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RESEARCH ON THE MORPHOLOGICAL COMPOSITION OF SOLID DOMESTIC WASTE OF THE CITY OF KHOROL IN POLTAVA REGION

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Abstract. The article presents the results of the research on the morphological composition of solid domestic waste of the city of Khorol in Poltava region. A brief sequence of research is given. The comparison of the results with the known data on the morphological composition of solid domestic waste characteristic of the settlements in Poltava region is carried out. The conclusions about the results of the conducted research are formulated.

Key words: solid domestic waste, waste management, morphological composition of waste.

1. Introdaction

The organization of an efficient solid waste management system requires knowledge of its morphological composition To do this, there is even a separate scientific direction – garbology (from English “Garbage”) or garbage collection – the direction in science that deals with the study of garbage waste, the peculiarities of its transportation, the ways of utilization and the determination of the impact of these processes on the environment. The study of garbage waste is closely related to the concept of morphology, which involves the definition of the composition of mixed mass of garbage [1, 2].

Nowadays, the most relevant is the research on morphological composition to determine the number of individual components in solid domestic waste. This need arises for the possibility of further introduction of modern, efficient waste management technologies and long-term forecasting of the formation of secondary raw materials that are a part of the solid domestic waste in the settlements with different population.

It is generally known that the morphological composition of trash can directly depend on the economic situation in the country. In turn, the composition of trash in different regions of the country may also be different. Nowadays in Ukraine there are different data that significantly differ in morphological composition of waste. There are only various data from a variety of available analytical reports. Therefore, for the future, there is a need to obtain reliable and relevant at present statistical information on the morphology of solid domestic waste for different types of settlements. Thus, according to one of the analytical reports, the following morphological composition of solid waste is typical for Ukraine [3]:

- materials of biological origin (residues of food products, plant residues, etc.) – 44 %;
- potential secondary raw materials: paper and cardboard - 13 %, metal - 2 %, glass - 9 %, polymers - 11 %);
- construction waste (inert materials, in particular: stones, ceramics, sand, brick, etc.) - 5 %;
- textiles – 5 %;
- wood – 1 %;
- other waste, including hazardous materials (aerosols, paints, chemicals, office equipment and its accessories) – 10 %.

It is accepted to separate potentially hazardous waste which requires special treatment methods from the concept of solid waste. These include medical waste, rechargeable batteries, battery packs, tires, fluorescent lamps and daylight lamps, mercury thermometers.

2. Experimental part

In the framework of the monitoring of implementation of the "Comprehensive Program on Solid Waste Treatment in Poltava Region in 2017–2021" [4] during the second half of 2018 the research on morphological composition of solid waste for the city of Khorol in Poltava region which is the regional center with the population of about 13200 people was conducted.

Determination of the morphological composition was carried out in accordance with "Methodological Recommendations for the Determination of the Morphological Composition of Solid Domestic Waste", approved by the Order of the Ministry of Housing and Communal Services of Ukraine dated February 16, 2010 No. 39 [5]. Guided by this technique, the morphological composition of solid waste was determined by the following morphological components:

1) food waste (vegetables, fruit, gardening waste, etc.);
2) paper and cardboard;
3) polymers (plastic);
4) glass;
5) ferrous metals;
6) non-ferrous metals;
7) textiles;
8) wood;
9) hazardous waste (batteries, dry and electrolytic accumulators, solvent containers, paints, mercury lamps, television kinescopes, etc.);
10) bones, leather, rubber;
11) the residue of solid domestic waste after the removal of components (small construction waste, stones, street waste etc.).

These recommendations provide for two possible sampling options to determine the morphological composition of solid waste:

1) waste from standard containers at separate container sites of the settlement;
2) waste entering the landfill immediately after unloading the garbage truck at the working waste disposal map of the landfill.

