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## HAZARDOUS HOUSEHOLD WASTE MANAGEMENT IN VINNYTSIA REGION

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**Abstract.** The article analyzes hazardous household waste, including detergents, paints, adhesives, expired medicines, luminescent lamps, pesticides, fertilizers, batteries and accumulators, electrical and electronic waste, mercury-containing materials. Research shows that they contain a large quantity of dangerous and toxic substances (compounds of heavy metals, chlorinated polymers, aromatic hydrocarbons, surfactants, etc.), which pose a significant risk to the environment and human. The analysis of hazardous household waste management in the Vinnytsia region has showed absence of the appropriate management system. Hazardous household waste is collected separately only fragmentary and is released into environment together with other household waste, creating an environmental hazard in the region. The article also contains recommendations for the hazardous household waste management.

**Key words:** hazardous household waste, toxic substances, waste management, batteries, luminescent lamps, mercury-containing materials, detergents.

### 1. Introduction

It is known [1] that municipal solid waste (MSW) includes approximately 0,1 % of hazardous household waste. This is the waste which has been generated due to human activity in the residential and non-residential buildings, and which has physical, chemical, biological or other hazardous properties that create or could create a significant risk to the environment or human health, and which requires special methods and means of handling. Such hazardous household waste includes detergents, paints, adhesives, expired medicines, luminescent lamps, pesticides, fertilizers, batteries and accumulators, electrical and electronic equipment waste, mercury-containing materials (e.g. thermometers). Nowadays, this type of waste is collected together with other municipal or household waste. It accumulates at landfills (waste dump sites), where it poses a serious risk

to the environment and human health, because the toxic compounds it contains have free contact with the environment. At the same time, in Ukraine there is no effective mechanism for managing this type of waste. The purpose of this article is to analyze hazardous household waste in the Vinnytsia region and ways of managing them, and providing appropriate recommendations as well.

### 2. Materials and methods

According to the data [2], MSW contain about 0,25 % (by weight) batteries, which in turn create 50 % of hazardous household waste. They contain hazardous substances such as compounds of heavy metals (zinc, manganese, mercury, copper, lead, cadmium, nickel), acids and so on. The metal covering of used and taken out together with other MSW batteries is destroyed, hazardous substances get into the environment, contaminating it.

Rapid technological development of society causes a sharp increase in electrical and electronic equipment waste. This includes, in particular, used household techniques, telecommunications equipment, computer equipment and its components, office equipment, telephones, cameras, radios, lighting equipment, electrical tools, toys with electrical or electronic components, other automatic device. The authors of the research [3] have found in such kind of waste polymeric materials consisting of polystyrene (42 %), acrylonitrile-butadiene-styrene (38 %) and polypropylene (10 %). The remaining 10 % are polyethylene, polyvinyl chloride and other polymers. Polymeric ingredients of electronic waste consist of synthetic high-molecular compounds. During their manufacture a lot of binders, plasticizers and fillers are used. These binders do not react with organic basis and may be released from the composition and pollute the environment. Under certain conditions in the environment (effects of ultraviolet radiation, temperature, humidity), not only products of their own decomposition can be released from such polymer materials, but also

trace amounts of low-molecular chemicals (monomers, plasticizers, hardeners, solvents, dyes, stabilizers, destruction products, etc.) can be found there. They typically have a strong biological action. However, the main environment polluters as a part of electrical and electronic equipment waste are heavy metals (mainly lead, mercury, cadmium and hexavalent chromium) and flame retardants – polybrominated biphenyls (PBBs) and polybrominated diphenyl ethers (PBDEs).

There are also widely used paints, varnishes, adhesives, glues. Their main components are binders (polymers, rubbers, cellulose derivatives, etc.) and pigments. The latter contain oxides and salts of metals that are potentially hazardous for the environment. These are, for example, lead carbonate, zinc sulfide, zinc chromate, chromate and lead sulphate, manganese and chromium oxides. Paint and varnish products are dangerous due to evaporation of volatile solvents. In some cases products of such substances decomposition are even more dangerous. This, for example, refers to such substance as styrene [4].

