

# **TURNING CONTAMINATED WASTE INTO CLEAN RENEWABLE ENERGY AND PAS 110 COMPOST – AN OVERVIEW OF THE MONSAL BIOWASTE PROCESS**

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## **ABSTRACT**

The Monsal Biowaste process has been specifically developed to allow contaminated ABPR Cat 3 organic wastes to be pre-conditioned and anaerobically digested to produce high yields of renewable biogas and good quality compost compliant with the proposed PAS110 standard.

The paper outlines the process and discusses many of the specific adaptations that have been made to the process to accommodate source segregated, commercial, industrial and OFMSW waste streams.

A case study is presented of one of the Biowaste plants successfully operating in Europe treating 48,000 wet tonnes per annum of mixed organic and green waste, heavily contaminated with grit and packaging.

## **KEY WORDS**

Municipal Solid Waste, Biowaste, Source Segregation, Mechanical In-Plant Separation, Organic Waste Fraction, Anaerobic Digestion, Biogas, Energy Production, Biomethane, BAT

## **INTRODUCTION**

Drivers such as climate change, energy security, carbon foot-printing and waste recycling have come to the forefront of most European Nations legislative agendas. In the UK the last 2 years has seen an exponential growth in interest in anaerobic digestion as a major contributor to the mammoth task of reducing the amount of organic waste.

This interest has led to positive action at government level with, for example, the re banding of Renewable Obligation Certificates to give 2 x ROC to anaerobic digestion for biowastes and the draft publication for the PAS110 standard allowing digestate derived from biowaste to be treated as a product rather than under the waste exemption license.

Interest is also developing commercially with projects being developed in the UK for the three main organic waste streams; farm manures, biowastes (commercial and industrial arising) and Municipal Solids Wastes (MSW). Each of these three waste streams has its own challenges; this paper concentrates on the later fractions and reviews the Biowaste flow sheet specifically designed to treat contaminated organic material and produce clean digested compost with excellent conversion of organic material to biogas.

## **PROBLEM DEFINITION / CHALLENGES BIOWASTES**

Biowaste and MSW are a good source of recoverable energy; however the difficulty has always been recovering this energy in an environmentally clean manor. Arguably the Best Available Technology for such recovery is anaerobic digestion due to considerable benefits offered including low operational cost, public acceptability, the production of renewable electricity, heat and potentially biomethane, along with a stabilised product which can be recycled to land as a soil conditioner and natural fertiliser. These combined benefits gives anaerobic digestion a considerable advantage over alternative technologies such as composting, which is a net user of energy rather than a net producer and incineration, which recovers a smaller fraction of the energy and is not as publicly acceptable.

The difficulty with all anaerobic digestion systems when dealing with biowastes and Organic Fraction Municipal Solids Waste (OFMSW) is contamination. A typical merchant digestion facility receiving organic wastes from commercial and industrial sources, household source segregated collection, mechanically recovered organic fractions from a Mechanical Reclamation Facility (MRF), or any such source will inevitably have to deal with a feedstock with between 20% and 50% contamination.

**Table 1 – Summary of relative process benefits**

	Anaerobic Digestion	Aerobic Composting	Incineration
Capital	Medium	Low	High
Electricity Generation	Yes	No	Yes
Heat Recovery	Yes	No	Yes
Biomethane	Yes	No	No
Recycling Organics	Yes	Yes	No
Recycle N, P, K	Yes	Yes	No

Experience from Germany is that during an initial 'good start', household collection produced a feedstock with only 4% contamination, but after the initial enthusiasm wore off, this deteriorated to 20% contamination. Contaminants include anything and everything from glass, plastic, stones, bones, knives and forks to name but a few. Similarly commercial sourced wastes typically contain packaging materials (plastic, glass, metal), which need to be separated from the organic fraction prior to biological processing. Finally organic fraction recovered from municipal solids waste by reclamation facilities will also be contaminated by a significant percentage of non organic materials. All of these contaminants will in turn cause downstream problems for the digester in terms of deposition, mechanical damage and floating material within reactors as well as leading to a poor product.

The recent draft Publicly Available Standard for anaerobically digested compost (PAS110) states that to be classified as a product, digestate must have less than 0.5% contamination by mass, a standard in line with the protocols for German plants.

