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**Plants for Mechanical-Biological
Waste Treatment**

Summary of the Final Report

by

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1 Introduction

1.1 Motive and initial situation

More than 7 million Mg (tons) of residual solid waste are annually treated in Germany in mechanical-biological waste treatment plants (MBT), mechanical-biological waste treatment plants with biological drying (MBS), mechanical-physical drying (MPS) or purely mechanic waste treatment plants (MA). The “cold” pre-treatment procedures have thus become a bearing pillar of the municipal solid waste management in Germany. The commissioning of many plants with biological process steps was related to essential technical problems, leading to controversial comments in these procedures in the media and under experts. Therefore, the German Environment Agency (Umweltbundesamt) wanted to get a comprehensive overview about the current situation of the plants and possibly existing problems in order to allow an objective, factual evaluation based on assured data. Wasteconsult international was assigned to carry out data collection and evaluation in the scope of the Environment Research Plan (UFOPlan). A summary of the final report will be presented here.

1.2 Important basic conditions for the MBT

Boundary values for deposit on landfills have already been determined in the technical directive for municipal waste (TASi) of May 14. 1993, which could be met for “traditional household landfills“ of landfill category 2 particularly of household waste and commercial waste similar to household waste only subsequent to pre-treatment. The objective was to assure environmentally tolerable deposit and with respect to the German Waste Recycling Law of 1993 redirection of lots of waste into recycling, which had been deposited before.

A period of 12 years until June 1, 2005 had been granted for complete adherence to the boundary values defined in annex B of TASi so that the waste management companies were able to adapt their long-term concepts correspondingly and would get sufficient time for planning, authorisation and construction of the required waste treatment capacities.

The boundary values determined in annex B of TASi for landfill category 2, e.g. the ignition loss of 5 weight-% can be completely met e.g. for household waste only by thermal treatment (waste incineration [MVA]). Both on the level of poli-

tics and under experts, this indirect commitment to exclusively thermal procedures was criticised in parts. As a result of this, projects have been carried out to investigate the qualification of MBT as alternative and supplement, respectively, to incineration on a national level (joint project MBT of the Federal Ministry of Education and Research) [6] and also in individual German states, predominantly in Lower Saxony. [3], [4].

The MBTs used until this date mostly had a low degree of technology and predominately worked according to the chimney aeration method. On the locations in Bassum, Lüneburg and Wiefels in Lower Saxony, large-scale pilot plants were constructed with a high degree of technology which received intense scientific assistance [3] and started operation from 1997. A similar project was accomplished in Bavaria with the MBT Erbenschwang [4].

It was concluded from the results of the research projects that also by mechanical-biological treatment a deposit can be produced for depositing that is ecologically compatible to category 2 landfills, even if it does not comply with the requirements of annex B of TASI. Annex 2 of the Waste Deposit Regulation (AbfAbIV) of March 1, 2001 thus contained as an innovation towards TASI allocation criteria and further requirements with regard to waste landfills for deposit of mechanically-biologically treated solid waste. In addition there were prescriptions under emission law in the 30th Federal Decree on the Prevention of Immissions (BlmschV) and annex 23 of the Waste Water Ordinance (AbwV) for waste water from the MBT.

The total requirements have not been met by any of the plants existing until then. Therefore 45 MBTs had to be essentially reconstructed or built completely new in the remaining 4 years up until June 1, 2005. The feasibility of a plant to fulfil the requirements could however not be completely proven with regard to industrial scale, but it could be derived from the results of research which were available until this date. Eventually, this was confirmed also in practice.

Very different treatment concepts had been used in the plants, which partly had not been proven at industry scale and had to be adjusted to the most different requirements and objectives of the operators at each location.

Planning and execution of the plants had been carried out by few engineering consultants and some medium-sized plant constructors. As indicated by the

arising problems/bottlenecks which resulted in late completion and commencement of regular operation, the large number of plants to be realised simultaneously within a short period of time clearly exceeded the capability of the few participating companies to some extent. This got worse because some operators delayed the period of tendering and assignment for a long time.

A hard price war came along to significant technical and logistic requirements which, in combination with carelessly (?) assumed warranties for procedures which had not been sufficiently tested before, endangered or destroyed the existence of the participating plant constructors. The insolvency of the companies Babcock-Borsig, Farmatic, Hese, Herhof and now also Horstmann additionally casts/casted a damp over realisation of numerous MBT-projects. Construction or completion of some plants or plant components thus occasionally had to be tendered anew. In the worst case this happened multiple times at the same location. Therefore, even with early planning and tendering, problems could arise for commissioning of plants in due time.

