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Sorting lines as an element of household waste management at the regional level

The article identifies the problems of household waste recycling, summarizes the data on the planned waste management infrastructure facilities, and substantiates the feasibility of building waste treatment facilities in Poltava region. The absence of a recycling system (including a separate collection system) for household waste results in Ukraine losing millions of tons of resource materials contained in waste that could potentially be put back into economic circulation. It has been established that sorting mixed household waste will enable its further reuse and recovery and reduce the load on landfills. It is determined that the stage of sorting (separation) of household waste is an integral part of integrated waste management solutions and, accordingly, is a mandatory stage before further application of waste treatment technologies

Keywords: household waste, sorting lines, secondary raw materials, territorial communities

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Introduction

Over the past decade, Ukraine has been experiencing a progressive accumulation of waste, and Poltava region is no exception. Human activity produces different types of waste: industrial, household, agricultural, etc. Household waste is mixed and/or separately collected waste from households, including paper, cardboard, glass, plastic, wood, textile, metal, packaging, bio-waste, electrical and electronic equipment waste, battery and accumulator waste, hazardous waste in household waste, bulky and repair waste, as well as mixed and/or separately collected waste from other sources if this waste is similar in composition to household waste [1].

The amount of waste increases with the growth of the settlement and the income of the population. Measures taken to prevent waste generation are insufficient, which threatens not only to deepen the environmental crisis but also to aggravate the socio-economic situation in general. Hence the need for further improvement and development of the entire legal,

regulatory, methodological and economic waste management system, taking into account domestic and international experience.

Review of the research sources and publications

The absence of a recycling system (including a separate collection system) for municipal waste (hereinafter referred to as MSW) leads to the loss of millions of tons of resource-rich materials contained in waste that could potentially be put into economic circulation in a processed or recycled form. The development of separate waste collection and recycling is an integral part of increasing the efficiency of natural resources use and the transition to a sustainable green economy [2]. The theoretical and practical aspects of this issue are covered in the works of such domestic and foreign scientists as O. Bent, S. Harichkov, 3. Broide, I. Drozd, V. Kolomiets, O. Hubanova, V. Vynnychenko, I. Korinko, G. Dawson, E. Mykhailova, G. Pancheva [3, 4]. Paying tribute to the achievements of scientists, it should be emphasized that it is

necessary to continue research on this issue, given the need for immediate steps by Ukraine to implement European standards in the relevant field.

Definition of unsolved aspects of the problem

The high level of waste generation and low rates of its utilization as secondary raw materials have led to the accumulation of significant amounts of solid waste in Ukraine's industry and municipal sector every year, of which only a small part is used as secondary material resources, while the rest ends up in landfills.

The system of household waste management in Poltava Oblast's settlements is reaching the level of an environmental disaster. The absence of waste processing plants, sorting lines or stations leads to the accumulation of waste in open areas, burning, and dumping into streams, rivers and open water bodies.

Government and public institutions are aware of the problem of environmental pollution by waste in settlements and are developing regulations, holding public hearings, and implementing various campaigns. However, this environmental problem is becoming more and more significant due to the increase in waste from year to year, and the public's awareness of waste sorting does not change and remains at the level of «a common waste collection container».

Problem statement

The purpose of this paper is to determine the feasibility of using sorting lines in the territorial communities of Poltava region as an element of household waste management at the regional level.

Basic material and results

A significant increase in household waste in Ukraine has led to an extremely tense environmental situation in settlements. The National Waste Management Strategy for Ukraine until 2030 was introduced to address the problems of household waste and develop effective mechanisms for its disposal. The strategy defines the main directions of state regulation in the field of waste management in the coming decades, taking into account European approaches to waste management, with considerable attention paid to waste management at the local and regional levels [5].

According to [5], regional waste management plans should cover all activities that fall within the powers of local executive authorities in the field of waste management and provide for:

- analyzing the current situation in the field of waste management in the region, defining current and strategic goals and necessary measures;
- selection of the optimal waste management system (infrastructure for collection, separate collection, transportation, treatment or disposal) and the practical measures required for its implementation;
- determining the geographical boundaries of joint service areas (territories) for which the plan has been developed and which should jointly use the services of a landfill or waste treatment facility;
- determining the obligations of various institutions and organizations that will be involved in the

implementation of measures and actions, the amount of costs and possible sources of funding.

