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DETERMINATION OF PROPORTION OF BIODEGRADABLE AND NON-BIODEGRADABLE CEMETERY WASTE FRACTION

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Abstract

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Municipal waste landfilling is the most common practice of municipal waste disposal in the Czech Republic. As a member state of the EU the Czech Republic must comply with the legislative requirements set for waste management. EU Council Directive 1999/31/EC requires member states to limit the amount of bio-degradable waste into landfill.
To achieve the objectives of the Plan of Waste Management of the Czech Republic, various methods has been proposed. Prior to the waste processing, it is necessary to know the waste material composition, and after that select the most appropriate method and procedure for waste utilization or disposal.
Therefore an analysis of graveyard waste composition has been carried out, where, by repeated measurements of samples weighing more than 500 kg (the total amount of analyzed waste was 3107 kg), it was found out that the graveyard waste consists of almost 77 % of bio-degradable matter. It is operationally impossible to separate bio-degradable matter from non-bio-degradable materials. Therefore it is desirable to collect compostable cemetery green waste separately from the waste coming from the decoration of gravestones that may be energetically utilized.

cemetery waste, municipal waste, biodegradable waste, waste utilization, the Plan of Waste Management

Municipal waste landfilling is the most common practice of municipal waste disposal in the Czech Republic. The percentage of biodegradable waste in municipal waste is stated in the range of 40–47%. (Mužík, 2005. Slejška, 2004. Slejška, Váňa, 2004) The garden and park waste, including the graveyard waste, belongs to the category of municipal waste as shown in Decree No. 381/2001.

Effective management and rational utilization of biodegradable municipal waste is still a subject to many discussions. The most serious problems are caused by the heterogeneous biodegradable wastes which contain too many biodegradable components to be landfilled, but also they contain too many non-biodegradable components and foreign materials to be composted. One of the examples of such waste is the cemetery waste.

The Czech Republic must comply with the legislative requirements set for waste management. In this particular case it means the EU Council Directive 1999/31/EC "On the Waste Landfills". The Directive requires the EU member states to limit the amount of BRW into landfills. The main purpose of this restriction is to reduce the amount of emitted gases, particularly methane as a greenhouse gas, into the atmosphere. Therefore, the Plan of Waste Management of the Czech Republic includes the requirement to reduce the quantity of biodegradable wase deposited into landfills to (at least) 75 $\%_{weight}$ in 2010, to 50 $\%_{weight}$ in 2013 and to 35 $\%_{weight}$ in 2020 compared with 1995 as shown in Decree No. 197/2003. The objectives are still unable to fully perform, and it is clear that there will be a lot of biodegradable waste deposited into the landfills.

To achieve the above-mentioned objectives, various methods has been proposed. Prior to the waste processing, it is necessary to know the waste material composition, and after that select the most ap-

propriate method and procedure for waste utilization or disposal.

The aim of this project was to determine the ratio of the biodegradable fraction and non-biodegradable fraction of the graveyard waste and, on the basis of this analysis, find an optimal method for utilization of such waste.

In both Czech and foreign publications similar data have not been published yet, therefore it is not possible to compare the results obtained in the project with other authors.

MATERIALS AND METHODS

The analysed graveyard waste was collected from the Central Cemetery in Brno, the analysis itself was carried out at the temporary dump very close to the Central Cemetery. Large quantities of the graveyard waste are stored there for a long time. The samples were always collected from the newly imposed waste. For practical reasons the waste from other cemeteries was not analysed, but we do not expect big differences (i.e. the difference in the tens of percent) in the waste composition coming from different cemeteries.

The sample was at first sorted in accordance with the Waste Catalogue, i.e. to 200201 Biodegradable Waste and 200203 Other Non-biodegradable Waste. The waste 200202 Soil and Stones was rarely found in the samples (< 2%) and therefore it was not taken into consideration.

The sorted ingredients were then put into bags of the volume of 0.16 m^3 and weighed on mechanical weight hanging (balance). In this way the approximate volume ratio of the particular cemetery waste components was simultaneously recorded.

The measurements were repeated six times. The size of each analysed sample was at least 500 kg.

Due to the weather conditions immediately preceding some of the measurements, the weight of such components was slightly affected by the presence of rain water. The measured values proved them to be irrelevant for the objective of this project.

