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The situation with greenhouse gas and odour emissions from digestion plants for biowaste and for residual waste - mechanical biological treatment MBT

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**gewitra** Introduction

Greenhouse gas emission trend for Austria 1990 – 2005 [Umweltbundesamt, 2007]

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Research project Composting / Anaerobic Digestion:

- input material: biowaste, residual waste (MBT)
- investigated treatment plants: open windrow, enclosed systems\*, In-building systems\*, (\*combination with digestion step)
- waste gas cleaning: without / acid scrubber / water saturator with biofilter
- determination data of emission control (C, CH<sub>4</sub>, NH<sub>3</sub>, N<sub>2</sub>O): concentration, emission factors, CO<sub>2</sub>-Equivalent
- R&D project of the German federal environmental agency: UFOPLAN Project of UBA will take until end of 2008

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Emissions from biological treatment (Global Warming Potential)

- carbon dioxide (CO<sub>2</sub>)  
strict aerobic process emission, origin native organic, GWP factor 0
- Total Organic Carbon (TOC)  
= Methane-C + NMVOC-C, GWP factor 21 only for methane
- Methane (CH<sub>4</sub>)  
climatic relevance from methane: GWP factor 21
- Nitrous oxide (N<sub>2</sub>O)  
climatic relevance from nitrous oxide: GWP factor 310
- Non-Methane Volatile Organic Compounds (NMVOC)  
(e.g. alcohols, aldehyde, alkanes, terpenes), National Emission Ceilings (NEC-D)
- Ammonia (NH<sub>3</sub>), National Emission Ceilings (NEC-Directive)

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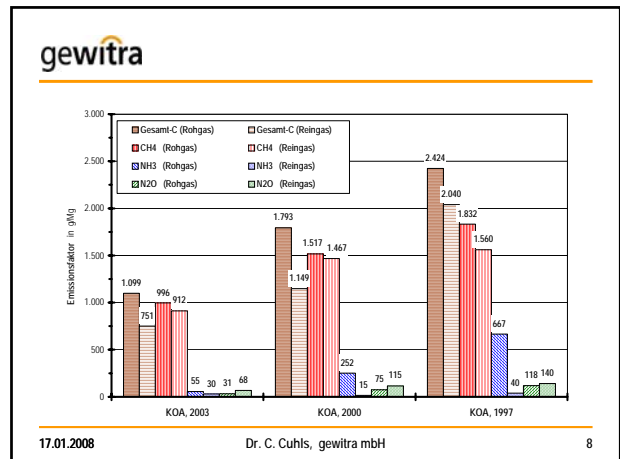
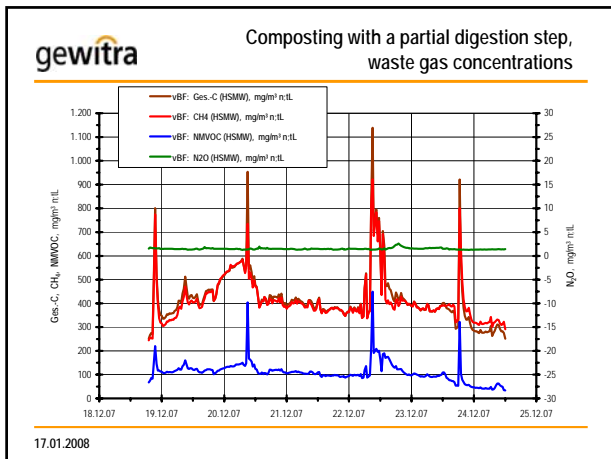
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Typical emissions from composting plant [Hellebrand and Kalk, 2000]

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**gewitra** Composting with a fully digestion step, waste gas concentrations

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**Arrangements to optimise / minimise process emissions to air**

- Guidelines: "Good practice of composting!"
- material characteristics: structure (high porosity), water content: max. 65-70 %, C/N ratio: 25-35
- process parameters: water content: 50-60%, O<sub>2</sub>-supply, turning cycles (intensive phase 1-2 times per week, phase of declining activity 0.5 times per week). Windrow profile: height max. 2.50 m (active aeration), height max. 1.50 m (passive aeration), best available technology must be decided case-by-case
- on principle: opposed formation of CH<sub>4</sub> and N<sub>2</sub>O within the biological process
- on principle: minimisation of the CH<sub>4</sub> and N<sub>2</sub>O emissions to air is the result of the right material characteristics and the right process parameters for the entire time of aerobic treatment. Because there is no end-of-pipe technology to reduce CH<sub>4</sub> and N<sub>2</sub>O in the waste gas

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**Arrangements for emission control (acid scrubber, biofilter)**