2 Data collection

2.1 Development, content and dispatch of the questionnaire

In co-ordination with the Federal Environment Agency, Wasteconsult international has developed a questionnaire which is universally suited for all types of plants inspected in the project. Particularly technical equipment, capacity, problems in operation, compliance with the legal boundary values and efficiency of the plants should be evaluated by it. At the same time, the intermediate storages allocated to the plants were listed.

The questionnaire on CD was sent by mail on February 3, 2007 to all plants identified until that date. For each plant one individual file was prepared with all data entered (e.g. from the ASA MBT-characteristics [2]). Further information was gathered from a report of LAGA [5] and an online-database of the German Association for the Waste Management Industry (BDE).

Return of the completed questionnaires was requested until February 16, 2007. The working committee 'Substance-Specific Waste Treatment' (ASA e.V.) supported the project by writing a letter to the plant operators organised in ASA, asking for co-operation in the project. In many cases the return of the question-

naires took place considerably slower than scheduled. All questionnaires returned until April 18, 2007 have been included in evaluation.

From a total of 78 plants, 1 BA (biological treatment plant), 10 MA, 2 MBT and 2 MBS did not provide data up until April 18. No more data arrived until the formal end of the project period (April 30). Data of such plants which had not provided any data was investigated from March on in the internet, at the Federal State Environment Agencies as well as at the Regional Commissions.

2.2 Considered plants

The plants considered in the project are entered in Table 2-1. For both biological plants a mechanical treatment plant also exists at the same location, from where the biological plant receives the material to be treated. Therefore, it principally is a matter of two mechanical-biological plants acting as separated plants predominantly for legal reasons. For presentation of the general information (also within the characteristics) and technical equipment, these linked plants will still be contemplated separately. For the further analyses on the quantity flow and adherence to boundary values, both BAs will be combined with the appropriate MA and treated according to their technology as aerobic MBT.

Table 2-1 Identified and considered plants

Federal state, (number)	Type	Amount	Plant
Baden-Wuerttemberg (6)	MA	3	Heilbronn, Mannheim, Ostalbkreis (Ellert)
	MBT	3	Buchen, Heilbronn, Kahlenberg (Hauptziel Brennstoffherzeugung)
Bavaria (1)	MBT	1	Erbenschwang
Berlin (3)	MA	1	Köpenick
	MPS	2	Pankow, Reinickendorf
Brandenburg (12)	MA	6	Premnitz, Recyclingcenter Jänschwalde, Recyclingpark Brandenburg, Schöneiche, Schwedt, Wilmersdorf
	MBT	5	Freienhufen (Schwarze Elster), Niederlausitz (Lübben-Ratsvorwerk), Schöneiche, Schwanebeck, Vorketzin
	MBS	1	Nuthe Spree
Bremen (1)	MA	1	Bremen
Hesse (3)	MA	1	Diemelsee-Flechtdorf
	MBS	2	Aßlar, Wetterau
Mecklenburg Western Pomerania (4)	MA	1	Ihlenberg
	MBT	2	Rosenow, Rostock
	MBS	1	Stralsund
Lower Saxony (12)	MA	2	Mansie, Oldenburg-Neuenwege
	MBT	9	Bassum, Großefehn, Hannover, Lüneburg, Osterholz, Sachsenhagen, Südniedersachsen, Wiefels, Wilsum
	MBS	1	Osnabrück
North Rhine-Westphalia (15)	MA	11	Bochum, Ennigerloh, Erwitte, Haus Forst, Köln-Heumar, Köln-Niehl, Krefeld, Meschede-Enste, Olpe, Paderborn, Viersen
	BA	1	Ennigerloh
	MBT	3	Gescher, Pohlsche-Heide, Münster
	MBS	2	Erfstadt, Neuss
Rhineland Palatinate(5)	MBT	3	Kaiserslautern, Linkenbach, Singhofen
	MBS	2	Mertesdorf, Westerwald (Rennerod)
Saxony (6)	MA	2	Delitzsch, Zwickau
	MBT	1	Cröbern
	MBS	2	Dresden, Vogtland (im Bau)
	MPS	1	Chemnitz
Saxony-Anhalt (2)	MA	1	Edersleben
	MBT	1	Gardelegen
Schleswig-Holstein (2)	MBT	1	Lübeck
	MBS	1	Neumünster
Thuringia (4)	BA	1	Nentzelsrode
	MA	1	Nentzelsrode
	MBT	2	Erfurt-Ost (Fertigstellung April 2007), Wiewärthe

