Mechanical-Biological Waste Treatment – an International Overview –

Lothar A. Deyerling and Brian E. Fuchs

For more than 20 years, W. L. GORE & Associates has been in the waste treatment business. Our first experience started right after the reunification of Germany supplying the first GORE Cover into a Soil Remediation[1] project. Within a short time period thereafter, the first demonstration projects were implemented for the category of Separate Organic Waste (SOW) treatment, leading to the many successful full scale operating plants seen today. From there, the cover technology was expanded into the category stabilizing the organic fraction of Municipal Solid Waste (MSW) and at the same time input material from waste water sludge (biosolids) and various other organic wastes. The cover is supplied directly or by an authorized supplier network of global sustainable partners to the end user. Today, the cover technology is used for the purpose of organic treatment in more than 15,000 tons per day including stabilization, mass reduction and drying before energetic use throughout Europe, Asia Pacific and North and South America. The cover technology provides the operator a high performing technology that meets the regulation at a low investment cost utilizing a flexible design from the standard heap version to fully encapsulated plants and capable of CO_2 equivalents of 12 kg/t input material [8].

The following will discuss how the GORE Cover technology is capable to successfully optimize the process of treating organic waste for meeting strict stabilization and emission regulations, while producing a high quality output finished product (RDF, CLO or stabilized material).

The Solid Waste Treatment business unit began at the companies Munich location during the same time period with the reunification in Germany. The first large on-site remediation plants where built in Germany, Italy, USA and France using the ePTFE membrane due to the solid capabilities of the waterproof yet breathable membrane – even in adverse climate regions:

[1] > 5 Mio tons of contaminated soils have been biologically remediated using GORE Cover

- air permeable (aeration) to maintain aerobic conditions
- external water tightness (up to a water column of 5 m) and internal moisture retention
- mechanically robust and long lasting of the covers (up to eight years)

It was becoming very clear that the similar features and benefits observed using the ePTFE membrane in soil remediation projects would also be used for composting of organic waste. However, the obstacles to become a certified technology according to the TA Luft[2] and BimSchV[3] took at first some references in place and the proof on meeting European Requirements. The reference plants proved that the ePTFE membrane cover is capable of being biologically inert, chemically resistant, temperature resistance (-200 - +260 °C), and UV resistant in order to withstand the very aggressive biological environment in the biological processing of organic waste from MSW. In addition, by combining the cover with positively aerated control process to conduct the biological treatment of Municipal Solid Waste (MSW) delivered a high level of control and produced a quality end use product:

- reliable hygenization of the organic matter
- measurable and consistent mass reduction
- primary step to the stabilized material process
- secondary step in the drying process of MSW
- increase in the Net Calorific Value of RDF (NCV)[4]

Stabilization and Biodrying the MSW waste before mechanical post treatment and the creation of Refuse Derived Fuels (RDF) were an obvious treatment application for the cover. Extended trials and research on existing installations in Germany (Oldenburg, Bremen, Uckermark) and Italy (Tuscany, Campanula, Sicily) became very active and with regards to meeting new regulations. These reference plants, along with Hungary and new European Countries joining European Community, were selected due to the representative and new infrastructure to support the path forward for MSW treatment, as well as proving the need to fulfil the European Landfill Directive (1999/31/EC) on the landfill of waste [2].

The first approaches in the treatment of MSW with plants sized between 5 – 10,000 tons per annum (tpy) using the high performing ePTFE membrane solution. The technology was selected due to the proven background of having a simple handling solution, flexible and expandable design, high level of performance, and a realistic investment cost structure with regards to a sustainable waste treatment approach; all the while operating in compliance with the Waste Framework Directive (2008/98/EC) in the MSW treatment [7]. Today, the technology is being used in Recycling Parks (MBT plants) that offer a daily treatment capacity of 2,000 tons (> 600,000 tons per year of MSW) which meet the stabilization parameters, including, and not limited to, the reduced treatment times in order to achieve DRI[5] or AT4[6] [11].

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[2] Air (Technical Instructions on Air Quality Control

[3] Federal Immission Control Ordinance

[4] CEN Draft Standard …*solid fuels prepared form non-hazardous waste intended to be recovered as energy in incineration or co-incineration installation according to … CEN / TS 15359…* Reference: SUEZ Environnement 2007

[5] Dynamic Respiration Index, DRI = 500 mg O_2 kf DM-1 h-1, Italy

[6] Example AT4 < 10 mg O_2/kg/DM, Poland

1. Germany

One of the first approaches of the treatment with the membranes in Germany were carried out by stabilizing MSW before applying to an incineration plant. The result showed:

- observed success to emission reduction during the treatment phase
- significant mass reduction of the different prepared MSW streams
- reduced treatment time

However, there is continued work being performed to evaluate the impact of uncontrolled increase of the NCV[7] of the material.