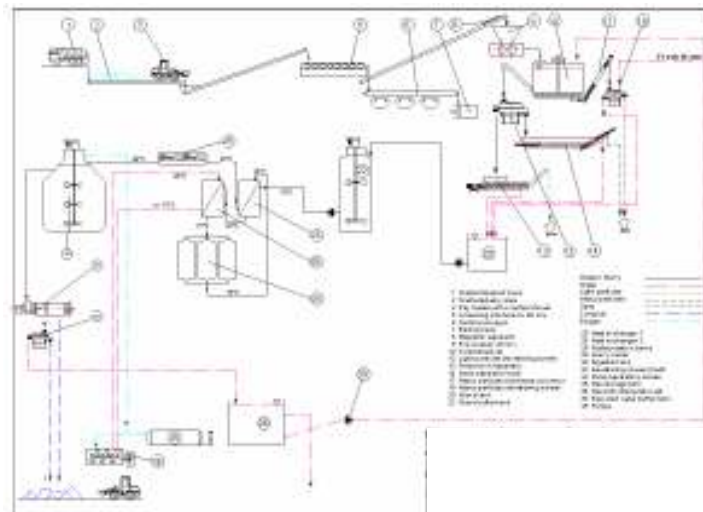
This paper outlines the Monsal Biowaste flowsheet, specifically designed to produce a clean anaerobically digested product from heavily contaminated feedstocks and draws on the experience gained from a number of facilities built and operated in Europe since the first plant in 1998.

### Monsal Biowaste Plant

The 'Biowaste' flowsheet has been developed initially in Germany over the last 10 years with the first installation for the City of Munster in 1998. It is delivered under licence in the UK by Monsal. Over the construction, commissioning and operation of 14 plants a well proven process flowsheet has been developed, which can be tailored to the degree and type of contaminated organic waste being treated.

Figure 2 below shows a typical Biowaste flowsheet designed to treat a typical source segregated feed stock containing food waste from household kitchens and garden waste along with the associated contaminating materials.

**Figure 1 – Schematic for Biowaste plant**



The incoming waste (1) is emptied onto an open surface (2) from where it is taken up with a shovel loader (3). This loader has built into its shovel a coarse crushing device which cuts the material at about 80 mm, thus opening plastic bags and larger packaging to release organic material inside.

The opened material passes a screen (5), which separates the material at 50 mm to give an initial coarse separation of larger packaging and woody garden waste. Above 50 mm there is a low level of organic material which would provide no benefit to the digester. This material can, depending on the degree of contamination, pass via a conveyor (6) to further recycling, for example within a MRF.

The undersize material now contains the enriched organic fraction circa 80% organics but still with 20% contamination. This material may be crushed (9) again to about 30 mm particle size but may also go directly into the Waste-Dissolver (10), which converts the organic material into a slurry.

Heavy particles (glass, stones, metals etc.) sink to the bottom of the dissolver tank, from where they are transported by worm conveyor (17) to dewatering screens (18), where they are spray-washed.

The slurry together with the light material (mainly plastics) is fed to another dewatering and separation screen (12). The slurry passes through the mesh while the light material remains on the screen. It is then squeezed into a worm press (13) to extract residual slurry.

The slurry passes a sand settling tank (14) to extract fine silts if required. This stage depends largely on the degree of fine grit contamination and this issue is discussed further below. The ready organic slurry is collected and stored in a storage/hydrolysis tank (22) where it is retained for about 3 days in order to achieve a certain homogenisation.

Then the slurry passes the pasteurisation stage (28) where it is heated to 70°C for one hour in order to kill all germs and pathogens. Pasteurised slurry is pumped via heat recovery to the digester (30) where it is kept for approx. 20 days. The biogas produced is collected in a storage tank (35).

In a continuous process slurry is fed to the digester and extracted after an average of 20 days. The digested slurry passes to dewatering (32) which separates the slurry from the remaining solids, the digestate or compost substrate. The slurry still contains some silt which is screened off (33) before it is recycled back to the preparation section to be used again for dissolving fresh waste.

The biogas can be utilised within a Combined Heat and Power (CHP) unit (36) where it is transformed into electricity and heat, or it can be used for the generation of Biomethane. Excess heat is removed using a closed loop air blast cooler.