On the one hand, the definition of the composition of waste at container sites allows to obtain data on the original waste composition which corresponds to the structure of consumption of goods as much as possible. On the other hand, the definition of the composition of the waste entering the landfill is most relevant, since in the case of further selection of the waste treatment method (for example, sorting), the main source will be waste with natural moisture and pollution, that is, after collecting at container sites and unloading from the garbage truck.

In the framework of this study, to determine the morphological composition of domestic solid waste in the city of Khorol , the following options were selected:

– at stage No. 1 of the research - the second option with the selection of representative samples of the total mass of waste brought to the urban landfill from different sources (public institutions, enterprises and housing stock). This sample was pre-loaded into an empty container with the capacity of 1.1 m^3 with the level of sealing close to the actual one in the containers (Fig. 1);

– at stage No. 2 of the investigation the first option was used with the definition of the composition of waste in containers of 1.1 m^3, collected in it on the day of sampling, brought to the landfill and unloaded to a specially prepared plot (Fig. 2).

Fig. 1. Photographic materials of the morphological composition of solid waste at the landfill in the the city of Khorol . Stage No. 1, 08/16/2018

Fig. 2. Photographic materials of the morphological composition of solid waste at the landfill in the the city of Khorol. Stage № 1, 21/11/2018

The main requirement of the research was to ensure the representativeness of the waste sample, which was largely determined by the sampling procedure and was based on the necessity of ensuring minimum deviations from the initial humidity and density in the selection and research of the sample.

According to the methodology [5], it is recommended to determine the morphological composition of solid domestic waste during four seasons of the year. In the framework of this study, determination of the morphological composition of solid domestic waste in the city of Khorol was carried out during two seasons: summer (stage number 1) – in August; autumn-winter (stage number 2) – at the end of November (with constant air temperature at the level of +5- 0 °C).

Measurement of the mass of individual components of the total mass of solid domestic waste samples was performed using manual scales.

Determination of the morphological composition of solid waste was carried out in accordance with the recommendations [5] in the following sequence:

1. The material was prepared for the research: plastic bags with the capacity up to 30 l, weight up to 50 kg with an error of weighing not more than 0.5±1 %, shovels, tape measure, forms for filling the results of the research (Table 1).

2. The total number of the employees involved in the process of sorting solid domestic waste was 2 people per container and, additionally, a person who recorded the mass of sorted composites of solid waste.

3. The sorters were given plastic bags for the collection of each component of solid domestic waste.

4. Before the measurements began, an instruction with the sorters of solid waste had been conducted directly at the site of the research

5. Prior to conducting the research at stage 2, a site was prepared at the landfill for unloading solid domestic waste that was brought in a container with the capacity of 1.1 m^3. A plot of 6 m × 6 m was covered with a polymeric film to minimize additional dusting and moisture content of the waste.

6. Using the tape measure, the level of filling the container (as the ratio of the height of the container space, not filled with solid domestic waste, to the height of the entire container, %) was determined, respectively, the data obtained was specified at the beginning of Tables 1 and 2. As standard containers were used in the research, their volume was determined according to the technical passport.

7. The waste density was determined by its calculation as the ratio of the mass of solid domestic waste loaded in the selected control container to the container volume, taking into account the degree of its filling.

8. At stage No. 2 of the research, the containers were manually thrown over and the waste was unloaded onto the prepared site in the landfill. At stage No. 1 of the research a site with already placed waste was selected, which was sent to the landfill not more than 1 hour before the study.

9. Solid domestic waste sorters collected individual components of solid domestic waste into plastic bags (packages). To fill the bags (packages), they used shovels or did it manually in special protective gloves.

10. Upon completion of the selection of the separate components in the bags (packages), the residue of the non-sortable solids was loaded.

11. Alternate weighing of packages with components of solid domestic waste, as well as waste residue was carried out. The results of each weighing were entered into the appropriate accounting forms. Filled and counted bags were unloded at the waste disposal map of the landfill.

