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Bio-Waste Composting in Rural Conditions

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ABSTRACT

One of the most serious problems of waste management of Czech Republic is the useful treatment of bio-degradable municipal waste because EU Council Directive 1999/31/EC requires member states to limit the amount of bio-degradable waste deposited into landfill. Solution of this problem can be composting of bio-degradable municipal waste but there are many operational and economic problems. This article describes advantages and problems of bio-waste composting in rural conditions (of Czech Republic) at all parts of composting process, i.e. from bio-waste sorting and collection through bio-waste composting to utilization and sale of compost. Bio-waste composting in countryside brings many benefits. The waste is treated at the place of origin and it is possible to get the organic mass of compost back to the field with minimal transport distances. Decentralized waste treatment brings jobs to regions of a small rate of employment. It is necessary to solve many problems related to the process of composting. Quality of input raw material is the first of them. It was found that the amount of undesirable impurities in separately collected biodegradable municipal waste depends on the type of building density and the settlement size. By the measurement of 200 kg samples of sorted bio-waste it was showed that purity of waste sorting is much better in small villages than in rather big cities. Right size of composting plant is another question to discussion. A lot of small composting plants built for several villages allow wastes treatment in the place of origin but just a big composting plant is reach enough to have adequate machine equipment. Of course, in this case there are long transport distances. Compost selling is connected with other problems. Farmers usually do not want even high-quality compost because the costs of compost application to the field (although missing of organic mass in the soil). Lots of low-quality compost is used as a reclaim material.

1. INTRODUCTION

One of the most serious problems of waste management of Czech Republic is the useful treatment of bio-degradable municipal waste because EU Council Directive 1999/31/EC requires member states to limit the amount of bio-degradable waste into landfill. In Czech legislation it is set forth in the Act No. 185/2001 Coll. on Waste and amendments to other Acts [8], and in objectives of the Waste Management Plan of the Czech Republic [9]. Just this requirement is one of the aims of Plan of Waste Management of Czech Republic that is not fulfilled. Solution of this problem can be composting of bio-degradable municipal waste but there are many operational and economic problems. Bio-waste composting in countryside brings many benefits. The first is the deflection of biodegradable waste from the landfills.

The waste is treated at the place of origin and it is possible to get the organic mass of compost back to the field (or the soil) with minimal transport distances. Decentralized waste treatment brings jobs to regions of a small rate of employment. In order to meet the aim there were realized several pilot projects of sorting, collection and utilization of biodegradable municipal waste. Through these pilot projects were identified the major operational problems of the composting system that are described in this paper.

These problems can be divided into three groups: 1) Quality of input raw material (depending on the system of bio-waste sorting and collection), 2) Right size of composting plant and necessary machine equipment and 3) Compost selling and utilization.

The quantity of bio-degradable waste in municipal waste is from 40 to 50 % [1], [4], [5].

The first operational problem is consequently sorting of biodegradable municipal waste by citizens and getting the input raw material into the composting plant. Right and correct grading of the system of sorting and collection of biodegradable municipal waste and the purity of sorted waste is a key factor for further processing and waste utilization.

Within the field measurements there has been monitored the quality of sorted waste in cities Kroměříž (that has more than 29 000 inhabitants) nad Náměšť nad Oslavou (that has about 5 000 inhabitants) and in villages Březník (about 630 inhabitants), Jinošov (about 310 inhabitants) and Naloučany (about 175 inhabitants).

2. MATERIAL AND METHOD

For operational reasons, separate waste was analyzed after its collection in the area of waste treatment facility. Individual samples were collected within two days of separate waste delivery, without any modifications (scattering, compaction). The sample size was at least 200 kg, the sample was manually sorted to components by

Table 1. Measured values of sorted biodegradable municipal waste in Kroměříž [7].

Date of collection	Sample weight [kg]	Biowaste weight [kg]	Impurities weight [kg]
28.04.2009	206	190.5	15.5
12.05.2009	205	191	14
26.05.2009	212	196	16
09.06.2009	201	183	18
23.06.2009	211	204	7
07.07.2009	208	200	8
15.07.2009	212	204	8
21.07.2009	213.5	206.5	7
29.07.2009	205	203	2
04.08.2009	224.5	206	18.5

Table 2. Measured values of sorted biodegradable municipal waste in Náměšť nad Oslavou [6].