Common to all Biowaste installations is the initial shredding operation which is designed to open packaging and aid the downstream separation of organic fraction from contaminants. The process can be designed to receive solid, semi solid or liquid feedstock and can deal with packaging ranging from plastic sandwich casing to cans.

Once the initial shredding and screening operations are carried out the organic fraction along with most of the contamination is loaded into one or multiple Waste Dissolver(s). The Waste Dissolver is a high shear mechanical mixing device which reduces organic particle to less than 2mm whilst leaving intact packaging material such as plastic.

The Waste Dissolver not only conditions the organic fraction by reducing the particle size, which in turn aids digestion, but also removes the remaining contamination. Heavy fraction contamination, glass, stones, metal, bones etc. sink to the base of the dissolver where it is continuously removed and dewatered. Light fraction contamination floats to the top of the dissolver where it is decanted along with the organic fraction going forward to the biological plant.

**Figure 3 - Waste Dissolver Installation**



The light fraction contamination (mainly plastic, wood and low density materials) is effectively removed by fine screens as it has not been reduced (in size) within the Waste Dissolver, leaving a clean wet slurry to feed forward to the digestion plant. This screening also ensures that all material going forward to pasteurisation is <12mm and therefore compliant with the Animal By-Products Regulations.

**Figure 4 – Organic Slurry from Dissolvers**



It is at this stage that the organic feed is watered down from (a typical) 30% solids to between 10% and 15% dry solids. This is a critical design basis for the plant as wet anaerobic digestion (less than 15% dry solids) is a more efficient process in terms of converting organic material to biogas than dry processes, ensuring higher biogas production and hence greater electrical, heat, and biomethane potential. In addition wet digestion tends to have lower operating costs than alternative dry digestion processes, due to lower power consumption and produces a more stabilised and therefore more acceptable product. Finally, contaminants can be easily removed from the slurry by simple and robust screens.

**Figure 5 – Contaminants removed by Waste Dissolver (Light and Heavy)**



In order to reduce solids concentration from 30% to 10% a significant quantity of make-up water is required. This water is recycled from the (post digestion) dewatering stage so as to minimise the requirement for fresh water to be added to the system. Some fresh water will generally be required to control salt inhibition within the digester dependant on the feedstock, however typically 70% to 100% of water is recycled.

### **Anaerobic Digestion Plant**

Once the feedstock has been conditioned and clean homogenous slurry produced, the next stage is anaerobic digestion. The organic slurry is treated within a 2 stage anaerobic digestion plant incorporating hydrolysis, pasteurisation at 70 C for 1 hour to comply with the Animal By-Products Regulations for category 3 material, and mesophilic anaerobic digestion. Each stage is briefly reviewed below.

#### **Hydrolysis**

The first stage of the process, dependant on the size of the plant and the recalcitrance of the organic material, is a hydrolysis tank or reactor. The hydrolysis tank acts as both a buffer to smooth out the intermittent operation of the separation plant with the 24 hour operation of the digester and a hydrolysis stage to liquefy the organic material into simpler breakdown products.

The hydrolysis tank is heated using heat recovered from the pasteurisation stage to optimise energy efficiency and to allow the process to operate at an optimal working temperature to maximise the hydrolysis and acidification reactions in the first stage.

#### **Pasteurisation**

The next stage of treatment is designed to achieve compliance with ABPR. Hydrolysed sludge is raised to >70°C using heat recovered from either Combined Heat and Power plant, hot water or steam boilers depending on site configuration. Pasteurisation is carried out in 3 parallel tanks, one unit filling, one holding and one drawing at any one time. This configuration ensures the required 1 hour batch hold with a continuous feed in and a continuous feed out.

The pasteurisation system records each batch for start time, end time, temperature at start and temperature at end (of batch) and gives each batch an individual reference tag. This allows a comprehensive log to be kept for HACCP purposes to demonstrate to the authorities that proper compliance has been met at all times. Any batch that fails to meet the requirement can be automatically recycled for re-treatment.

Experience from plants operating in Germany has demonstrated that the required time and temperature (70C for 1 hour) reliably inactivates indicator pathogens, which show no sign of reactivation even following centrifugation. Figures 13 to 15 (at end of paper) show 2 years of results from the Koblenz plant in Germany demonstrating compliance.