Very often, particularly in the residential houses, in the total MSW volume the remains of pesticides, which are highly toxic, can appear. In many pesticides generally nonionic surfactants are used (emulsifiers, dispersants), for example, acrylic esters of polyoxyethylene, or mixtures of ionic surfactants, such as alkyl benzene sulphonate. Anionic polyelectrolytes are used as stabilizers (alkylsulphonates of Na or Ca) [4]. In addition, the base of the entire group of pesticides is dangerous sulfur- and phosphorus-containing organic compounds. The environmental risk of pesticides is connected to their persistence, i.e. the ability to exist in the environment for some time without losing biological activity. As a result of pesticides degradation, other very dangerous compounds are produced – dioxins that are strong carcinogens.

Most washing powders and detergents are made from phosphates, chlorine, anionic surfactants, oil products. Besides, household chemicals contain hydrochloride sodium (causes the cardiovascular system damage), oil distillates (negatively affect the vision and nervous system), phenol and cresol (may cause disruption of liver and kidneys), nitrobenzene, formaldehyde (strong carcinogen) [5]. Thus, releasing the traces of these substances into the environment along with other household waste also poses a risk. If there is no treatment of domestic waste water (typical situation for majority of municipalities) these substances can move free to the environment and contaminate sources of drinking water.

Medical waste periodically appears in household waste. It can consist, for example, of expired medicines, bandages, used syringes. In medical facilities such waste is subject to mandatory incineration, but in households it is a part of total MSW volume. Thus, there is a serious risk of biological pollution.

Mercury-containing waste materials are among the most dangerous MSW components. The most common ones are thermometers and luminescent lamps. If they are damaged or handled improperly, including taking out with other household waste, mercury is released to the environment. For example, one luminescent lamp contains 80 to 120 mg of mercury, which relates to substances of 1st class of hazard and together with the general toxic effect has embryotoxic, teratogenic and mutagenic effects. The danger of mercury and its vapor is increased by high rate of evaporation. The concentration of mercury vapor in the room depends on the area of evaporation, air velocity over the mercury surface, the state of its surface, temperature and other factors. It is known [6] that the rate of evaporation of metallic mercury in still air at 20 °C is 0,002 mg/(cm<sup>2</sup>·hour), and at 35–40 °C if it is exposed to the sunlight, it increases 15–18 times and can reach 0,036 mg/(cm<sup>2</sup>·h). In the case of breaking a luminescent lamp that contains 80 mg of metallic mercury, more than 11000 mercury balls with diameter of 0,01 cm and overall total surface of 3,454 cm<sup>2</sup> are formed. After one hour at 20 °C in a room with the volume of 60 m<sup>3</sup>, mercury concentration will reach 0,4 of the average daily limit value [6].

Summarized information about dangerous chemicals in the above mentioned hazardous household waste is given in the Table.

**Dangerous chemicals in hazardous household waste**

Hazardous household waste	Substances
Detergents and household chemicals	Phosphates, sulphates, chlorine, acids, amines, phenols, anionic surfactants
Varnishes, paints, adhesives, glues	Compounds of lead, zinc and chromium, volatile solvents (styrene, benzene, acetone, butyl acetate, xylene, butanol), phenol
Luminescent lamps and other mercury containing materials	mercury
Pesticides, fertilizers	Heavy metals and their compounds, chlorine compounds, dangerous sulfur- and phosphorus-containing organic compounds
Accumulators, batteries	Nickel, cadmium, lead, manganese, mercury, sulfuric acid
Electrical and electronic equipment waste	Mercury, cadmium, lead, tin, nickel, zinc and their compounds, organic compounds containing bromine

### 3. Results and discussions

#### 3.1. Analysis of ways of hazardous household waste handling in the Vinnytsia region

The situation with hazardous household waste in the Vinnytsia region remains very difficult. Companies and organizations are obliged to collect such waste separately and enter into contracts with licensed companies

for their removal or disposal. Therefore, hazardous waste management in the commercial sector is generally carried out in a proper way, except for some cases of absence of such contracts with appropriate sanctions for companies-violators. In addition, all organizations that deal with hazardous waste have to get a special permit under the Regulations on the procedure for issuing permission to operate with hazardous waste.

The situation with the hazardous household waste handling by people is much worse. According to the "Rules of providing the waste management services" hazardous household waste is transferred by consumers and by providers of waste management services in accordance with the sanitary requirements to specialized companies which have received licenses for operations with hazardous waste. Despite the existing legislation, programs and commitment not to take out hazardous household waste together with other MSW there are no mechanisms of realization of the state policy in this sphere.