RESULTS AND DISCUSSION

The aim of this project was to determine the proportion of biodegradable fraction and non-biodegradable fraction of cemetery waste in relation to its further utilization. Due to the research methodology, the mass analysis has a higher value; the measured and calculated values of the mass analysis are shown both in tabular and graphical form for better lucidity. The volumetric analysis may be flawed, as just *an approximate* volume of waste bulk has been measured. Therefore, the results of volumetric analysis are expressed only in the tabular form. For a more precise assessment and elimination of differences in a sample size for each measurement of the mass and volume analysis, the data results were converted into weight and volume percentages ($\%_w$, $\%_v$) of the particular components.

It is apparent that the particular measurements show only small differences in composition, with the unmatched content to biowaste variability in mixed municipal waste. By measuring II i.e. on April 3, 2009, there was greater proportion of green waste from the cemetery maintenance in the sample; the other samples were very well balanced. It appeared that the proportion of biowaste and non-biowaste does not depend on weather conditions or the season (winter – spring).

Biodegradable wastes (Cat. No. 200201) are largely made up of branches of conifer trees and the cones; composting is possible though difficult and lengthy. Another waste component is flowers, where composting is smooth.

All non-biodegradable waste fractions come from the city residents - from the decoration and maintenance of graves and the minimum degree is made up of mixed municipal waste, i.e. non-cemetery waste. The biggest part is made up of plastic materials and pieces of paraffin, glass and metal represent only a small part of it. Other components of non-biodegradable fraction (such as ceramic pots) are completely negligible. There is no possibility of efficient material utilization of non-biodegradable cemetery waste, but it can be used to produce energy.

In some cases, the biodegradable and non-biodegradable wastes make up a unit which is difficult to disconnect (e.g. funeral wreaths). Such waste is only suitable for producing energy.

The measured values of particular measurements and converting them to mass respectively volume percentage are listed in Tab. I and Tab. II.

The above-mentioned 26 % quantity of non-biodegradable impurities in the graveyard waste (mixed) does not allow to use the waste as a raw material for composting or in biogas stations for biogas production.

I: *Mass of graveyard waste components*

Measurement/ date	Non-biowaste [kg]	Biowaste [kg]	In total [kg]	Non-biowaste [$\%_w$]	Biowaste [$\%_w$]
I/11 Mar	138	379.5	517.5	27	73
II/3 Apr	68.5	454.5	523	13	87
III/21 Apr	122.5	390	512.5	24	76
IV/30 Apr	135	405	540	25	75
V/4 May	136	297	500	27	73
VI/7 May	123	391	514	24	76

II: *The volume of graveyard waste components*

Measurement/ date	Non-biowaste [m³]	Biowaste [m³]	In total [m³]	Non-biowaste [% v]	Biowaste [% v]
I/11 Mar	1.01	2.67	3.68	28	72
II/3 Apr	0.64	4.27	4.91	13	87
III/21 Apr	1.20	3.36	4.56	26	74
IV/30 Apr	1.28	4.12	5.40	24	76
V/4 May	1.12	3.20	4.32	26	74
VI/7 May	1.04	352	4.56	23	77

For better utilization of cemetery waste, the most appropriate way is to introduce sorting of the waste generated by the citizens as well as the waste that comes from the maintenance of cemetery green (this waste is less contaminated by littering than the city maintenance green waste). The separated waste from the cemetery green maintenance can be composted, the waste generated by the citizens in the untreated form can only be used as an alternative fuel. Another possibility of its disposal is composting and then landfilling as stabilized waste.

Owing to the difficulty of cemetery waste sorting and economic performance of its incineration, it can be expected that the cemetery waste will mostly be deposited into landfills.

Unfortunately, in both Czech and foreign publications similar data have not been published yet, therefore it is not possible to compare the obtained results with other authors.

SUMMARY

Municipal waste landfilling is the most common practice of municipal waste disposal in the Czech Republic. As a member state of the EU the Czech Republic must comply with the legislative requirements set for waste management. EU Council Directive 1999/31/EC requires member states to limit the amount of bio-degradable waste into landfill.

Serious practical waste management problems are caused by heterogeneous biodegradable wastes which contain too high proportion of biodegradable components to be landfilled, but also too many non-biodegradable components such as glass, plastic, metals etc. to be composted. One of the typical examples of such waste is that from cemetery which contain a high proportion of vegetation but also substances like glass, plastic, candles or metal.

To achieve the objectives of the Plan of Waste Management of the Czech Republic, various methods has been proposed. Prior to the waste processing, it is necessary to know the waste material composition, and after that select the most appropriate method and procedure for waste utilization or disposal. Therefore, an analysis of cemetery waste composition has been carried out.

The analysed cemetery waste was collected from the Central Cemetery in Brno. The sample was at first sorted in accordance with the Waste Catalogue, i.e. to 200201 Biodegradable Waste and 200203 Other Non-biodegradable Waste. The waste 200202 Soil and Stones was rarely found in the samples (< 2%) and therefore it was not taken into consideration.