Date of collection	Sample weight [kg]	Biowaste weight [kg]	Impurities weight [kg]
23. 09. 2009	210	209	1
23. 09. 2009	223	222	1
06. 10. 2009	235	231	4
06. 10. 2009	224.5	220.5	4
05. 05. 2010	207.7	207.4	0.3
05. 05. 2010	206.9	206.1	0.8
19. 05. 2010	214.8	213.4	1.4
19. 05. 2010	208.2	207.8	0.4
02. 06. 2010	210.4	207.5	2.9
02. 06. 2010	207.2	205.6	1.6

the Waste catalogue at first, it means to 200201 Biodegradable waste and to 200203 other non-biodegradable waste (impurities including biodegradable waste unsuitable for composting, e.g. animal by-products [10]. Individual fractions were placed in containers with a capacity of 20 litres and then weighed on the mechanical scales (spring scale). The recorded values were used to determine unacceptable impurities by weight in the sorted biodegradable municipal waste.

3. RESULTS AND DISCUSSION

3.1. Sorting of biodegradable municipal waste

In tabs there are shown measured values. Weight percentage representations of specific fractions are shown in graphs. Unacceptable impurities were either small objects (such plastic, glass or metal pieces, exceptionally animal remains), or bags of mixed household waste.

Fig. 1. Rate of admixture at sorted biodegradable municipal waste in Kroměříž.

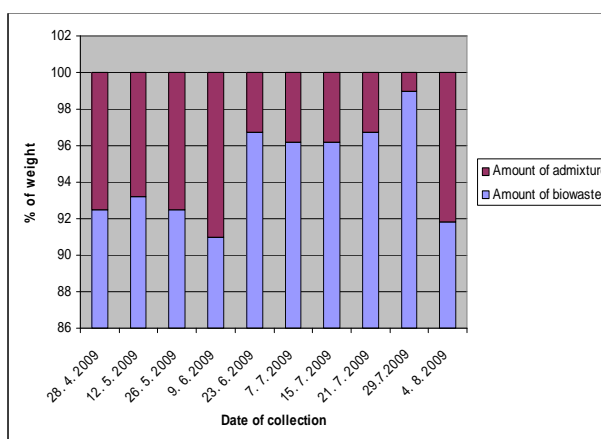


Fig. 2. Rate of admixture at sorted biodegradable municipal waste in Náměšť nad Oslavou.

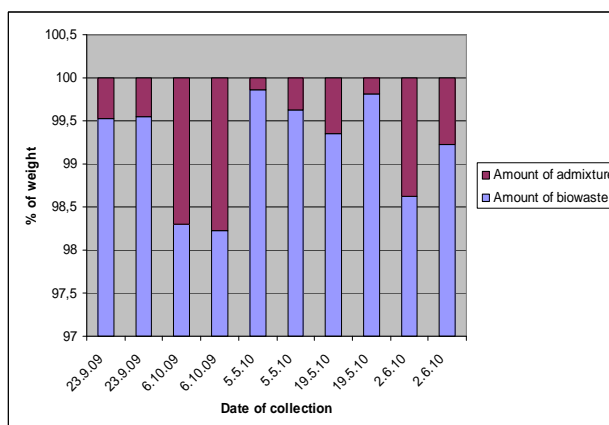


Table 3. Measured values of sorted biodegradable municipal waste in Březník, Jinošov and Naloučany

Date of collection	Sample weight [kg]	Biowaste weight [kg]	Impurities weight [kg]
23. 09. 2009	205	203	2
23. 09. 2009	214	211	3
06. 10. 2009	212.5	212.5	0
06. 10. 2009	213	211	2
05. 05. 2010	217.3	215.5	1.8
05. 05. 2010	210.5	210.5	0
19. 05. 2010	218.3	217.9	0.4
19. 05. 2010	225.3	225	0.3
02. 06. 2010	207	204.1	2.9
02. 06. 2010	203	203	0

As evident from the measured values, the amount of unacceptable impurities in separate biodegradable waste varies depending on the size of the city or village. It is probably caused by the anonymity during sorting and collection in big cities. In Annex 5 to Decree No. 341/2008 Sb. [11] those permitted additives for composting rate is a maximum of 2%wt. as well as operators of composting plants in dependence on technological equipment require 1-2%wt. of impurities in the input raw material [3].

In practice this means that sorted biodegradable municipal waste from Kroměříž city is unusable for composting because the amount of impurities varies from 1 to 9 %wt. Quite different is the situation in small towns and villages. Degree of impurity in sorted waste in Náměšť nad Oslavou varies from 0.14 to 1.78 %wt. and in villages Březník, Jinošov and Naloučany varies from 0 to 1.4%wt.