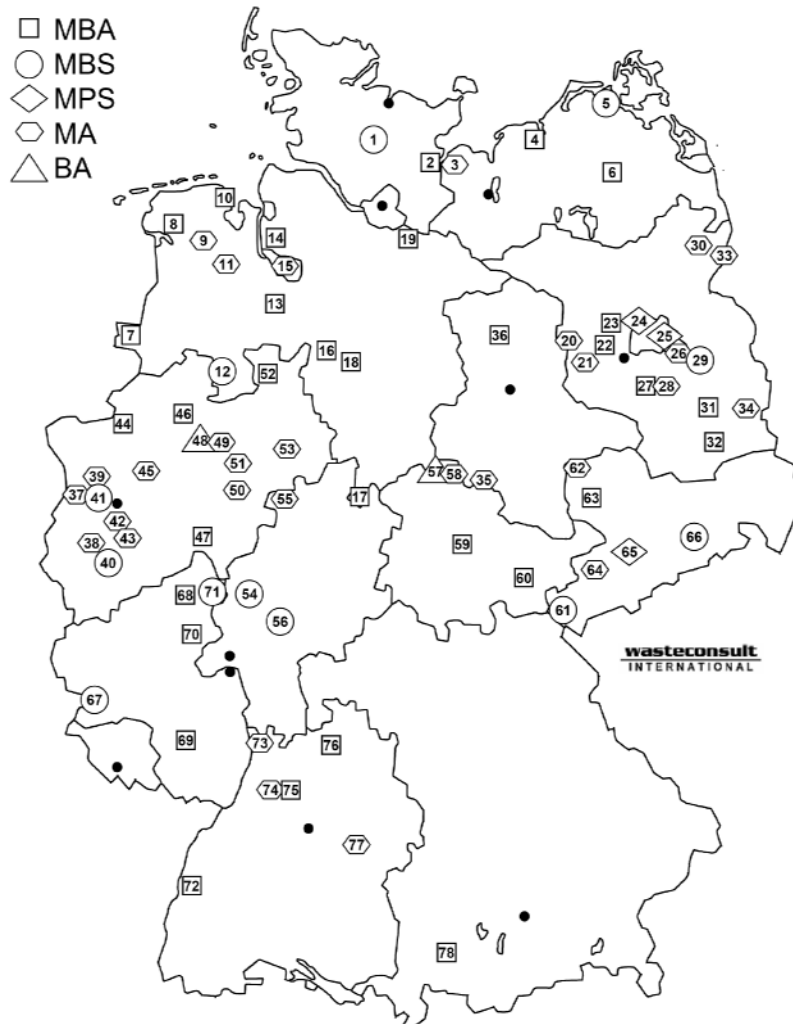


Figure 2-1 Site plan of mechanical, mechanical-biological and mechanical-physical solid waste treatment plants in Germany

3 Results

3.1 Preliminary note

The investigation in the present report is focused on such plants that are subject to the German Waste Storage Ordinance (AbfAbIV) and/or 30th Federal Decree on the Prevention of Immissions (BlmschV) as well as annex 23 of the Waste Water Ordinance (AbwV), thus mechanical-biological plants (MBT) prior to deposit and mechanical-biological drying plants (MBS). The detailed research results were presented and discussed on the occasion of an expert discussion on

May 8, 2007 which took place at the Federal Environment Agency. Suggestions on content and representation have already been taken into.

3.2 Material flow and treated amounts of waste

Figure 3-1 represents the material flow arising from the total of the considered plants (extrapolation). It should be observed for contemplation of the treatment capacity that 3.6 million Mg (tons) of plant output require further treatment or energetic utilisation.