According to V. Strutynska [6], the situation with waste recycling in Ukraine is significantly different from that in the European Union. In the EU, more than 60% of waste is recycled, with Sweden being the leader, where 99% of waste is recycled and used as a source of energy for heating homes and generating electricity. Some countries, such as Germany, Switzerland, and Austria, also have a high level of waste recycling, where 97% of waste is recycled and recycling companies use it as a source of energy, which brings economic and environmental benefits [6]. This saves billions of liters of oil products. In addition to saving budget funds, such enterprises create jobs and solve environmental problems. However, not all European countries have a similar level of waste recycling. For example, Italy, Bulgaria, Romania, and the Baltic States [7] face problems in waste management and have giant landfills, but not all waste is recycled [8, 9]. Some of these countries even export their waste to countries with high recycling rates [5].

The absence of a recycling system [10] (including a separate collection system) for household waste leads to the loss of millions of tons of resource materials contained in waste that could potentially be put into economic circulation every year. The development of separate waste collection and recovery is an integral part of increasing the efficiency of natural resource use and the transition to a sustainable economy [5].

Sorting mixed household waste will allow for its further reuse and recovery, reducing the load on landfills.

Primary recovery (processing) is the second step after sorting. Its essence is to radically reduce the volume of waste disposal. These issues require active government involvement to stimulate investment in this area at the level of local communities, using modern technologies. The third stage involves the use of waste as secondary resources.

Household waste is consumer waste generated in the course of human activity in residential buildings, social and cultural institutions, public, educational, medical, commercial and other facilities (food waste, waste paper, glass, metals, plastics, polymeric materials, etc.).

The peculiarity of municipal waste is that it is mixed, i.e. a mixture of components. The division of household waste components into separate constituent parts is called morphological composition. Mixing of household waste occurs at the stage of its generation, storage, transportation and disposal. This leads to the formation of harmful chemical compounds that pollute the air and groundwater.

Problems in the field of household waste management need to be addressed urgently, provided that measures are funded at the local and state levels.

The practical experience of household waste management in European countries shows that it is necessary to implement a comprehensive household waste management system that ensures the use of waste as a secondary raw material in accordance with

environmental safety requirements. This will allow for less waste disposal to landfills and landfills and the development of waste treatment facilities using secondary resources, involving them in production.

According to [11], the main waste management infrastructure facilities that are focused on servicing the entire territory within a cluster/subcluster (subregion) are planned:

- regional landfills;
- sorting and processing complexes, which are based on mechanical and biological waste processing facilities or thermal neutralization facilities;
- sorting and transshipment stations or reloading stations;
- sorting stations / lines are stationary or mobile [11].

The organization of a system for the separation and separate collection of these wastes as part of household waste is planned to be carried out at the expense of [11]:

- 1) creation of specialized stationary collection points for recyclables, hazardous waste from household waste, and specific waste;
- 2) creation of communal points (bases or sites) for the integrated acceptance of various types of waste from the population;
- 3) organization of hazardous waste acceptance at «mobile facilities/acceptance points»;
- 4) organizing containerized collection in specialized labeled containers;
- 5) organizing centralized sorting of household waste as an additional or main element of the separate collection system (sorting stations/lines).

The choice of one or another option for organizing separate collection of individual components of household waste should be consistent with the chosen scenario for waste treatment, the planned infrastructure in a particular cluster.

The basis for organizing a system for the collection and subsequent management of household waste within each of the territorial communities and the organization of separate collection of household waste are indicators of material flows of these wastes [11, Annexes 3.2.1 - 3.2.4].

Taking into account the results of studies of the morphological composition of municipal waste conducted in Poltava region in 2017-2023, as well as the results of the expert assessment of the morphological composition of municipal waste by GIZ project experts (2015-2016) [12], indicative strategic indicators for the selection of individual resource-rich components of municipal solid waste at the stage of generators (primarily the population) were determined:

- the urban population selects about 14.5% of recyclable components (plastic, glass, paper and cardboard, metals) from the volume of these wastes generated in municipal solid waste;
- the rural population selects about 14% of recyclable components (plastic, glass, metals) from the volume of these wastes generated as part of solid household waste, in addition: about 90% of paper and cardboard is used for incineration in individual energy installations (stoves) and about 65% of organics is used

for home composting and other personal needs, which is approximately 9-9.5% of the total volume of solid household waste.