## Anaerobic Digestion

The design of the anaerobic digester is critical and the particular characteristics of the feed material must be considered. Many digesters operating on contaminated organic wastes suffer from build up of sediment within the base of the reactor and a floating mat of light fraction contamination on the surface.

Deposition is caused due to heavy contaminants passing through the early separation stages and sinking due to gravity in the less active anaerobic digester tank. The effect of such deposition is to gradually reduce the working volume of the digestion process leading to a reduction in operating efficiency and eventually failure. Providing sufficient mixing energy within the digester to suspend grit is generally not an economical option and therefore it is critical to remove as much heavy contaminants before digestion.

For plants treating commercial and industrial sourced materials the Waste Dissolvers provide a sufficient level of separation that, when combined with regular degritting within the digester, can control solids deposition. However for MSW feed stocks and other heavily contaminated (with grit) materials, experience from operation of many plants in Europe has shown that an additional stage such as a grit trap is required before the digester(s).

The widely experienced problems with floating material in digesters have been with the interference of biogas production and the blockage of outlet pipework. As with the heavy contamination, the design of the Waste Dissolvers and the subsequent fine screening removes the greater majority of this contamination. However it is impossible to prevent some passage of fine floating materials and therefore the digesters are designed to allow regular removal from the top surface of the digesters of any remaining light contamination that will concentrate there.

## Dewatering

Following digestion the solids are dewatered to approximately 30% dry solids (see figures 13 – 15 below). This provides an excellent quality digested compost, which demonstrates good stacking qualities, low in odour and that will comply with the expected PAS110 standards. This material will therefore be allowed to be recycled to land as a product rather than a waste material. Typical chemical analysis for compost is provided below in Figures 13 - 15.

**Figure 6 - Digested Compost**



The liquor from dewatering contains some solids and ammonia along with various salts and can be used on land as a liquid fertiliser. The standard flowsheet to be offered however incorporates an aerobic sequential batch reactor stage to treat the ammonia in the liquor prior to recycling to the Waste Dissolvers. This stage has a dual purpose in that it prevents the build up of ammonia, which may then cause toxicity to the digesters and limit conversion of organic material to biogas and also means that the excess liquid discharged from the site meets a good standard of treatment reducing any subsequent 'Mogden Formula' charges if discharged to sewer. Again typical chemical analysis is given in Figures 13 - 15 below.

## **Biogas Handling and Use**

The second product of anaerobic digestion (other than the compost) is biogas. Biogas is collected from the digesters and transported to a gasholder for storage and buffering purposes. If required the biogas can be treated to remove hydrogen sulphide, the requirement for which will depend largely on the protein content of the raw feed material. Biogas can be further utilised in a number of ways:

### *Combined Heat and Power*

The recent revision to the government White Paper increased the incentive for power generation from anaerobic digestion of biowaste by introducing a 2 x ROC banding. The current buyout price for ROC's is £35.76 per MWhe and assuming £55 per MWhe as a cost offset for power generated this gives electricity generated from anaerobic digestion a minimum value of £126.52 per MWhe.

The Monsal Biowaste process combined with anaerobic digestion has the potential to generate a continuous 0.4 MWe of renewable electricity for every 10,000 wet tonnes (per annum) of feed material or 3,504 MWhe per 10,000 wet tonnes.

Furthermore interest is beginning to develop at government level for introducing incentives for recovering heat from processes such as anaerobic digestion. A typical CHP unit will convert 35% - 40% of the energy in biogas to electricity and 40% to 45% of the energy to heat. Some of the heat generated by the CHP is required to pasteurise the feed material, but due to the heat recovery build into the flowsheet the anaerobic digestion process typically only requires 1/3<sup>rd</sup> of the heat generated, the remainder is available for export.

### *Biomethane*

Another area of interest is the purification of biogas which consists largely of methane and carbon dioxide to 'mains standard' methane typically >98% methane with added odour elements. This can either be added to the gas main directly or compressed to liquid form for transport and storage or as a transport fuel directly.

In this case some of the methane would be required to be used to heat the anaerobic digestion process itself and typically 20-25% of the biogas would be required for this purpose and the remainder would be available for sale.

## Case Study - Koblenz

The following case study describes the Biowaste plant operated at Koblenz in Germany. The plant treats 48,000 wet tpa approximately 1/3<sup>rd</sup> of which is green waste and 2/3<sup>rd</sup> organic material.