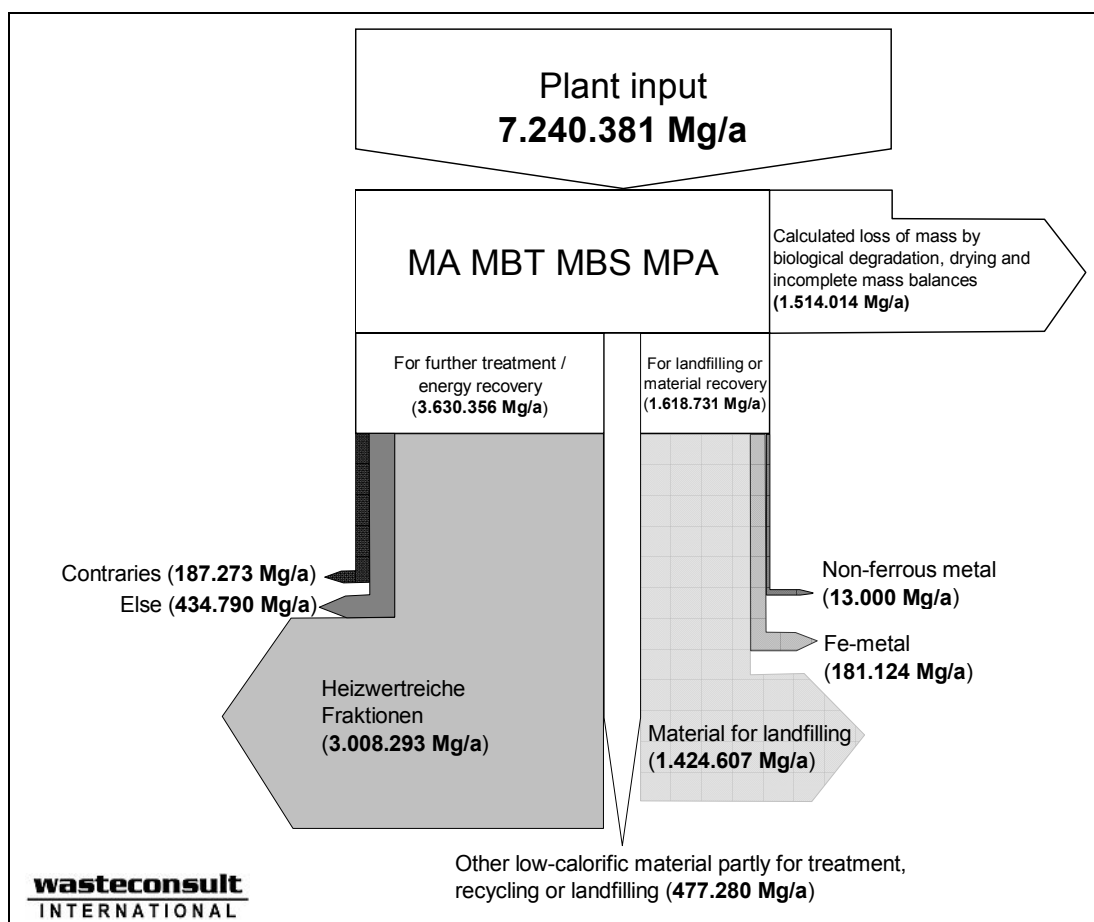


Figure 3-1 Material flow extrapolated to the overall stock of plants in 2006

Table 3-1 shows the number of plants of the different procedure types and the extrapolated actual operational capacity in the year 2006. The completely plausible input/output relation for the MAs might be attributed to inaccurateness for mass accounting of the plants.

Table 3-1 Total number of plants and extrapolated actually treated waste amount 2006

Plant type	Amount	Input [Mg/a]	Output [Mg/a]
MA	30	2,333,040	2,006,666
MBT*	33*	3,082,898	2,339,407
MBS	12	1,361,443	1,071,135
MPS	3	463,000	309,160
Sum	76* (78)	7,240,381	5,726,367

*incl. 2 separately authorised BA / MA combinations at one location each

The fractions of output materials are partitioned quite differently depending on type of plant, thus as to the purpose of the plant. In Figure 3-2 this is shown with the exception of the MA.