- Methane (CH<sub>4</sub>)**  
only very less / no reduction in biofilters at suitable air loads > 50 m³/m³h
- Nitrous oxide (N<sub>2</sub>O) and nitric oxide (NO)**  
no reduction, but rather new generation due to NH<sub>3</sub> degradation in biofilter,
- Non-Methane Volatile Organic Compounds (NMVOC)**  
normally good reduction of easily degradable compounds (~ 80%) at well operating biofilters and suitable air loads < 100 m³/m³h
- Ammonia (NH<sub>3</sub>)**  
high deposition in biofilter enable, accordingly new generation of N<sub>2</sub>O and NO, declining pH value -as a result of nitrification- reinforces accumulating NH<sub>4</sub>. Acid scrubber (H<sub>2</sub>SO<sub>4</sub>) precipitates NH<sub>3</sub> > 90%, necessary after anaerobic step!

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**First results emission factors (total input 8,300 000 Mg/a for D)**

- Methane (CH<sub>4</sub>)**  
Assumption UBA: Measurement data of Gewitra:  
2500 / 3400 g/Mg 100 – 200 g/Mg low level  
250 – 1000 g/Mg medium level (realistic)  
1200 – 1800 g/Mg high level  
> 2000 g/Mg points at poor operation  
43000 g/Mg equal to amount of methane from digestion  
preliminary value: - 1 kg/Mg or 8000 Mg/a for D
- Nitrous oxide (N<sub>2</sub>O)**  
Assumption UBA: Measurement data of Gewitra:  
83 / 60 g/Mg 70 g/Mg waste gas before biofilter  
100 g/Mg clean gas after biofilter  
preliminary value: 560 – 800 Mg/a for D

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**First results emission factors (total input 8,300 000 Mg/a for D)**

- NEC Directive (emission upper limits in 2010)**  
Reference NOx NMVOC Ammonia (NH<sub>3</sub>)  
\*emission total (D) 1112 Gg 987 Gg 610 Gg  
emission upper limit 1051 Gg 995 Gg 550 Gg  
balance +61 Gg -8 Gg +60 Gg
- Emissions from composting (D)**  
preliminary value: 0.2 Gg 2 Gg waste gas: 1.6 Gg  
clean gas: 0.16 Gg
- Percentage composting to \*emission total (D)**  
preliminary value: 0.02 % 0.2 % waste gas: 0.26 %  
clean gas: 0.026 %

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First results CO<sub>2</sub>-Equivalent (basis 2005 in D), **Conclusions I**

- **Methane (CH<sub>4</sub>)**  
 Total (D): 2.268 Gg    composting: ~ 8 Gg    percentage: 0.35 %
- **Nitrous oxide (N<sub>2</sub>O)**  
 Total (D): 215 Gg    composting: 0.56 – 0.8 Gg    percentage: 0.26 – 0.36 %
- **Ammonia (NH<sub>3</sub>)**  
 Total (D): 618 Gg    composting: 0.16 – 1.6 Gg    percentage: 0.03 – 0.26 %  
 (preliminary value)
- **CO<sub>2</sub>-Equivalent** (data totalized from methane and nitrous oxide)  
 Total (D):            waste gas ~ 30 – 40 kg/Mg    clean gas ~ 70 – 80 kg/Mg
- **Conclusions I:** estimated emissions are overvalued so far (CH<sub>4</sub>, NH<sub>3</sub>), specific contingent of composting/digestion is rather low (<0,5% of total national emission)

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**gewitra** **Conclusions II**

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- Guidelines for operators: “Good practice of composting” are important to minimise emissions.
- CH<sub>4</sub> and N<sub>2</sub>O should be reduced in the aerobic process. They could not be reduced in the biofilter afterwards.
- Biofilters will reduce NMVOC (> 80 %) and odour (> 90 %) effectively, typical odour concentrations are 4000 GE/m<sup>3</sup> in exhaust from receiving bunkers and mechanical waste treatment, 16000 GE/m<sup>3</sup> in waste air from biological process. Scrubber and moderate air loaded biofilter reduce to < 500 GE/m<sup>3</sup>.
- Acid scrubber helps to precipitate NH<sub>3</sub> emissions and prevents new N<sub>2</sub>O generation in biofilter. Mostly necessary for composting plants with integrated anaerobic digestion step.
- Ammonium sulfate from acid scrubbers could be used as fertilizer in agriculture.
- An integrated digestion step could reduce the air requirement of the composting step but waste air concentrations of CH<sub>4</sub> and NH<sub>3</sub> are high.

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**gewitra** Composting plant with digestion step and biogas utilization, biofilter

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**gewitra** Acid scrubber,  $\text{NH}_3 + \text{H}_2\text{SO}_4 \leftrightarrow (\text{NH}_4)_2\text{SO}_4$

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**gewitra** Open biofilter of an enclosed composting plant

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