Geomechanical properties and landfilling of mechanically and biologically pretreated (MBP) municipal waste (abstract)

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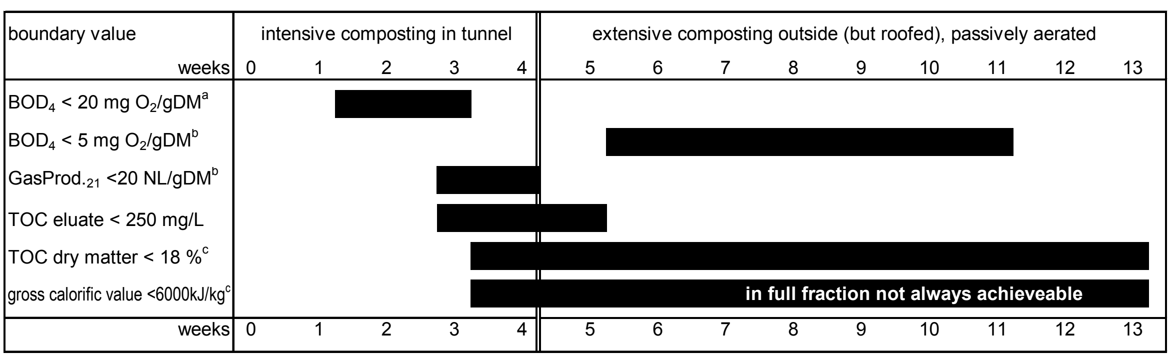
1 Introduction

MBP-output differs significantly from untreated municipal waste. It is much more homogeneous, has a smaller average grain size, low biological activity and more soil like properties. This affects the construction and operation of landfills. Based on tests and examinations done by the ISAH in the years 2000-2002 and practical experiences at 3 MBP-landfills, the properties of MBP-output are described. As a result advises for landfill construction and operation are given.

2 Legal boundary values in Germany and treatment effort

After June 2005 landfilling of untreated municipal waste will be prohibited in Germany. If mechanical-biological treatment is used, drastic reductions of biological activity and energy content / total organic carbon have to be achieved. The bio degradation can be compared with the situation in a conventional landfill after 50 years or more. But in opposite to a conventional landfill, the degradation is homogeneous and there are no areas, which were not or only insufficiently affected by the degradation process.



a) limit for not encapsulated treatment; b,c) can be alternatively used

Pic. 1 Boundary values for landfilling of MBP-waste and e.g. necessary treatment duration of the biologically treated fraction (0-150mm) in a well operated composting tunnel

3 Effects of mechanical and biological treatment on the physical waste properties

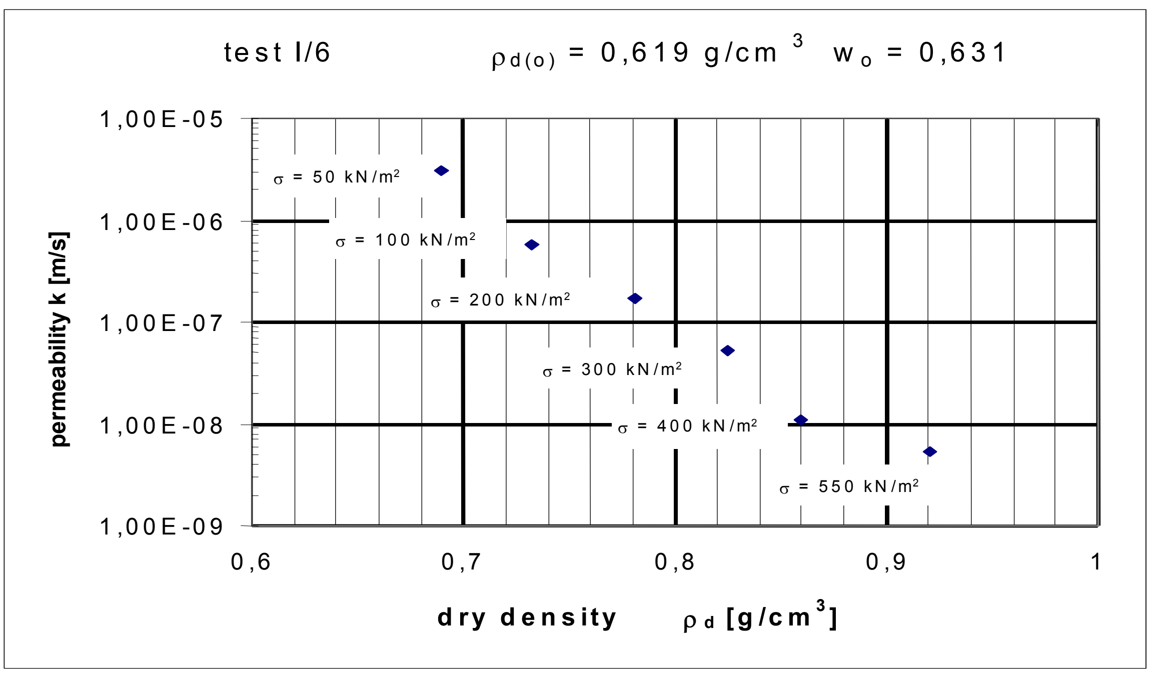
The following table shows some of the main influences of MBP on the waste properties. The mechanical treatment is focused on a final sieving with 60 mm hole diameter, which is expected to be (the minimum) usually necessary to securely achieve the limited calorific value. Larger sieve hole diameter will bring the mechanical properties much closer to those of untreated waste. All properties are heavily dependent on the waste composition.