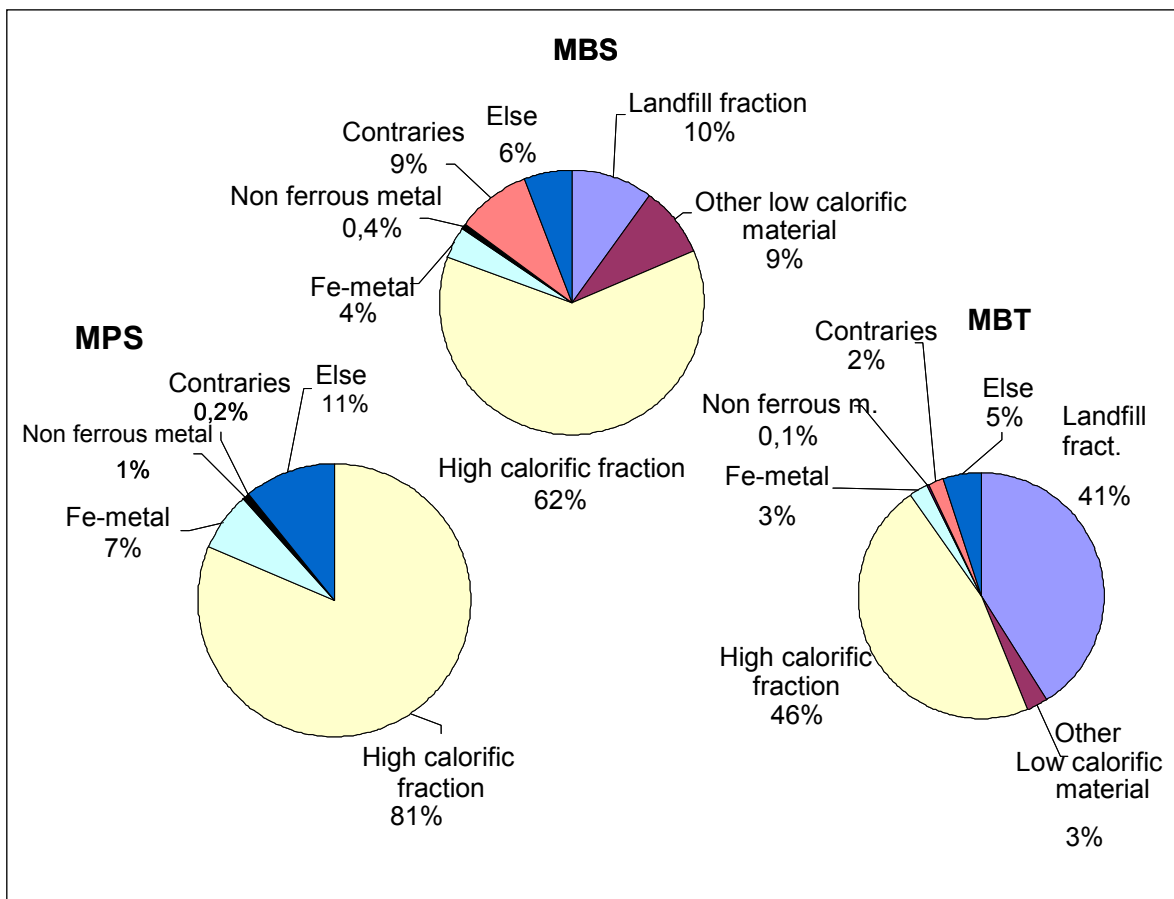


Figure 3-2 Fractioning of output flow with regard to total output (without loss due to degradation and drying) of the different plant concepts

3.3 Problems in operation and adjustment of waste treatment technology

Several plants had to be changed with respect to the operating method or technical equipment in order to reliably produce a deposit which meets the Waste Deposit Regulation.

The milling technology (e.g. higher degree of crushing) was improved in many plants or amended by additional units. Also the screening lines have been adjusted to finer screening.

For biological treatment changes have been accomplished with regard to duration and cultivation of the post-composting. Also improvements have been made to ventilation (aeration) and irrigation. For some plants with anaerobic process steps additional cleaning or external disposal of process water was attached. Measures for early fire detection were required locally.

The following further occurring problems have been mentioned:

Mechanical Treatment:

- Congestions due to ribbons, deadlocks / standstill / damages by contraries
- High wear, change of the degree of crushing and screen cut due to wear

Biological Treatment

- High cleaning effort, particularly for ventilation
- Wear, e.g. moving (walking) floor
- Limited potentiality for hall ventilation
- Release of ammonia gas, anaerobic zones in the composting
- Instable process during fermentation
- High employment of labour and machine breakdown in wet processing
- Formation of floating cover, foam formation, decanter problems (all problems occurring at wet processing)
- Fluctuation in drying, too wet compost output

3.4 Compliance with landfill parameters

In the following the number of plants is evaluated whose landfill output meets the requirements of the German Waste Deposit Regulation (AbfAbIV). Foreign readers should consider that comparatively strict values apply in Germany. Compliance with the boundary values that apply in other countries might be easier to achieve by the plants inspected in the scope of the project.

Figure 3-3 shows which part of the plants have consistently met the most important parameters influenced by the treatment method according to annex 2 of the Waste Deposit Regulation (AbfAbIV). The situation will further improve in 2007, since 2 of the plants which were not able to meet the boundary values for landfilling shall be shut down in 2007. Also by optimisation of the rest of the plants the situation will further improve.