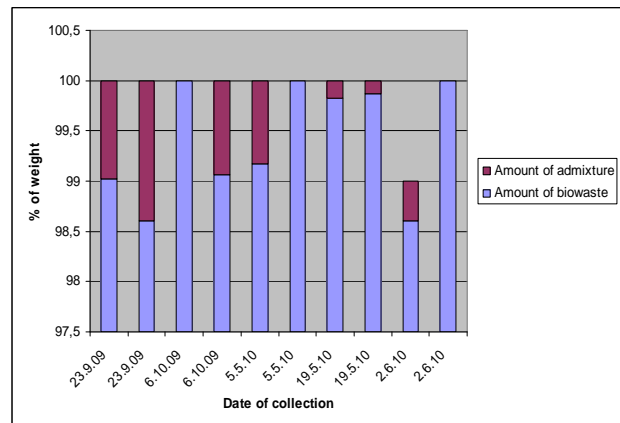
The system of biodegradable municipal waste sorting is almost perfect and allows the production of high quality compost. Some samples from small villages were completely free of unwanted impurities. In the case of samples from small villages, the rate of impurities in excess of 1%wt. was recorded only once.

3.2. Size of composting plant and its technical equipment

In rural conditions of Czech Republic it is not easy to design a composting plant. Of all the possible technologies of composting we think only about heap composting but there are still several problems whose solutions often confront. It is better to build more smaller composting plants but just a big composting plant is reach enough to have necessary technical equipment which includes:

- a). *Energy resources* - tractors, front loaders, tool carriers.
- b.) *Preparation of raw materials into compost* - crushers, chippers.

Fig. 3. Rate of admixture at sorted biodegradable municipal waste in Březník, Jinošov and Naloučany



c). *Aeration and mixing of compost* - compost turner.

d). *Sieving of finished compost* - screening equipment.

Ad a). In practice it appeared that the tractor must be equipped with additional gear box reductor with the gear ratio $i = 18$ to slow (the ground speed is 0.1 – 2 km per hour) because of the use of the tractor as a energy source for the compost turner. Otherwise, the clutch will be destroyed very soon [2].

Ad b). The main function of crushers and chippers are:

- volume reduction (economically efficient);
- enlarge of the surface of composted materials (great area because of microbiological action);
- ensure the homogeneity of composted materials.

Crushers cannot provide compliance with any requirements of the particle size of output; depending on the type of work system prevalent in the process of disintegration impact crusher, quarry and smearing.

Chippers operating mechanism has a fixed blade; it means that chipper "planes" the raw material. The main type of stress is shear (cut).

For this reason the chippers are suitable only for wood without additives and they are highly susceptible to damage! [2]

Ad c). Ridging of compost is the most important operation during the process of composting.

The compost turner is irreplaceable by any technical equipment (for example front loader).

The main required features and functions of a turner are:

- good aeration and mixing of raw materials in the whole area of heap profile;
- low ground speed and possibility of its regulation in range from 0,1 to 1,0 km per hour;
- partial crushing of raw materials;
- forming of materials into a pile of specified profile;

- good manoeuvrability and sliding properties. [2].

Ad d). Not sifted compost is unmarketable, sifted is irresistible. The main required features and functions of a screen are:

- sorting of finished compost from unwanted impurities;
- possibility of using of sieves with different mesh sizes (15, 20, 40 mm);
- the screen is equipped with a cleaning brush [2].

3.3. Compost selling and utilization

Sale of compost is the most serious problem of biodegradable municipal waste composting (in conditions of Czech Republic). Many farmers does not want to use compost, even if the compost is free.

Compost with the addition of sludge of wastewater treatment plant is unmarketable. The composting plant can be build with the support of subsidies (from EU) but composting plant operation must be funded by self-earned money. Main income comes from payments for waste but the income from sale of compost is irreplaceable.

For these reasons it can be expected that composting plants will produce several types of product:

- 1). Compost or garden substrates of carefully chosen raw materials.
- 2). Substrates for the maintenance of urban green.
- 3). Substrates for the reclamation of landfills.

4. CONCLUSION

In this paper are described problems of biodegradable municipal waste utilization in rural conditions of Czech Republic.

Purity and quality of input waste (into composting plant) is the key factor of the compost quality. As is shown, the problem of too large amount of admixture in selected biowaste related to the size of the city. In rural areas the problem is not so serious because of small amount of impurities is sorted biowaste.

In practice it appeared that it is impossible to operate the composting plant without basic technical equipment. The composting plant can be build with the support of subsidies (from EU) (including necessary technical equipment) but composting plant operation must be funded by self-earned money.

Main income comes from payments for waste but the income from sale of compost is irreplaceable. It is unwise to start the project of composting plant building without solved problem of compost sale.

Concrete project has to be based on local (rural) conditions, especially on the mass of biodegradable waste and on the waste take-away route. It is better to build a composting plant with a small possibility of capacity increase (if you are successful, other villages want to participate).

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