3. Results of investigation

The results of the research were processed in the following order:

- the mass of each sorted component of solid waste was determined by summing up the corresponding weighing results;
- The total mass of the sorted solid domestic waste was determined by summing up all the data

obtained during the weighing of the components of solid waste and its residue;

§ having taken 100 % of the total mass of the sorted solid household waste, the content (as a percentage) of each component of solid domestic waste in this representative sample was calculated;

§ based on the results of the calculations, the average morphological composition and density of solid household waste for each representative sample were determined.

The obtained results of calculations of morphological composition and density of solid domestic waste on each representative sample are given in Table 1.

These results indicate:

- significant content of food waste in solid waste in the city of Khorol – about 31÷34 %;
- average potential of recycled materials (waste paper, glass, plastic) – at the level of 25÷33 %;
- significant percentage of the components of solid waste that have energy value – about 30 %;
- practical absence of hazardous waste in the composition of the solid waste, which needs to be clarified at additional stages of the research;
- absence of waste of ferrous metals as a result of the preliminary individual selection of this waste from the mass of solid waste;
- high content of "residual" waste (taking into account waste of textiles and rubber, leather, bones) in the total mass of solid domestic waste that is subject to burial - about 32÷40 %.

Table 2 shows the comparative characteristic of the morphological composition of solid waste, determined during the investigations in the city of Khorol and tentative data on the morphology of solid waste, characteristic of the settlements in Poltava region, provided in the Subregional Strategy of Solid Domestic Waste Management in Poltava region in 2016 [6] and the data for 2008, presented in [7].

Table 1

Results of the research on the morphological composition of solid waste in the landfill in the city of Khorol

No.	The name of the sample component	Stage No. 1, Date held on 08/16/2018, time of carrying out $9^{\underline{00}} – 11^{\underline{00}}$		Stage No. 2, Date held on 11/21/2018, time of carrying out $10^{\underline{00}} – 12^{\underline{00}}$	
		Mass of solid waste according to the number of weighings, kg	Percentage of total mass,%	Mass of solid waste according to the number of weighings, kg	Percentage of total mass,%
1	Food waste (vegetables, fruit, gardening waste, etc.)	47.5	34.03	42.0	31.53
2	Paper and cardboard	11.8	8.45	18.0	13.52
3	Polymers (plastic, plastics)	17.9	12.82	15.0	11.3
4	Glass	5.2	3.72	11.0	8.25
5	Ferrous metals	0	0	0	0
6	Non-ferrous metals	1.0	0.72	3.2	2.4
7	Textile	6.9	4.94	3.0	2.25
8	Tree	0	0	2.0	1.5
9	Hazardous waste	0	0	0	0
10	Bones, leather, rubber	0	0	3.0	2.25
11	The solid waste after removal of components (small construction garbage, stones, street waste, etc.)	49.3	35.32	36.0	27.0
12	**The total mass of the sample solid domestic waste**	**139.6**	**100 %**	**133.2**	**100 %**
13	**Density of the solid domestic waste sample**	**0,140 t/m^3**		**0.133 t/m^3**	

The presented data show some differences in the morphology of solid domestic waste:

firstly, significantly larger volumes of actual food waste production in the city of Khorol compared to official data for 2016, and vice versa, the correlation with the data for 2008;

secondly, significant differences between the percentage of the formation of resource-intensive components of solid waste (paper, polymers, glass), as well as a certain difference between the percentage of waste wood, rubber and leather.

Accordingly, the results of the analysis prove the necessity of conducting similar research for each settlement or the united territorial communities.

Table 2

Comparative characteristics of the morphological composition of solid waste, determined during the research