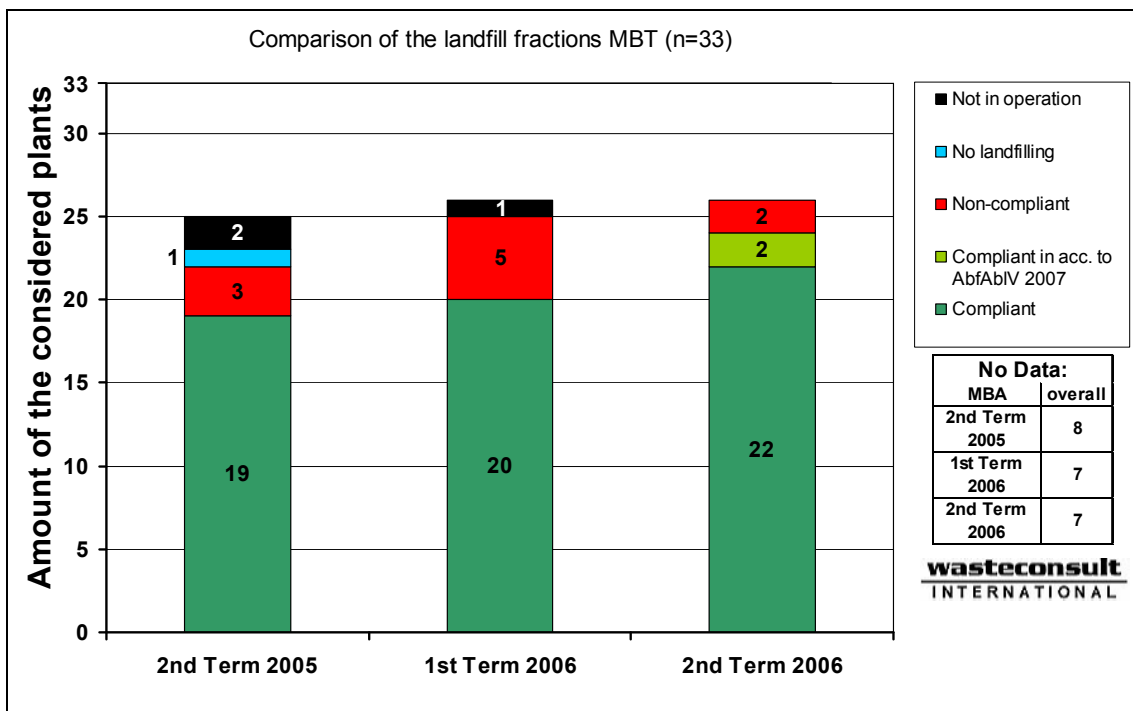


Figure 3-3 MBT total: Simultaneous compliance with the boundary values AT4/GB21, TOC in eluate and gross (upper) calorific value (Ho)/TOC DM of the landfill fraction¹

Aerobic plants and plants with anaerobic process steps are able to a different

¹ The plants that are non-compliant to the boundary values are planned to be closed in 2007

degree to meet the requirements of the Waste Deposit Regulation (AbfAbIV). There are noticeably greater problems with the anaerobic plants (see Figure 3-4). Mainly percolation systems and plants with full-flow wet fermentation are affected by this.

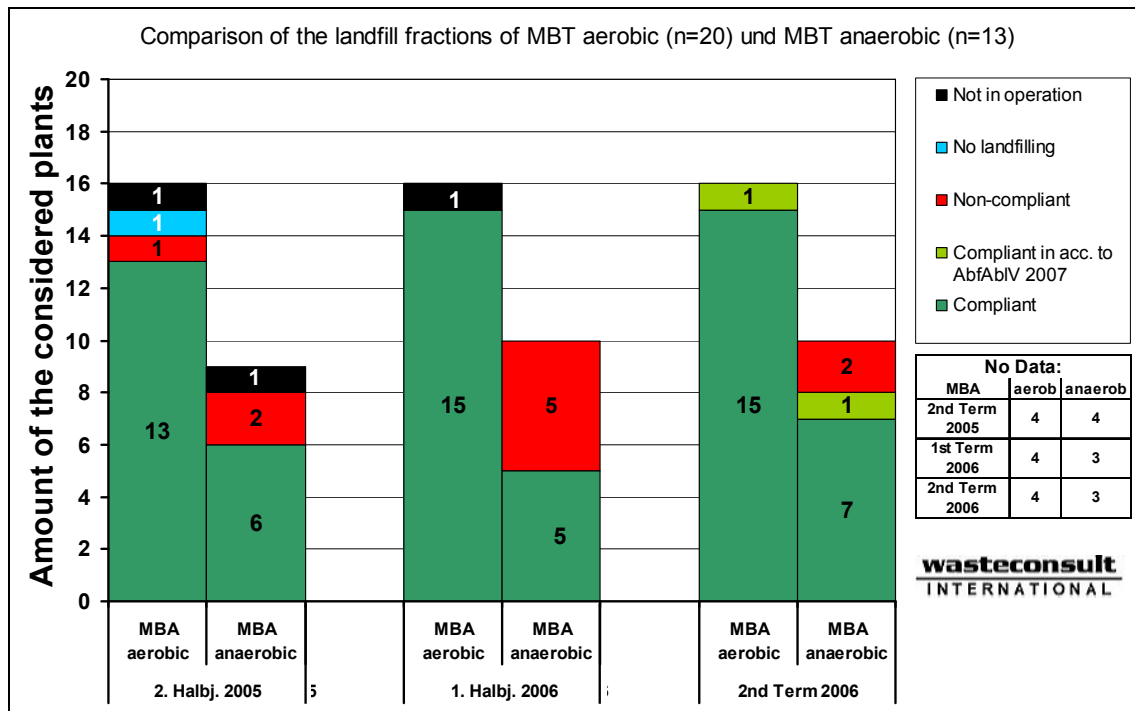


Figure 3-4 Compliance AT4/GB21, TOC in eluate and Ho/TOC DM for aerobic and plants with anaerobic process steps ²

A particularly critical parameter for many plants turned out to be the TOC in the eluate. The boundary value for the TOC (respectively DOC from 2007) in the eluate determined in the version of the Waste Deposit Regulation was raised in the Waste Deposit Regulation valid from February 2007 from 250 to 300mg/L and the permissible range was considerably extended³. This will further increase the share of those plants producing disposable material, as can be derived from Figure 3-5.

