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Composting sludges from municipal waste water treatment plants from two Slowenian towns

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Abstract

The article discusses experimental composting of sludge from two munical waste water treatment plants in Kranj and Ptuj. The same project was adopted for both plants in spite of their different input and amounts of produced dewatered sludge. For composting straw and foliage was added to the sludge in Ptuj and wood shawings in Kranj. The effect of mixing ratios, of temperature and of pH, adjusted by adding lime, was studied. The results are encouraging from the point of view of increasing the C/N ratio, destroying pathogens and parasites and production of fertilizer.

Introduction

The towns of Kranj and Ptuj which are, in terms of their geographic characteristics and industrial hinterland, quite different from each other, have central municipal waste water treatment plants which treat municipal waters generated by the residential suburbs, the town and partly by the industry.The two plants are similar in terms of principle of treatment, which is mechanical and biological, without denitrification and dephosphatisation, but are quite different in terms of input.

At normal operation 3500 m^3 of sludge is generated by the Kranj treatment plant and 6000 m^3 of sludge by the Ptuj treatment plant.After anaerobic fermentation, coagulation and dewatering, the sludge still presents a problem, due to the great volume and the possibility of sludge management.

These were the reasons that led Komunala Ptuj, JPK Kranj and EEK Videm, as a commercial partner, to join forces in a project concearning composting of the sludges.

After one year, the project yielded the results given below.

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The Principle

The content of nutrients in the composted substance is one of the basic conditions of successful composting. Of particular importance is the content of carbon and nitrogen, i.e., their ratio which should be as follows:

$$C/N = 15 \text{ to } 30 \quad (1)$$

or

$$C/N = 25 \quad (2)$$

where C is carbon content of composted mixture (%) and N nitrogen content of composted mixture (%). The C/N ratio in sludge produced by the treatment plant is usually lower than 15 (between 5 and 12).

With various additives, this ratio can be improved, thus ensuring problem-free composting.

The amount of sludge added to the composted mixture is determined by the following equation:

$$C/N = \frac{XsCs + (100 - Xs).Ca}{XsNs + (100 - Xs)\ Na} \quad (3)$$

where:

Xs = sludge in composted mixture (%)
Cs = carbon in sludge (%)
Ns = nitrogen in sludge (%)
Ca = calcium in additives (%)
Na = natrium in additives (%)

Rearrangement of the equation gives:

$$Xs = \frac{((C/N)\cdot Na - Ca)\cdot 100}{(C/N)\cdot(Na - Ns) + Cs - Ca} \quad (4)$$

Typical values of sludge and additives used in our experiments are shown in Table 1. Table 2 shows the percentage of sludge in the composted mixture.

The calculated values show that the share of sludge in the composted mixture is very low and that only with the use of straw and sawdust of deciduous trees is it possible to achieve the optimal C/N ratio.

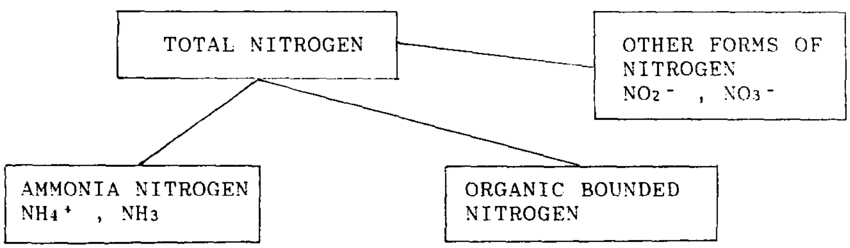
Table 1: Typical composition of materials

Material	c(% ss)	N (%ss)	C/N
sludge from plant (Kranj,Ptuj)	28.6	4.3	6.6
straw (Ptuj)	34.4	0.6	57.3
grass (Ptuj)	32.3	2.4	13.5
foliage (Kranj)	33.6	1.5	22.4
sawdust (coniferous) (Kranj)	35.7	2.1	17.0
sawdust (deciduous) (Kranj)	35.9	1.2	29.9