In order to reduce the volume of waste disposal at the landfill, increase the life of the landfill, and ensure the selection and reuse of resource-rich waste [13] (wood, metal, paper, plastic, glass, etc.), it is advisable to use sorting lines that will allow waste to be sorted throughout the year.

After the sorting line, only the residual waste that cannot be treated is sent to a municipal landfill.

According to the generalized data on planned waste management infrastructure facilities [11, Table 3.5.2], the feasibility of building 35 waste treatment facilities in Poltava Oblast is substantiated, including: sorting lines/stations – 13; sorting and reloading facilities – 8; reloading stations – 11; sorting and processing complexes – 3.

Thus, the stage of sorting (separation) of household waste is an integral part of integrated waste management solutions and, accordingly, is a mandatory stage before further application of waste treatment technologies.

Thus, for the Poltava region, the need for sorting stations with a capacity of 10,000 tons per year (operating in two shifts) is 11 units, and for 50,000 tons per year (operating in two shifts) – 2 units.

A significant advantage of the Poltava region is the presence of a manufacturer of such facilities, Consort [14], which creates equipment for production and logistics automation: conveyors, lines for transportation, sorting, processing, etc.

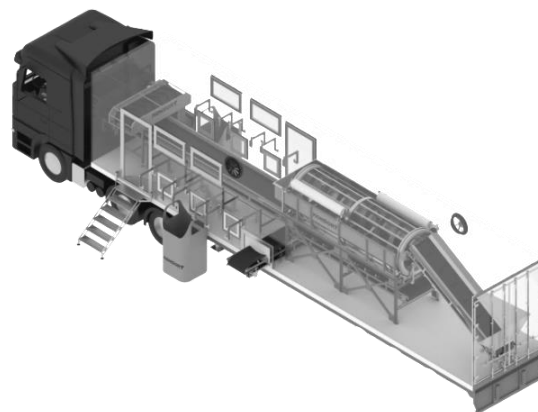


Figure 1 – Mobile line for sorting household waste [15]

Mobile sorting line - designed for manual sorting of household waste with the separation of resource-intensive components in household waste (ferrous and non-ferrous metals, glass, polymer, wood and paper). The main advantage of this line is that it is not tied to the place of accumulation of household waste and can be moved quickly and conveniently from place to place. The mobile solid waste sorting line is equipped on the basis of a cargo trailer with wheels for transportation. Transportation is possible with a tractor or a tractor with a rolling trolley. The trailer is equipped in accordance with all ergonomic labor standards. The

trailer is equipped with the following: windows, doors and ventilation system, lighting, electrical panel with control panel, sorting holes with fasteners for big-bag bags, bactericidal lamps. The useful fraction is collected in big bags. The line is powered by 380 volts (panel or generator) [15].

For manual sorting with the separation of resource-intensive components in municipal solid waste (ferrous and non-ferrous metals, glass, polymer, wood and paper).

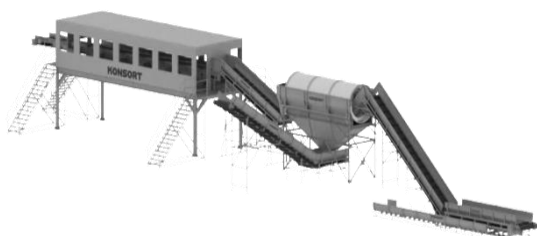


Figure 2 – Line for sorting household waste up to 50,000 tons per year [16]

The solid waste sorting complex involves the selection of valuable recyclable materials from garbage and subsequent shipment to the final processing points. Household waste is delivered to the receiving department in a specially designated pit, in which there is an L-type receiving conveyor, then the conveyor delivers the waste to the drum separator (screen). After the inlet conveyor, the garbage enters the screen, where the fine fraction (organic matter, earth, etc.) is separated. The screen is made of a mesh drum and has a bag tearing system. Under the screen is a conveyor designed to discharge the fine fraction into a special container. From the screen, the selected raw material is fed to the beneficiation room through an inclined conveyor. In the room there is a sorting department with an inspection (sorting) conveyor for manual sorting of useful secondary raw materials [16]. An automatic iron separator is installed at the end of the sorting conveyor, which separates metal products into a container. Special containers for collecting household waste are installed under the room for selecting the useful fraction.