² The plants that are non-compliant to the boundary values are planned to be closed in 2007

³ This is particularly due to considerable range of fluctuation for the results of the analyses of the same samples.

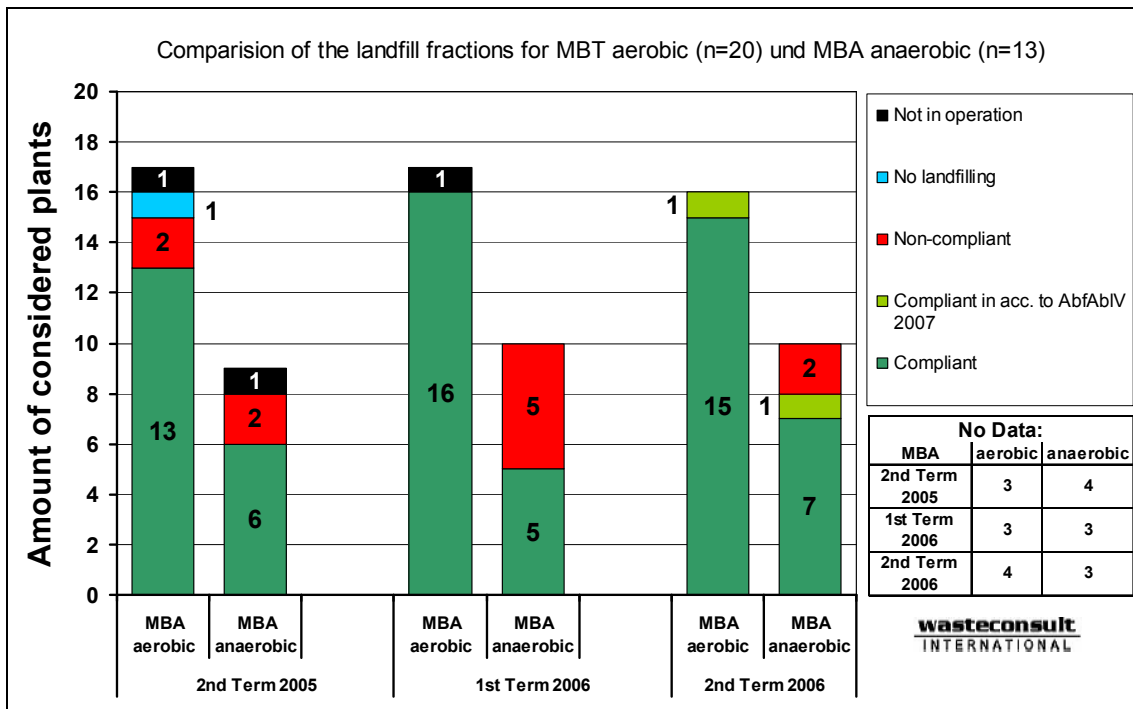


Figure 3-5 MBT aerobic / anaerobic: Compliance with boundary value TOC-eluate

3.5 Treatment of exhaust gas

3.5.1 Operation problems and adjustment of exhaust gas treatment

Particularly the regenerative-thermal treatment of exhaust gas (RTO) resulted in considerable problems. Next to corrosion problems (e.g. by condensation), primarily silica deposits in the heat exchangers led to substantial maintenance effort and thus to limitation in functionality of the plants. In a lot of cases the RTO-systems had been dimensioned too small so that an additional line had to be installed. Problems also arose in many cases from the measuring technology, most notably for the parameter of dust.

Next to increase of RTO-capacity, particularly shortened maintenance intervals, insulation of pipelines and containers as well as improvements to the measuring technology have been accomplished.

Nevertheless the following problems are still often occurring:

- Siloxane blocking of RTO
- Corrosion
- High energy consumption (RTO)
- Failure of measuring and control technology, particularly dust measuring (e.g. caused by condensate)
- Too low availability

3.5.2 Compliance with boundary values of the 30th Federal Decree on the Prevention of Immissions (BImSchV)

The retrofitted RTO-lines and shortened maintenance intervals have led to a considerably improved situation also on the side of discharged air. This is represented on the basis of the parameter ‘organic substances’ in Figure 3-6.