Table 1: Changes of waste characteristics due to treatment

	Calorific Value	Ash content	Glowing loss	DS-content	Water content
	%				
MSW	+53,6	+11,5	-4,4	+37,9	-50,4
MSW likewise Industrial waste	+20,9	-12,6	+3,0	+8,2	-22,6

Source: Horn, A.: Trockenstabilat – Versuch '97, Blockland Deponie Bremen, Ingenieurbüro Horn & Müller, Berlin, 1997

Taking these experiences into consideration, the first larger facilities on a continuously processed MSW stream were implemented in Italy in the early 1990's. The plant sizes averaging 35,000 tpy of MSW provided a fair and solid foundation to the collection of data and experience using the technology. Several case studies were developed to study the impact on air quality, water quality and finished product quality. These studies include odour measurements confirming an odour reduction of > 90 % atop of the membrane [3]. A study to show a clear separation of storm/rainwater from process/leachate water can be achieved. And the monitoring of the final product as a finished stabilized waste that can put onto the nearby landfill as daily cover.

Figure 1: MBT and landfill, one of the first plants in Italy using side walls and GORE Cover starting operation with 35,000 tpy; Handling Cover: manually

Source: BioE s.r.l., Milano, Italy

Figure 2: Stabilized organic fraction on the landfill meeting DRI

[7] Net Calorific Value

Table 2: Test Results on DRI

Analyzed material after 21 days treatment	Volatile Matters	Index of the breathability of the compost (statically index – method IPLA)
	% p/p s.s	mg O_2/kg SV • h
Biostabilized organic fraction (1A)	46.7	498
Shredded and biostabilised residual waste (1B)	43.3	431

Resulting from these experiences in the years 2001 – 2008 a large landfill remediation project took place in the north of Italy. The landfill was closed 30 years prior and was now polluting the ground water and required to be remediated meeting European Landfill Requirements. The excavated 110,000 ton per year of MSW was grinded, put onto the positive aeration under cover, stabilized, screened, and compost like output (CLO) that met stabilization criteria DRI put back on the new landfill as a daily landfill cover. The remaining over sized material with a high calorific fraction was bundled and used for energetic use.

Figure 3: Handling Cover : First generation Mobile Winder

2. Hungary

Large visitor tours form Hungary went to Italy to seek solutions for the adoption of a national strategy on MSW. The group visited reference plants in Tuscany and Naples area. With the experienced gained from the visits and the support with ISPA and SAPARD funds from the European Union, the Hungarians developed a strategy and new standards as a new member to European Union for the treatment of MSW.

The leading University carried out case studies also with regards to the potential use of Refuse Derived Fuel (RDF) from the MSW [4]. Based on these studies, the Hungarian strategy for the treatment of MSW were founded which included the stabilization and mass reduction of the organic matter plus energetic use of the valuable fraction. What followed next were first coordinated efforts of getting a more than 110 municipalities (reflecting 250,000 + inhabitants in a decentralised area) to work together to create the first Recycling Plants. The recycling plant concept is a cooperative agreement to develop a single serving processing canter; for sorting and reuse recycling and stabilization of the MSW, and separate organic waste stream for composting.

The National Waste Management Plan[8] will implement a landfill tax starting Jan 2013 with a significant fee and, according to the preparation of the new National Waste Management Plan, the AT4 is the guiding landfill criteria, will be implemented not later than 2015.