The sorted ingredients were then put into bags of the volume of 0.16 m³ and weighed on mechanical weight hanging (balance). In this way the approximate volume ratio of the particular graveyard waste components was simultaneously recorded.

The measurements were repeated six times. The size of each analysed sample was at least 500 kg.

Due to the weather conditions immediately preceding some of the measurements, the weight of such components was slightly affected by the presence of rain water. The measured values proved them to be irrelevant for the objective of this project. Due to the research methodology, the mass analysis has a higher value. The volumetric analysis may be flawed, as just *an approximate* volume of waste bulk has been measured.

For a more precise assessment and elimination of differences in a sample size for each measurement of the mass and volume analysis, the data results were converted into weight and volume percentages ($\%_w$, $\%_v$) of the particular components.

Measured values showed that the rate of non-biodegradable impurities is more than 23 % of weight (more than 23 % of volume). It makes cemetery waste impossible to composting or any other material utilization.

SOUHRN

Stanovení podílu biologicky rozložitelné a biologicky nerozložitelné složky hřbitovního odpadu

Skládkování je v České republice nejrozšířenějším způsobem zneškodnění komunálního odpadu. Česká republika jako členský stát Evropské unie musí dodržovat legislativní požadavky, které jsou stanoveny pro nakládání s odpady, v tomto případě se jedná o směrnici Rady EU 1999/31/ES „o skládkách odpadů“. Směrnice ukládá členským státům omezit množství biologicky rozložitelných odpadů ukládaných na skládky.

Největší problémy způsobují heterogenní komunální odpady, které obsahují příliš velký podíl biologicky rozložitelné složky na to, aby bylo vhodné je skládkovat, ale rovněž příliš velký podíl příměsí a biologicky nerozložitelných látek na to, aby bylo vhodné je kompostovat. Typickým příkladem takových odpadů je právě odpad ze hřbitovů.

Vzhledem k předepsaným cílům Plánu odpadového hospodářství České republiky jsou navrhovány různé metody jejich dosažení. Před zpracováním odpadů je však nezbytné znát jejich materiálové složení, a teprve poté vybrat nejvhodnější metodu a postup pro využití či zneškodnění. Cílem práce proto bylo stanovit materiálové složení hřbitovního odpadu.

Analyzovaný hřbitovní odpad byl shromážděn z Ústředního hřbitova v Brně. Vybraný vzorek byl nejdříve roztříděn na složky dle Katalogu odpadů, tj. na 200201 Biologicky rozložitelný odpad a 200203 Jiný biologicky nerozložitelný odpad. Odpad 200202 Zemina a kameny se ve vzorku vyskytoval v minimální míře (< 2 %), a proto nebyl uvažován.

Vytříděné složky byly následně volně vkládány do objemných tašek a v nich váženy na závěsné mechanické váze (mincíř). Tak byl současně při vážení zaznamenán přibližný objemový poměr jednotlivých složek hřbitovního odpadu.

Měření bylo celkem šestkrát zopakováno. Velikost každého vzorku pro analýzu byla minimálně 500 kg.

Vzhledem ke klimatickým podmínkám těsně předcházejícím vlastnímu měření byla v některých případech hmotnost jednotlivých složek mírně ovlivněna přítomností srážkové vody. Pro naplnění cíle práce je však toto ovlivnění nepodstatné. Vzhledem k metodice výzkumu má vyšší vypovídací hodnotu hmotnostní analýza. Objemová analýza může být zatížena chybou, protože byl měřen pouze *přibližný* objem odpadů.

Pro přesnější posouzení a eliminaci rozdílné velikosti vzorku při jednotlivých měřeních byly hodnoty hmotnostní a objemové analýzy přepočítány na procentuální hmotnostní a objemové zastoupení jednotlivých složek.

Naměřené hodnoty ukazují, že míra biologicky nerozložitelných příměsí je více než 23 % hm. (více než 23 % obj.). Hřbitovní odpad tedy není možné kompostovat ani jinak materiálově využívat.

hřbitovní odpad, komunální odpad, biologicky rozložitelný odpad, využití odpadů, Plán odpadového hospodářství

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Vyhláška č. 381/2001 Sb., v úplném znění, kterou se stanoví Katalog odpadů, Seznam nebezpečných odpadů a seznamy odpadů a států pro účely vývozu, dovozu a tranzitu odpadů a postup při udělovaní souhlasu k vývozu, dovozu a tranzitu odpadů (Katalog odpadů).

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