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Determination of the PCDD/F Levels in Large-Scale Sewage Sludge Composting

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1. Introduction

In general, sewage sludge of mechanical and secondary treatment in municipal sewage disposal plants are biologically stabilized by anaerobic fermentation. In Germany a small part of the appearing sewage slugde is processed by composting it with other coarse-structured organic material. In addition to their fertilizing properties these products are said to improve the soil structure and also to support the agricultural use of sewage sludge.

2. Experimental

We have investigated a sewage sludge composting plant over a longer period. In this plant waste water from households as well as industrial waste water is processed.
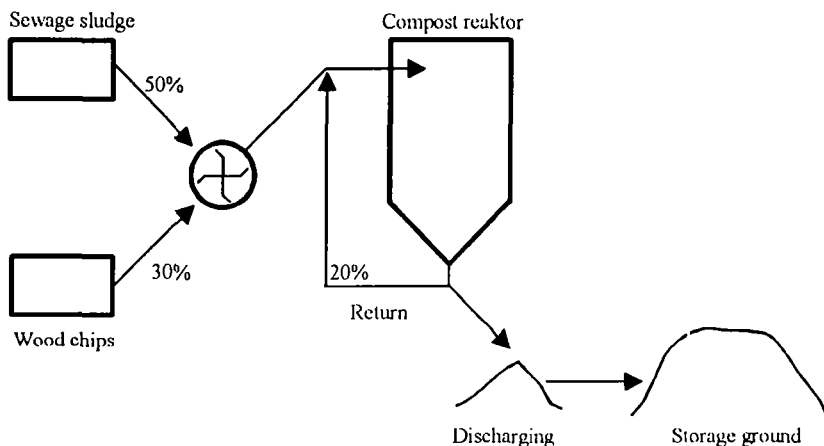

Fig. 1: Operating principle of a sewage sludge composting plant

The average treatment time is 22 days in the 220 m^3 reactor. The storage times on storage grounds amount to several months. The temperature in the reactor is 65-70 °C. After delivery to the storage grounds it decreases very slowly within several months so keeping its biological activity.

3. Results

In the first sampling in 1994 an I-TEQ of 442.1 ng/kg was determined. Due to this high value the PCDD/F levels of all feeded municipal and industrial sewage sludges were determined. The samples were all taken from collecting reservoirs of several hundred m^3. They can be regarded as a representative mixed sample covering a longer period of time. The values obtained of 11.2 and 18.0 ng I-TEQ/kg were on a low level. The value in the wood chips added was slightly higher, i.e. 31 ng I-TEQ/kg, and in the mixture of the dewatered sludge to which wood chips in a 5:3 ratio were added it amounted to 13 ng I-TEQ/kg. As the compartments sludge and wood chips showed similar results in all other further samplings only their mixture is indicated in Table 1.

	1994	1995	1996
Sewage sludge / chips	13,0	14,2	14,8
Fresh compost (discharging)	167,1	56,8	58,0
Old compost (storage ground)	442,1 / 386,1	165,7	119,0

Table 1: Results of the sampling in ng I-TEQ/kg

The results of the investigations show increasing values of the I-TEQ levels with time of the biological composting process. The highest levels were found in the oldest material stored on the storage ground. On the other hand these maximum values are decrease from year to year.
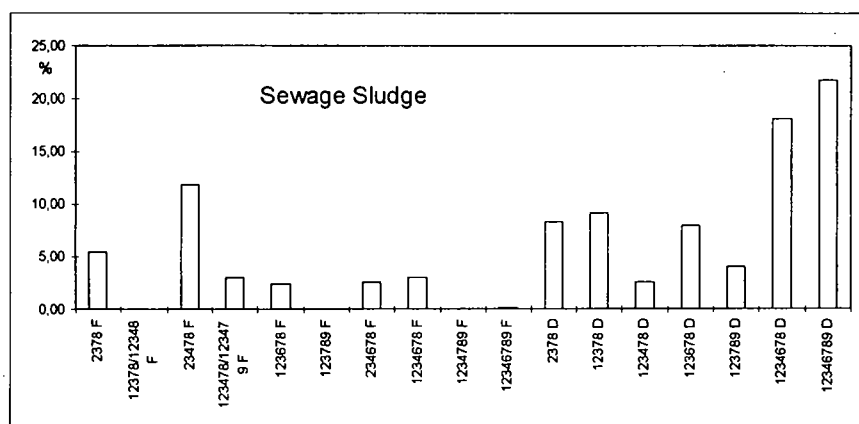

Fig. 2: Percentage of the 2,3,7,8 substituted PCDD/F in the total I-TEQ of sewage sludge
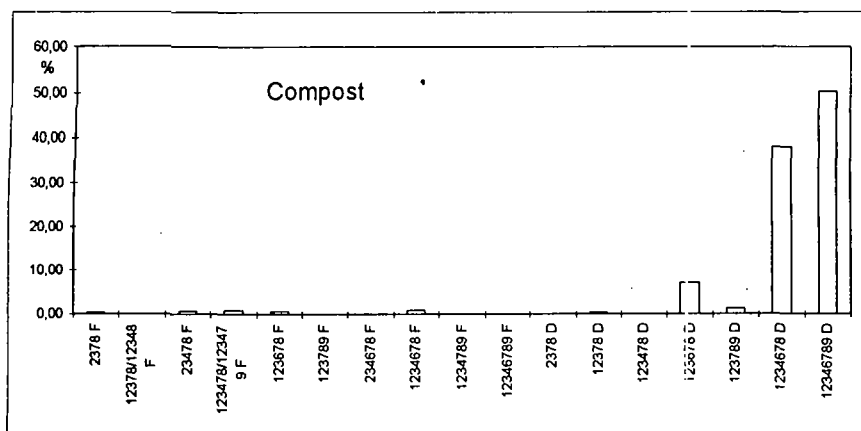
Fig. 3: Percentage of the 2,3,7,8 substituted PCDD/F in the total I-TEQ in compost

The representation of the congeners' profiles of the 2,3,7,8-PCDD/F in the initial mixture and the old composts is shown in Fig. 1 and 2 as a percentage in the total TE.

The diagrams eludicate a strong shift of the I-TEQ parts resulting exclusively from 1,2,3,4,6,7,8-HpCDD and OCDD. Only in the samples taken in 1996 there is a significant influence on the I-TEQ due to 1,2,3,4,7,8-HxCDF and 2,3,4,7,8-PCDF. The increase in HpCDD and OCDD is described in the literature for investigations of composting domestic waste and green waste (1,2). Own laboratory experiments in the anaerobic fermentation and composting of sewage sludge also resulted in an increased formation of 1,2,3,4,7,8-HxCDF (3).

Due to the very low concentrations the simultaneous determination of chlorophenols and chlorobenzenes before and after composting lead to unsatisfactory results. These substances do not seem to influence the formation of the PCDD/F. But it can be assumed that the time dependent decrease of the I-TEQ values may be an indicator for an anthropogenic origin for the formation.

References

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