No.	The name of the sample component	Average percentage of total mass,%, according to the generalized results of solid waste research of the Khorol city	Percentage of the total mass,%, according to the Subregional Strategy (in 2 categories: cities> 5000 citizens) [6]	Tentative composition of solid waste,%, as of 2008 [7]
1	Food waste (vegetables, fruit, gardening waste, etc.)	32,76	19,0	30,0−36,0
2	Paper and cardboard	11,0	7,0	25,0−30,0
3	Polymers (plastic, plastics)	12,06	13,0	1,5−5,0
4	Glass	6,0	21,0	2,0−8,0
5	Ferrous metals	0	1,1	2,0−4,0
6	Non-ferrous metals	1,55		
7	Textile	3,6	3,5	2,0−7,0
8	Tree	0,75	1,9	2,0−4,0
9	Hazardous waste	0	0,6	-
10	Bones, leather, rubber	1,12	4,4	0,5−2,0
11	The solid waste after removal of components (small construction garbage, stones, street waste, etc.)	31,16	28,5	8,0−15,0
12	**The total mass of the sample solid domestic waste**	**100 %**	**100 %**	**100 %**

Conclusions

The above results of the research on the morphological composition of solid domestic waste in the city of Khorol and the comparison of the obtained data with the tentative data on the solid waste morphology, published in [6], prove:

1) the need for clarifying the composition of solid waste at each local level separately, which implies the obligation to conduct the research on the morphology of solid waste as a preliminary step in making strategic decisions on further waste management;

2) the need for determining the potential of secondary raw materials in the composition of solid waste and the component composition of the solid waste which has energy value for further optimal choice of appropriate organizational and technological solutions taking into account local specifics.

Thus, one of the first steps in the organization of waste management at the local level is the research on the morphological composition of solid domestic waste.

References

[1] Upravlinnia tverdymy pobutovymy vidkhodamy v umovakh reformuvannia mistsevoho samovriaduvannia ta rozvytku mizhmunitsypalnoho spivrobitnytstva. Navchalno-praktychnyi posibnyk / Za zahalnoiu redaktsiieiu Tolkovanova V. V., Illiash O. E., Zhuravlia T. V., Holika Yu. S. - Kyiv, 2018. – 393 s.

[2] Pohribnyi I. Ya. Problemy vyznachennia morfolohichnoho skladu tverdykh pobutovykh vidkhodiv z urakhuvanniam suchasnykh umov pererobky / I. Ya. Pohribnyi // Efektyvna ekonomika. - No. 11, 2012. [Elektronnyi resurs]. - Rezhym dostupu: http://www.economy.nayka.com.ua/?op=1&z=1527

[3] Tverdi pobutovi vidkhody v Ukraini: Potentsial rozvytku - Stsenarii rozvytku haluzi povodzhennia / Pidsumkovyi zvit. - Kyiv, 2015. – 114 s. [Elektronnyi resurs]. - Rezhym dostupu: https://www.ifc.org/wps/wcm/connect/region__ext_content/ifc_external_corporate_site/europe+and+central+asia/resources/2015ukrmunicipalsolidwastedevelopmentpotential

[4] Kompleksna prohrama povodzhennia z tverdymy pobutovymy vidkhodamy u Poltavskii oblasti na 2017–2021 roky. – Poltava, 2017. – 143 s.

[5] Nakaz Ministerstva z pytan zhytlovo-komunalnoho hospodarstva Ukrainy vid 16.02.2010 r. No. 39. “Metodychnykh rekomendatsii z vyznachennia morfolohichnoho skladu tverdykh pobutovykh vidkhodiv”, zatverdzhenykh Nakazom Ministerstva z pytan zhytlovo-komunalnoho hospodarstva Ukrainy vid 16.02.2010 № 39. [Elektronnyi resurs]. - Rezhym dostupu: https://zakon.rada.gov.ua/rada/show/v0039662-10

[6] Subrehionalna stratehiia povodzhennia z tverdymy pobutovymy vidkhodamy dlia Poltavskoi oblasti, proekt “Reforma upravlinnia na skhodi Ukrainy” “Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) Gmbn”, predstavleno dlia Poltavskoi oblasnoi derzhavnoi administratsii, GFA Consylting Group, sichen 2016. – 83 s.

[7] Povodzhennia z vidkhodamy na Poltavshchyni. Monohrafiia / Za zahalnoiu redaktsiieiu Holika Yu. S., Illiash O. E. – Poltava: Poltavskyi literator, 2009. – 292 s.