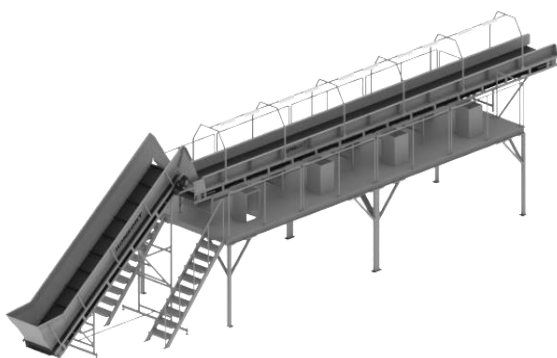


Figure 3 – Line for sorting household waste up to 10,000 tons per year [17]

The line is used at landfills or separately constructed plants for shredding and sorting various waste materials: household waste, mixed waste, construction waste, organic and inorganic waste, waste paper and polymers, for their further reuse and recovery.

The sorting complex for household waste involves the selection of valuable recyclable materials from the garbage, with subsequent shipment to the final processing points. Household waste is delivered to the receiving department, into a specially designated pit, which contains an L-type receiving conveyor. Then the raw material is shaken on the inspection (sorting) conveyor for manual sorting of useful secondary raw materials, goes through an inclined conveyor along the inspection (sorting) conveyor for manual sorting of useful secondary raw materials. Special containers for collecting household waste are installed under the inspection table [17].

The line is used at landfills or separately constructed plants for shredding and sorting various waste materials: household waste, mixed waste, construction waste, organic and inorganic waste, waste paper and polymers, for their further reuse and recycling.

Conclusions

The potential of using household waste as a secondary raw material can become a powerful factor in the development of a sustainable economy in Ukraine, provided that the institutional, organizational, and economic framework for its involvement in production and consumption is formed. To achieve this goal, it is necessary to ensure the adoption of regulations aimed at implementing economic instruments, in particular: stimulating the recovery of household waste; full cost recovery by including all costs associated with the provision of such services in the household waste management tariff; introduction of a mechanism for full financing of the waste management system, taking into account the principles of «polluter pays», «extended producer responsibility» and «pay for what you throw away»; reforming the system of holding tenders for the provision of household waste removal services; improving the procedure for setting tariffs for household waste management services.

At the same time, local state administrations and local self-government bodies should intensify their activities in the following areas: developing and approving local waste management plans, attracting investments in the development of proper infrastructure for separate collection, sorting and recovery of household waste, creating specialized municipal waste collection points and accepting certain types of household waste, conducting an information and awareness campaign, developing a system of indicators to monitor the level of household waste management at the local and regional levels.

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Сортувальні лінії як елемент управління побутовими відходами на регіональному рівні

У статті визначено проблеми перероблення побутових відходів, узагальнено дані щодо запланованих об'єктів інфраструктури управління відходами, обґрунтована доцільність будівництва на території Полтавської області об'єктів оброблення відходів. Основними проблемами у сфері поводження з побутовими відходами залишаються значні обсяги відходів, що утворюються, площі сміттєзвалищ і полігонів, застарілі методи управління у цій сфері, відсутність можливостей та небажання сортувати відходи, відсутність можливостей для роздільного збору та переробки різних видів відходів. Кількість відходів збільшується з ростом населеного пункту та доходом населення. Відсутність системи перероблення (у тому числі системи роздільного збирання) побутових відходів призводить до втрати Україною щороку мільйонів тонн ресурсоцінних матеріалів, що містяться у відходах, які потенційно можуть бути введені у господарський обіг. Розвиток роздільного збирання та відновлення відходів є важливою частиною підвищення ефективності використання природних ресурсів і переходу до сталої економіки. Встановлено, що сортування змішаних побутових відходів дасть можливість їх подальшого вторинного використання та відновлення зменшити рівень навантаження на сміттєзвалища побутових відходів. Для зменшення об'ємів видалення відходів на звалищі (полігоні), збільшення терміну експлуатації полігону, забезпечення відбору та повторного використання ресурсоцінних відходів (деревини, металу, паперу, пластику та скла тощо) доцільним є застосування сортувальних ліній, що надасть можливість сортувати відходи впродовж року. Визначено, що етап сортування (відокремлення) побутових відходів є невід'ємною складовою комплексних рішень в сфері управління відходами й відповідно є обов'язковим етапом перед подальшим застосуванням технологій оброблення відходів

Ключові слова: побутові відходи, сортувальні лінії, вторинна сировина, територіальні громади

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