Figure 4: 160,000 tpy, Recycling Park, MSW, Started operation in 2009, Production of high quality compost from separate collection, RDF for the cement industry, Stabilized organic towards landfill; Handling Cover: Winder on the push wall

Figure 5: 150,000 tpy, 2 Recycling Parks, MSW, Started operation in 2010, Serving 107 municipalties (330,000 inhabitants); Handling Cover: Winder on the push wall

Figure 6:

Biodrying of the MSW fraction for further treatment (mechanical) before used as RDF in the cement industry; Fine fraction stabilized according to Hungarian waste legislation; Handling Cover: Winder on the push wall

A high value outcome of the MSW treatment strategy is the production of RDF from MSW. The potential destinations for the high calorific fractions from MBT plants and the specific requirements were recently presented during the ASA Recycling Days 2012 [10]. The following examples show the final material after biological treatment with a high NCV (> 18 MJ/kg):

[8] Ministry for the Environment and Country Development (KvVm)

Figure 7:

Top left – the fraction < 100 mm after the biodrying, Top right – the screened material 30-100 mm and Bottom left and right – after the post grinding before supply to the Cement Industry

Source: Alexa, L.: Mixed Waste Treatment Technology – MBT, Szent Istvan University, Gödöllö, Hungary, 2011

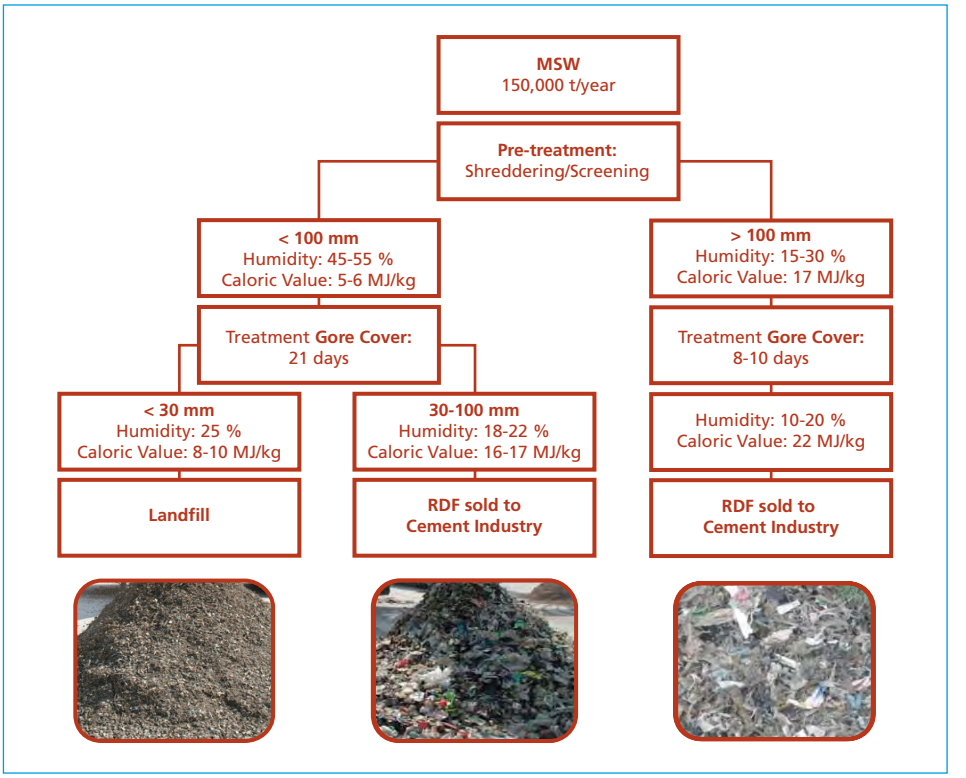

Figure 8: Low and high calorific value material depending on size and treatment time

3. Austria

Existing plants using sophisticated encapsulated mechanical technologies can also experience emission problems and poor finished product quality can also benefit from the technology as retrofit or expansion of the existing technology. A plant in Austria employing

a highly mechanized tunnel technology required an upgrade on emission control suffering from high odour complaints from the neighbours and poor final product quality due to inefficient treatment process. The plant processed on average 30,000 tpy with an ongoing treatment time of six to nine weeks.

The objective of the plant was to solve the emission (odour) situation in the maturation area and to enhance the final stabilization of the organic fraction before landfill meeting AT4 < 7 mg O_2/g DS. It was decided to add the technology as a secondary treatment process post tunnel processing, which after the GORE Cover has been installed; no more odour complaints were notified for more than five years of daily use and producing a higher quality finished product.

Figure 9: MSW post treatment facility

4. Poland

Schäfer presents information on the latest developments with regards to the Municipal Waste Act in Poland starting 1st January 2012 of the waste disposal obligation [13] and with enforcement starting 1st July 2013.