Waste is brought in by RCVs and discharged by tipping into the reception area. A front end loader piles the material against a retaining wall and feeds a large above ground reception hopper. As can be seen below the 'source separated' material is heavily contaminated and requires significant levels of treatment prior to digestion.

**Figure 7 – Source Segregated Waste Reception**



The waste is conveyed beneath an over-band magnet to a disc screen with a nominal separation of 100mm. The undersize is conveyed to a shredder and the oversize, comprising mainly large garden waste, is conveyed by high angle conveyor to an enclosed storage area with odour control. From here it is periodically removed for composting. At this stage the green waste is separated out leaving approximately 32,000 wet tpa organic material going forward to the Waste Dissolvers.

The shredded waste (<35 mm) is conveyed via high angle conveyor to the two Waste Dissolvers operating in parallel. Recycled water is added to achieve a slurry concentration of 10% dry solids by weight. Heavy materials such as slate, brick, stones and glass are periodically removed from the Waste Dissolvers and sent to skip.

Unusually, the Waste Dissolvers discharge directly to the pasteurisation plant and then to a screen. The oversize material comprising packaging and indigestible garden waste (which is relatively unaffected by the Dissolver) is removed, dewatered in a 2 stage compactor and sent via high angle conveyor to an enclosed storage area with odour control. It is then taken from site to an aerobic composting facility for further treatment.

**Figure 8 – Waste Dissolvers**



The undersize fraction then passes to grit traps due to the high degree of fine grit within the feed materials, prior to digestion. It is reported by site that 1,000 tpa of grit is removed from the slurry (approximately 3% of remaining material by weight) prior to anaerobic digestion.

**Figure 9 – Heavy Fraction Contaminants from Waste Dissolver**



The anaerobic digestion plant consists of a single 3,500m<sup>3</sup> digester giving a retention time of 16 days within the reactor at 10% dry solids feed. After an average residence time of 16 days the digestate is removed and stored in a 350 m<sup>3</sup> holding tank, prior to dewatering by centrifuge.

**Figure 10 - 3,500m<sup>3</sup> Anaerobic Digester**



The dried digestate/compost falls through the mezzanine floor into an area that is separated from the adjacent compost store by large doors to limit odour omission. However, there is little odour from the dewatered cake at this stage.

**Figure 11 – Anaerobic Digestate Product**



The compost is moved by front end loader to the adjacent compost store of 9,000 t capacity. A large store is necessary as the compost is not spread during the wettest winter months. It is of interest that this storage area is open to atmosphere and does not require odour extraction.

**Figure 12 – Compost Product in Storage Area**



The compost is purchased by the local farmers and is a popular product. There is very little visual plastic or extraneous matter. The centrate is sent to an SBR and 80% of the water is recycled through the process.

## **CONCLUSIONS**

The Monsal Biowaste plant combined with anaerobic digestion offers an integrated solution to the challenges of treating organic waste feedstocks including source segregated, commercial and industrial and organic fraction municipal solids waste to produce a clean compost product, which will exceed the requirements of the draft PAS110 standard, together with a high rate of biogas production. The process has been developed as a turn-key process enabling anaerobic digestion to be reliably utilised as the Best Available Technology for organic waste recycling.

The process is a net exporter of electricity and biogas and recycles water within the system to minimise use of resources. The process has a proven track record of treating ABPR Category 3 waste input streams, demonstrating reliable compliance with pathogen reduction, metal concentrations and seed propagation tests. Upgrades are available for Category 2 waste inputs.