Only recently in some areas (Vinnytsia, Ladyzhyn, Stryzhavka of Vinnytsia region) the collection points for the most common hazardous household waste were organized (luminescent lamps, batteries, thermometers). This initiative has been implemented by private companies and the public. Some points have information materials (see Fig.).



Collection point for hazardous household waste in Ladyzhyn

A campaign of organized collection and recycling of used batteries started in Vinnytsia in cooperation with Poland in 2013. The project involves collaboration with educational institutions (participation of most schools and universities), public organizations and shops, which

were provided special containers to collect used batteries free of charge. Transportation and processing is also provided by the project organizers. During the first two months over 1 ton of used batteries was collected. Besides this, seminars where participants were acquainted with the Polish experience and methods of effective education campaigns were held and they encouraged people to collect hazardous household waste.

Efficient and environment-friendly system of MSW management in the Vinnytsia region is only being formed. Thus, such projects are of particular importance for the development of the infrastructure of MSW management and for increasing the environmental awareness and culture of citizens.

In all other cases, hazardous household waste is taken out together with other waste, coming further to landfills (waste dump sites). Unfortunately, companies specializing in hazardous waste management in the Vinnytsia region operate only in Vinnytsia and the surrounding area. They collect following hazardous waste for further handling: luminescent lamps and other waste containing mercury; oil; lead-acid batteries; solutions of acids or alkalis; waste and scrap of electrical and electronic products; medical waste; waste of production, preparation and usage of pharmaceutical products; waste of production and usage of inks, dyes, pigments, paints, lacquers, varnishes; waste of production and usage of rubbers, latex, plasticizers, glues, binders; waste containing chemicals that do not meet specifications or which are expired; waste of mixtures oil/water, carbohydrates/water, emulsions; galvanic mud; solutions after metals etching. Even if collection points of hazardous household waste exist, there is a problem of its further transportation. Such geographical location actually makes it impossible to operate in most areas of the Vinnytsia region. In addition, specialized companies working in the Vinnytsia region do not recycle or disarm hazardous waste, but only collect it and transfer to other companies. It should be noted that capacity of companies that can recycle or disarm the hazardous household waste is very small in Ukraine.

### 3.2. Recommendations for hazardous household waste management

The most relevant recommendations in the sphere of hazardous household waste management are as follows:

- harmonization of European [7–9] and Ukrainian legislation [10] in the sphere of hazardous household waste management. The legal basis for the establishment of an effective and unified system of hazardous household waste management should be prepared.
- improvement and legislative strengthening of the list of hazardous household waste, applying to it the requirements that now exist for other dangerous (industrial) waste.

- obligation of producers of goods, which become hazardous household waste after usage, to keep records of the quantities, properties and origin of this waste and the provision of information availability to all stakeholders.
- preventing hazardous household waste from being released into the environment due to its separate collection.
- creating collection points for hazardous household waste and identifying the requirements for them.
- creating an effective system of monitoring of hazardous household waste and companies involved in handling it.
- establishing the rules of packaging and labelling of hazardous household waste in accordance with international and EU standards.
- development of guidelines for the identification of hazardous household waste, its separation and basic rules of its handling.
- establishing the coordinated activities of local and regional authorities, public and other stakeholders in the sphere of hazardous household waste management.
- creating an effective system of informing the public about safe hazardous household waste handling.
- development a stimulation system for correct hazardous household waste management.
- establishing the responsibility for violations of hazardous household waste management.

#### 4. Conclusion

The authors have identified a large quantity of hazardous and toxic substances (compounds of heavy metals, chlorinated polymers, aromatic hydrocarbons, surfactants and others) in the hazardous household waste. The situation in the sphere of hazardous household waste management in the Vinnytsia region is quite complicated. Only recently the collection points for the most common hazardous household waste (batteries and, sometimes, mercury-containing lamps) were organized in some localities. Unfortunately, one more reason why the situation does not improve is insufficient quantity and capacity of specialized compa-

nies in the sphere of hazardous waste management. Thus, even if collection points for hazardous household waste exist, there is a problem of their further transportation and processing. Nowadays, in the Vinnytsia region there are no real mechanisms to reduce the environmental impact of hazardous household waste except for some public initiatives. The main recommendations for the effective handling of hazardous household waste are preparing an appropriate legislative framework, taking into account international experience and creating the real mechanisms for environment-friendly management of this type of waste.

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