The obligation to reduce the large amount of biodegradable MSW put on the landfill has allowed for a high amount of sorting stations/ transfer plants to be established in a short time period. Using a phased in approach, the sorting stations/ transfer plants are using state of the art sorting lines and is a significant portion of the treatment goal which can be achieved right away. Following those sorting plants and meeting the treatment goal for the landfill disposal criteria [2] a number of MBT plants have been already been built and set in operation with great results using the cover approved by the Polish Ministry of Environment.

With the following examples we want to demonstrate an efficient and sustainable approach using unique designs, both heap model and a box design (Biodgma).

The Biodegma Butterfly technology offers the sustainable and solid track record throughout the treatment of MSW in the past 15 years and is utilized whenever a building or tunnel solution are demanded. Both the GORE Cover heap and Biodegma box design are accepted designs currently in use in Poland.

At one reference the client is using both designs to cost optimize the treatment process for meeting standards utilizing a flexible design and being profitable on one location for the production of RDF.

Figure 10:

Organic fraction from MSW, first plant in Poland in Spring 2009 starting operation with 12,000 tpy, Fraction 0/80 mm, AT_4 < 10 mg O_2/kg/DM; Handling Cover: Biodegma Butterfly

Source: SUTCO Polska; Biodegma GmbH, Germany

Figure 11:

Additional capacity in Poland in Spring with 28,000 tpy using both, the butterfly version in the intensive phase and the heap model in the maturation in order to achieve Landfill criteria, AT_4 < 10 mg O_2/kg/DM; Waste code: 19 05 99 code of fraction after bio stabilization of fraction < 80 mm; Handling Cover: Biodegma Butterfly

Source: SUTCO Polska; Biodegma GmbH, Germany

Example:

Total input at the front gate:	~ 170,000 tpy
Input:	MSW
Pre treatment:	Grinding, < 300 mm, screening
Input Biological treatment 0/65 mm:	~ 95,000 tpy[9,10] – stabilization[11]
Input Biodrying treatment 65/300 mm	~ 65,000 tpy biodrying RDF[12]

Biodegma GmbH, located in Ludwigsburg, Germany provides reliable, high performing services in consulting, engineering and training in all categories of organic waste treatment, specializing in MSW stabilizing and production of RDF material. Biodegma has key competence in order to support and meet the requirements set in Municipal Waste Act in Poland. Biodegma has key references with regards to MSW treatment in Germany, Poland, Spain, Slovenia, Turkey and Middle East.

[9] Started of first treatment capacity in Dec 2011; final capacity already at site; construction in progress

[10] The change with regards to the size of the material from < 65 mm to < 80 mm will become effective starting 01.09.2012.

[11] landfill AT4 < 10 mg O_2/kg/DM, Waste code: 19 05 99

[12] Drying < 20 % Humidity, post grinding > 30 mm, cement industry, 19-21 MJ/kg

Figure 12:

Installation of first treatment capacity fraction 0/65 mm stabilisation before landfill AT_4 < 10 mg O_2/kg/DM, 2nd phase for 100,000 tpy in start up phase adding 26 heaps; Handling Cover: small mobile winder

Figure 13:

Biodrying Plant Poland; Fraction 65/300 mm, End user: Cement industry, 30 mm < 20 % humidity; Handling Cover: winder on the wall

Source: EQUIPO, Ksawerów, Poland and Biodegma GmbH, Stuttgart, Germany

5. Italy after the early beginnings

Italy, currently has the largest plant using GORE Cover which started operation in autumn last year with a daily input stream of 2,000 + tons of MSW.

This plant concept dates back to 1994 offering the longest history in respect to using the cover as the treatment technology for fulfilling the MSW treatment strategy. Up until this plant was built, the largest significant plants were treating up to 1,700 tons per day of MSW. The next step into a large MBT plant and using the cover as the key in the biological treatment was not only based on the trials that have been carried out but also on the requirement of Best Available Technique (BAT[13]) meeting both, technical and economical sustainable requirements. The site utilizes a state of the art Mechanical Pre-treatment equipment and utilizes a very thought through logistic stream with a high level of performance for both, the pre treatment and biological process at the site.

