces.

The separation of components with a high calorific value compensates for the increase in calorific value brought about by further drying (weight reduction), which would be counterproductive to the subsequent treatment in a household refuse incineration plant in terms of throughput. The residues remaining for incineration after pretreatment in an MBP facility have to be optimally adjusted to the furnace systems in terms of lumpiness, calorific value, etc. The MBP technology makes it easier for RIPs to meet regulatory requirements and improves emissions and ash qualities.

Over the last few years, our company has carried out numerous semi-commercial and large-scale incineration trials using MBP output. In cooperation with various research organizations and plant manufacturers, it was possible to investigate very different incineration processes for their suitability. This included various grate firing systems, the smoldering-burning technique, the conversion technique and fluidized-bed technologies.

An MBP facility designed for material flow separation offers the possibility to divide the residual refuse into the following fractions:

- Ferrous and non-ferrous scrap and other materials for recycling, if applicable
- Noxious substances and pollutants;
- Materials for energy recycling (SBS);
- Mineralized materials for dumping;
- Residuals for thermal waste elimination.

The separated fractions of residual refuse can thus be individually passed on to the next treatment or removal stage, which is adapted to their material characteristics.

5. APPLICABILITY IN OTHER COUNTRIES

The efficiency of mechanical-biological processes can be increased even further compared to German standards if the waste to be treated has a higher organic and water content due to the eating habits and/or disposal systems existing in different countries. This is the case in some Asian countries, for instance.

The operation of an MBP facility upstream of a new or already existing disposal site considerably extends its service life and reduces the cost of maintenance after its closure, e.g. for leachate treatment and landfill gas disposal.

If an MBP facility is to be combined with a refuse incineration plant and a landfill to create an integrated waste management concept, this is generally a highly cost-efficient solution as costly incineration capacity can be saved. The MBP technology optimally prepares municipal solid waste for incineration (volume reduction, drying, homogenization).

In view of the frequently scarce landfill space and limited financial means for the construction of costly incineration capacity, the MBP technology is a cost-effective way to engage in controlled waste management.

6. CONCLUSION AND OUTLOOK

The mechanical-biological treatment of solid municipal waste is a process, which has been tested for many years. It can be used with the aim of subsequently depositing the residual waste in a landfill or in combination with thermal treatment processes.

The plants may be designed in a modular form so that any future increases in waste quantity can also be coped with. The changing requirements of recycling management can be met at all times thanks to the design of the mechanical pretreatment section within the MBP facility.

Mechanical-biological treatment will be an efficient and flexible technology to be used in waste management for many years to come.