Figure 15 –Analysis Digestate from Koblenz

BUNDESGÜTEGEMEINSCHAFT KOMPOST e.V.																																							
4034		UNTERSUCHUNGSBERICHT		TM 02/2013																																			
Gütercode 41 fest		Analyseergebnisse		13.03.2013																																			
Probekennz. 03_24_2105				18-N-5-P-24-C-1-250038																																			
<b>Physikalische Parameter</b>			<b>Pflanzensubstanz</b>																																				
1. Rohstoffe (Volumengewicht)	789 g/ FM	11. Stickstoffgesamt (N)	3,54 % TM																																				
2. Trockermasse	27,8 % FM	12. Phosphat gesamt (P <sub>2</sub> O <sub>5</sub> )	1,15 % TM																																				
3. Fremdstoffe > 2 mm (gesamt)	0,02 % TM	13. Kaliumoxid gesamt (K <sub>2</sub> O)	1,12 % TM																																				
4. Flächenkohle/Fremdstoffe (unter Fremdstoffen < 0,1 Gew.-%)	n.u. (n.r.) FM	14. Magnesiumoxid gesamt (MgO)	1,09 % TM																																				
		15. Schwefel gesamt (S)	0,48 % TM																																				
		16. Ammonium Salze (NH <sub>4</sub> +)	43 mg/ FM																																				
		17. Nitrat-Nachfr. (NO <sub>3</sub> -N)	0 mg/ FM																																				
<b>Biologische Parameter</b>			<b>Chemische Parameter</b>																																				
5. Organische Säuren	188 mg/kg FM	18. Salzgehalt	2,9 g/ FM																																				
6. Geruchskennz.	Neutral	19. pH-Wert (CaCl <sub>2</sub> )	7,8																																				
<b>Hygiene</b>			<b>Vorsorge Bodenschutz</b>																																				
7. Keimfreie Samen und Pflanzenteile	0,0 (g / FM)	<table border="1"> <thead> <tr> <th rowspan="2">Schwermetalle</th> <th colspan="2">B4-BioAblV Abs. 3</th> <th rowspan="2"></th> </tr> <tr> <th>Batz 1</th> <th>Batz 2</th> </tr> </thead> <tbody> <tr> <td>20. Blei (Pb)</td> <td>150</td> <td>100</td> <td>28 mg/kg TM</td> </tr> <tr> <td>21. Cadmium (Cd)</td> <td>1,5</td> <td>1,0</td> <td>0,74 mg/kg TM</td> </tr> <tr> <td>22. Chrom (Cr)</td> <td>100</td> <td>70</td> <td>27,0 mg/kg TM</td> </tr> <tr> <td>23. Kupfer (Cu)</td> <td>100</td> <td>70</td> <td>55,0 mg/kg TM</td> </tr> <tr> <td>24. Nickel (Ni)</td> <td>50</td> <td>35</td> <td>19,0 mg/kg TM</td> </tr> <tr> <td>25. Quecksilber (Hg)</td> <td>1,0</td> <td>0,7</td> <td>0,14 mg/kg TM</td> </tr> <tr> <td>26. Zink (Zn)</td> <td>400</td> <td>300</td> <td>235 mg/kg TM</td> </tr> </tbody> </table>				Schwermetalle	B4-BioAblV Abs. 3			Batz 1	Batz 2	20. Blei (Pb)	150	100	28 mg/kg TM	21. Cadmium (Cd)	1,5	1,0	0,74 mg/kg TM	22. Chrom (Cr)	100	70	27,0 mg/kg TM	23. Kupfer (Cu)	100	70	55,0 mg/kg TM	24. Nickel (Ni)	50	35	19,0 mg/kg TM	25. Quecksilber (Hg)	1,0	0,7	0,14 mg/kg TM	26. Zink (Zn)	400	300	235 mg/kg TM
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8. Salmonellen	0 (D x n.n.)																																						
<b>Bodenverbesserung</b>																																							
9. Organische Substanz	81,7 % TM																																						
10. Bas. wirts. Stoffe (CaO)	6,0 % TM																																						
<b>Sonstige Parameter</b>			<b>Wert/ Einheit</b>																																				
a) Chlorid	368 mg/ FS																																						
b) Natrium	505 mg/ FS																																						
c) Carbonate	3,3 Gew. % TM																																						
d)																																							
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Die Analyse wurde entsprechend dem "Methodebuch zur Analyse organischer Düngemittel, Bodenverbesserungsmittel und Substrate" der BGK e.V. durchgeführt.																																							

40017

UNTERSUCHUNGSBERICHT

Seite 2 von 3

Gärprodukt fest  
Produkt-Nr.: QZ 042008

Produktinformation

1.1.2019  
TÜV-RV 6-112418-10562-06

Einhaltung RAL-Gütesicherung:

- Produkt Gärprodukt fest
- RAL-Gütesichertes Gärprodukt (RAL-GZ 245)
- Fremdtüberewachung der Bundesgütegemeinschaft Kompost e.V.