Table 2: Amount (%) of sludge in composted mixture

type of additive	Xs at C/N = 15(%ss)	Xs at C/N = 25 (%ss)
straw	41.4	19.7
grass	-	-
foliage	23.6	-
sawdust (coniferous)	10.5	-
sawdust (deciduous)	33.3	7.0

Nitrogen in fresh sludge produced by the treatment plant exist in the following forms:



Most of the nitrogen in the sludge comes from organic nitrogen compounds (proteins, urea, industrial wastes). In the biochemical process of ammonification, the amine-bound organic nitrogen is transformed into an ammonium form. At lower pH values, ammonium occurs mostly in a dissociated NH form, while in the alkaline form it is transformed into non-dissociated NH_3 form. The following reaction occurs in the process:

$$NH_4^+ + OH^- \longrightarrow NH_3 + H_2O \qquad K_d = 1,6 \cdot 10^{-5}$$

The generated ammonia may evaporate already at a low temperature so it can be easily removed from the original substrate, either with forced aeration, or even with the process of natural convection. This fact was used with advantage in our work.

Procedure

To the fresh sludge, 5% of calcium hydroxide was added, calculated as dry matter, and the mixture was homogenised. The mixture was spread over an asphalt surface in the thickness of 20 cm to 30 cm (see Fig.1), over a period of one month, the content of nitrogen decreased by more than 50%. The results are shown in Table 3.

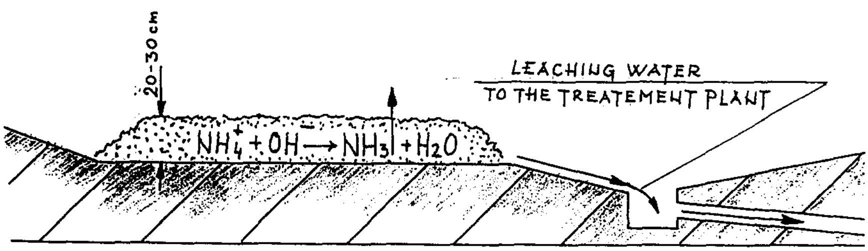


Fig. 1 Arrangement of the composting plant

The increased C/N ratio enabled us to use significantly greater share of sludge in the composted mixture, which is clearly shown in Table 4.

The increased amount of calcium has a positive effect on the process of composting. Instead of quicklime it is possible to use other materials with alkaline chemical reaction as wood ash, Thomas slag, calcium hydroxide

Table 3: Change of composted mixture during 30 days

Days	pH value	Total nitrogen (%ss)	Ammonia (%ss)	Org.carbon (%ss)	C/N
0	11.2	4.3	2.0	28.6	6.7
1	11.3	4.2	1.9	28.5	6.8
3	10.5	3.8	1.6	28.5	7.5
5	9.8	3.4	1.2	28.5	8.4
10	8.7	3.0	1.1	28.4	9.5
15	8.4	2.7	0.9	28.5	10.6
20	8.2	2.4	0.7	28.3	11.8
25	8.1	2.2	0.8	28.3	12.9
30	8.0	2.1	0.8	28.3	13.5

Table 4: Composted mixture with increased amounts of sludge

Type of additive	Xs at C/N=15 (%ss)	Xs at C/N=25 (%ss)
straw	88.8	44.5
grass	-	-
foliage	77.6	-
sawdust (coniferous)	84.8	-
sawdust (deciduous)	84.8	19.6

Conclusion

The procedure of removal of ammonium from the sludge with alkalines, is a simple and effective way of increasing the C/N ratio and thereby also the possibility to use a larger share of sludge in composted mixture.

The consequence of this is the saving in other structural materials, composting under optimal conditions and lower cost of composting.

The lye destroys the various pathogenic microorganisms and eggs of parasites already before the beginning of composting.

The addition of calcium favourably affects the structure of the compost. It becomes lumpy and so aerated.

The method is less suitable when the content of calcium in the sludge is high, because the addition of quicklime would further increase its content. Such compost is not useful for additional fertilisation of plants (azaleas, rhododendrons, conifers).

This situation can be remedied, at least to some extent, with the use of leaching agents (Thomas slag, wood ash, potassium lye etc) which do not contain calcium or only small amounts.

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