[13] The term *best available techniques* is defined in Article 2(11) of the Directive as *the most effective and advanced stage in the development of activities and their methods of operation which indicate the practical suitability of particular techniques for providing in principle the basis for emission limit values designed to prevent and, where that is not practicable, generally to reduce emissions and the impact on the environment as a whole.*

Figure 14: Intensive rot – stabilization, drying of < 65 mm fraction

Mass data on the example site:

Total input at the front gate:	620,000 tpy
Input:	MSW (no separate collection)
Pre treatment:	Separation of PET, Plastic, Glass, Paper/Cardboard, FE/NE in total > 50 % of the input material
Input towards Biological treatment:	~ 310,000 tpy
Mass reduction fraction <65 mm:	~ 90,000 tpy (biological process)
RDF (Refuse Derived Fuel):	~ 70,000 tpy
Landfill material at the end	~ 150,000 tpy (< 25 mm fraction)

Surface/dimensions:

(Reception, Mechanical pre treatment)	- 10,000 m²
Biological treatment area	- 14,400 m²
Post treatment	- 1,000 m²

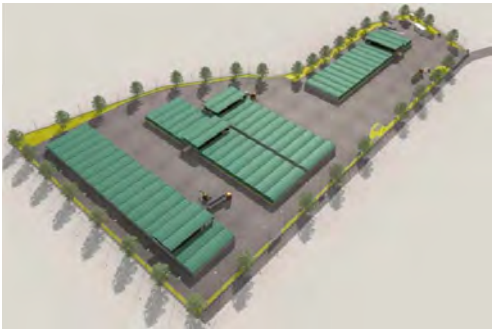

Figure 15: The biological plant from a sketch to reality – 2,000 tons per day MSW

Source: BioE s.r.l., Milano, Italy

Figure 16: Biological Treatment GORE Cover showing 45 out of 60 modules during construction; Handling Cover: Hydraulic frame

Source: BioE s.r.l., Milano, Italy

Figure 17:

Fraction < 65 mm after mechanical pre-treatment in the biological process for 21 days; During ongoing emission testing

Source: BioE s.r.l., Milano, Italy

Odour measurements are continuously monitored to prove validity of the performance of the plant – a very necessary part of the sustainable waste treatment on the site.

After the total treatment on the site, less than 30 % of the total received MSW in a fraction < 25 mm have been put as a stabilized material on the landfill meeting DRI criteria and fulfilling the emission requirements.

In this application, the cover is also fixed on a frame and sealed onto the side walls with strong forces – air tight and the only way to release the humidity is through the membrane. A key characteristic of the membrane is moisture control, which performing under such conditions reduces emissions, enhances drying and stabilizing of the organic fraction. This tunnel design delivers a total encapsulated plant solution, and if needed can be combined with adjacent supporting structures for pre-treatment (receiving, sorting, mixing/ grinding in a solid building, requiring air treatment due to fully encapsulated), while MBT or composting process supplied into the technology, reducing the infrastructure costs. This cover encapsulated design has been successfully in use for more than three years now.

Our Italian partner lately installed the first large facility (MBT plant) in South America with a treatment capacity of 130,000 tpy in the first phase using the comprehensive know-how gained throughout the learning and development during the past years. The plant technology after pre treatment is again using heaps with side walls and handling of the GORE Cover with a mechanized winding machine.

Figure 18:

Handling Cover: Big Winding Machine, mobile

6. Summary

The performance zone of the cover application in some numbers:

Sizes of plants	2,000 tpy	→	200,000 tpy	→	630,000 tpy	→ 1,000,000 tpy[14]
Ton per week	39 tpw		4,000 tpw		12,000 tpw	20,000 tpw
Ton per day	~ 7 tpd		~ 670 tpd		~ 2,000 tpd	~ 3,200 tpd

References	MSM, SOW, BS, Landfill Remedation 250 + plants
Treatment experience	15,000 tons per day + (min. 12 months in operation)
Staff	80,000 tpy MSW plant = 2 workers
Buffer zone	from 50 m (example: UK, London, 35,000 tpy) onwards
Energy consumption	MSW 1.0 kw/t input → 4.5 kw/t

The article demonstrated a solid background and a great performance in affordable waste treatment technology. Achieving the strict stabilization criteria's with the technology in various countries, the know-how of the partner and fit for use GORE Cover made its way from the early days. At the given experience, not only in Germany, a cost effective and sustainable approach by choosing treatment technologies is key in the future MSW treatment to our point of view. However, even if a fully encapsulated plant is desired to what ever reason – reference plants even on this specific request are available.

Figure 19: Active Plants using GORE Cover

[14] Plant under construction

7. Literature

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Head office: Dorfstraße 51 D-16816 Nietwerder-Neuruppin Phone: +49.3391-45.45-0 Fax: +49.3391-45.45-10 E-Mail: thome@vivis.de
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