property / influence	mechanical treatment (grain size < 60 mm)	biological treatment	mechanical and biological treatment
water permeability			decrease (10^{-5}-10^{-10}m/s)
angle of shear φ*	apparently no change	increase	increase
cohesion c´*	apparently no change	apparently no change	apparently no change
angle of tensile ξ*	extreme reduction	apparently no change	extreme reduction
oedometric modulus*	increase		increase
calorific value	~20% decrease	~15-40% decrease	~35-60% decrease
subsidence	decrease	decrease	huge decrease
mass reduction	25-50%	~15-20%	40-70%

*based on Ziehmann, 1999

4 Laboratory and field tests with material < 60 mm or smaller sieve cut

At proctor density or less, coefficients of permeability between 10^{-5} and 10^{-10}m/s were determined for various MBP materials. The water permeability is extremely dependent on placement moisture and surcharge. Therefore coefficients of permeability are only meaningful if moisture content, proctor moisture content, placement density and surcharge are documented. By-pass effects at the seam of the test vessel are often a serious problem.



Pic. 2: E.g.: Influence of surcharge on permeability and dry density (Duellmann, 2002)

In situ measurements in proving grounds built by the ISAH with the same material confirmed the laboratory measured permeability. Results of laboratory investigations with different sievings of two treatment batches (V4 and V5) are shown in the following table.

grain size		mm	0-20				0-40				0-60			
origin			V4		V5		V4		V5		V4		V5	
placement moisture		% moist	36		41		37		46		36		41	
		% dry m.	56		70		58		84		57		70	
placement density	mo.	g/cm³	1.4		1.5		1.4		1.5		1.4		1.4	
	dry	g/cm³	0.9		0.9		0.9		0.9		0.9		0.8	
angle of shear		° fail/slide	33	33		34	34	34	36	36	35	35	35	27
cohesion c´		Kn/m² f/s	38	21		16	43	21	23	11	35	20	49	62
oedometric modulus Es at a surcharge of [KN/m²]	25	MN/m²	0.39				0.49				0.28			
	50	MN/m²	0.84				1.07				0.94			
	100	MN/m²	1.99				1.59				1.49			
	200	MN/m²	1.87				1.68				2.44			
	400	MN/m²	3.29				2.88				3.03			
coefficient of permeability		laboratory	a		a	b	a		a	b	a		a	b
		m/s	7.8*E-8		3.7*E-9	2.3*E-10	6.5*E-6		3.6*E-6	7.0*E-10	6.2*E-6		5.2*E-5	1.8*E-8
placement moisture		% dry m.	56		70	72	58		64	67	57		70	54
placement density	mo.	g/cm³	1.2		1.4	1.39	1.11		1.2	1.42	1.17		1.0	1.32
	dry	g/cm³	0.77		0.8	0.81	0.71		0.7	0.85	0.75		0.6	0.86

Field trials by the ISAH and practical landfill experience revealed:

- Placement densities between 1,0 and 1,4 g/cm³.
- Compactor weight, method of compaction (dynamic / static) and layer thickness of 30 or 50 cm had no or negligible influence on the compaction success; a maximum of 3 compaction turns is enough, the remain is done by the surcharge of following layers.
- Surface runoff is unlikely under natural rain intensities, but the material gets quickly very swampy and impassable (for heavy vehicles).
  Reiff & Marx (1999) reached higher densities and in certain cases surface runoff with different material, which could be better compacted with heavier compactors.
- Landfill gas production is reduced 90% or more, gas composition (main components) is equal to conventional landfills. Leachate COD is between 500 and 2500mg/L.

5 Recommendations for landfill construction and operation

- Placement should be done in 50cm (20 inch) layers with a tamping roller (for better indentation of the layers), at dry weather conditions, in a small placement area and the infiltration of precipitation should be limited.
- Placement moisture should be low to prevent stability problems by excess porewater pressure caused by compaction, very low permeabilities and gas production in the landfill. Possibly an internal drainage can be necessary (research needed).
- The stability analysis has to consider the individually analyzed properties of the local MBP output. If the MBP output is deposited on untreated waste, measures have to be taken to maintain the water circulation in the old material.

6 Literature cited:

Duellmann, H. (2002): Untersuchungen zum Einbau von MBA-Abfaellen auf der Zentraldeponie Hannover. Laboruntersuchungen zum Verdichtungs-,Durchlaessigkeits-, Last-Setzungs- und Scherverhalten. Unpublished. By order of Abfallwirtschaftsbetrieb Hannover.

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