RAL-GZ 245

Einhaltung Rechtsbestimmungen:

- Düngemittelverordnung
- Bioabfallverordnung
  - gemäß § 4 Abs. 3 Satz 1
  - gemäß § 4 Abs. 3 Satz 2

Kennzeichnung nach Düngemittelverordnung<sup>1)</sup>

**Gärprodukt fest**  
**Organischer NPK-Dünger 0,25 - 0,22 - 0,21 mit 5**  
0,25 % N-Gesamtschmelze  
0,22 % P<sub>2</sub>O<sub>5</sub>-Gesamtschmelze  
0,21 % K<sub>2</sub>O-Gesamtschmelze  
0,12 % S-Gesamtschmelze  
17,2 % Organische Substanz

**Zusammensetzung Ausgangsstoffe:**  
Biosubstrat gemittelt gemäss (100 %)

**Mineralien:**  
Anreicherung der Nährstoffe:  
Stickstoff in Anwendungszustand<sup>2)</sup> 6 %  
Phosphor und Kalium in der Fruchtfrühe: 100 %

**Legierung / Verwitterung von Abzugungen und Auswaschungen**

Bei einer Aufbringung auf leicht trockenen Flächen sind Abzugs- und Mängelauswaschungen aus ökonomischen Vorschriften (BöSchV, ABöSchV) zu beachten.

Auf versauften, salz-, wasser- und düngemitteltechnische Vorschriften zu beachten.

**Inhaltsstoffe<sup>3)</sup>**

Inhaltsstoffe (gesamt)	Trockenmasse	Fruchtmasse
N gesamt	3,54 % TM	0,28 % FM
P <sub>2</sub> O <sub>5</sub> gesamt	1,15 % TM	0,32 % FM
K <sub>2</sub> O gesamt	1,12 % TM	0,31 % FM
MgO gesamt	1,24 % TM	0,30 % FM
Bes. wirks. Stoffe	9,3 % TM	2,2 % FM
Org. Substanz	61,7 % TM	17,2 % FM

**Düngerberechnung<sup>4)</sup>**

Inhaltsstoffe (in der Fruchtfrühe)	je Tonne	je m <sup>2</sup>
N gesamt	3,50 kg FM	7,73 kg/m <sup>2</sup> FM
N organisch	0,74 kg FM	7,88 kg/m <sup>2</sup> FM
N anrechenbar <sup>5)</sup>	0,55 kg FM	0,42 kg/m <sup>2</sup> FM
P <sub>2</sub> O <sub>5</sub> gesamt	3,20 kg FM	2,52 kg/m <sup>2</sup> FM
K <sub>2</sub> O gesamt	3,10 kg FM	2,45 kg/m <sup>2</sup> FM
MgO gesamt	3,00 kg FM	2,37 kg/m <sup>2</sup> FM
Bes. wirks. Stoffe	23,1 kg FM	18,2 kg/m <sup>2</sup> FM
Organische Substanz	17,2 kg FM	13,8 kg/m <sup>2</sup> FM

**Sonstige Angaben<sup>6)</sup>**

Hygiene geprüft	
CN-Verhältnis:	10
Nährwertindex <sup>7)</sup> :	15
Düngewert <sup>8)</sup> (N-anrechenbar <sup>5)</sup> , P, K, CaO)	4,89 €/t FM 3,88 €/t m <sup>2</sup>

<sup>1)</sup> Anwendungszustand: Anreicherung der Legierung und Anreicherung, Abzugs- und Mängelauswaschungen sind ökonomische Vorschriften (BöSchV, ABöSchV) zu beachten.  
<sup>2)</sup> Werte nach Düngemittelverordnung. Zufügender fruchtfrühe Fruchtfrühe, Anreicherungszustand in der Fruchtfrühe, Anreicherungszustand.  
<sup>3)</sup> Werte des Rohwertes (Trockenmasse) 100 %.  
<sup>4)</sup> Düngemittelberechnung: Berechnung der Nährstoffmengen (BöSchV) für die Fruchtfrühe und Fruchtfrühe.  
<sup>5)</sup> Werte des Rohwertes (Trockenmasse) 100 %.  
<sup>6)</sup> Hygiene, Stickstoff, Stickstoffindex und Nährwertindex sind nach Düngemittelverordnung zu beachten.