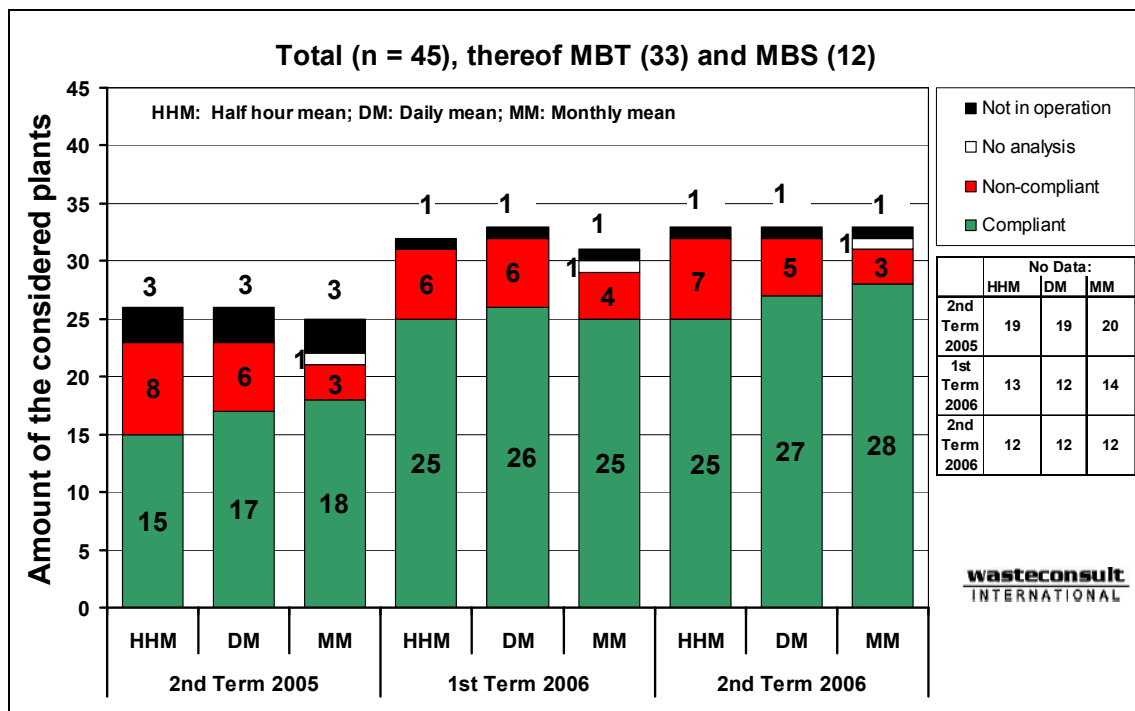


Figure 3-6 Compliance with emission of organic substances (VOC) MBT + MBS (45 plants)

However, problems occurred not only with the exhaust gas treatment systems itself, but also with the emission measuring technology, where it came to break-

downs/disruption of operations. It must be acted on the assumption that exceeding the parameter 'total dust', which can easily be met by means of the conventional technology, must be attributed to failure of the measuring technology to a considerable part and not to actually raised emissions.

Figure 3-6 shows the situation with respect to compliance with the boundary values for emission of organic substances (VOC) representative for the parameters listed in the 30th Federal Decree on the Prevention of Immissions (BlmSchV) in Germany.

3.5.3 Odour problems

17% of all plants considered in the study confirm the occurrence of odour problems (Table 3-2). These particularly resulted from waste handling as well as dealing with compost material. Also adjacent landfills and intermediate storage sites have been specified as odour source in the broader sense. This should be regarded specifically in dealing with complaints of residents. It is hard to differentiate from outside if MBT, composting, intermediate storage or landfills are the source of possible odour emission.

Table 3-2 Occurrence of odour problems

Plant type	Amount	Yes	No	n/a	Yes	No	n/a
BA	2			2			100%
MA	30	1	10	19	3%	33%	63%
MBT aerobic	18	4	10	4	22%	56%	22%
MBT partial flow fermentation	4		2	2		50%	50%
MBT full flow fermentation	6	2	3	1	33%	50%	17%
MBT percolate	3	2	1		67%	33%	
MBS	12	3	4	5	25%	33%	42%
MPS	3	1		2	33%		67%
Total	78	13	30	35	17%	38%	45%

4 Conclusion

A challenging pioneer work has been done by large-scale introduction of MBT under difficult general conditions. Not all constructed plants proved of value,

which is reflected in the planned shut-down of 2 plants.

It should be pointed out here that the development of thermal waste treatment plants over decades, which also left expensive investment ruins as the failure of pyrolysis plants according to the Thermoselect® method or smouldering-combustion procedure, however will in no way question the efficiency and qualification of thermal waste treatment. Mostly complex optimisation processes, but also throwbacks must be taken into account when introducing new technologies.

The problems existing for MBT could be resolved to a great extent, or clearly be reduced. MBT has proven to be an appropriate technology for the treatment of municipal solid waste according to legal requirements. The still existing difficulties are focused mainly to plants with anaerobic process steps, particularly percolation and full-flow wet fermentation.

5 Literature

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