

# Collection and sorting of glass waste for recycling in the production of building materials and products

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**Abstract.** The problems of collecting and sorting glass waste at the place of their formation, extraction of waste from dumps are considered. The sorting of glass waste according to the principle of the former purpose of the product made from it is proposed. It is proposed to divide all glass waste collected or extracted from dumps into ten groups for subsequent processing in the production of a wide range of building materials and products.

## 1 Introduction

Of all the components of solid household waste, the recycling of glass waste is considered particularly advantageous [1]. Glass waste is a valuable raw material for the production of a wide range of building materials and products. Most of the glasses (with some exceptions) are completely recyclable and economically profitable, including in the form of a fight. It is known that the recycling of glass waste saves up to 21% of energy consumption in comparison with the production of new glass [2]. In addition, the collection and disposal of glass waste is a necessary condition for the ecological well-being and safety of the regions. This is not only an environmental event, but also an extremely important area for scientific research and practical use of waste in the production of materials such as ceramics, glazes, enamels, glasses, glass-crystalline substances.

Glass waste collection is usually carried out at the place of their formation, but it is possible to separate glass from mixed waste at specialized enterprises [3, 4].

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## **2 Collection and sorting of glass waste at the place of their formation**

In our opinion, this is the most rational approach to solving the problem. Glass collection can be carried out by organizations that procure recyclable materials (waste paper, rubber, textiles, wood, etc.). Special containers are installed to collect glass waste in places of their possible formation. Along with stationary, a mobile method of collecting cullet is also used, which includes a regular detour of enterprises and residents of cities and towns. A significant part of the total volume of waste is usually the fight of glass containers, which are successfully used for packaging, storage, transportation of liquid, pasty, solid products. For example, 1800-1850 million glass bottles are produced annually in Russia and up to 700 million are imported [5]. The most significant mistakes of individual enterprises producing glass containers are unjustified, both from an economic and artistic point of view, the form of glass products having convex–concave elements, branded signs, inscriptions, etc. molded on the side of the glass container, made under the guise of "design" studies, "creative" approach and individual orders. Such a glass container can be considered lost, since it practically does not return to circulation and is thrown out as unnecessary. That is, one of the main reasons for the growth of glass waste is the exclusion of a significant part of glass containers from repeated / multiple turnover. For example, in 1987, up to 95% of bottles were returned to factories through reception points, in 1995 – only 45%, in 2003 – about a third of glass containers [5]. The situation is no better with other glass products: lamp flasks, spent kinescopes, ampoules, scraps of flat glass, etc.

A very justified way of collecting any glass waste, including combat, is the installation of large containers by glass receiving enterprises. It is possible to use mobile mechanized reception points, where glass is not only collected, but also sorted by color, and if required, then crushed [6, 7]. The implementation of the glass container collection system is facilitated by such events as the organization of competitions between educational institutions, the production of wall posters, the establishment of awards for the collection of secondary raw materials, and extensive coverage of these events in the media [7].

In large cities, glass waste is collected mainly by specialized enterprises [8]. This work is carried out by organizations assigned to enterprises producing glass. The process of collecting glass waste consists in installing special containers marked with color and corresponding symbols. Waste sorting and recycling plants are usually installed directly at glass factories [7, 9]. In particular, in Germany, more than 97% of house territories are equipped with special containers for glass waste, there are also automatic machines that accept containers from the population, sort it by color and grind it [1]. Along with the container method of collecting cullet in Australia, its block-by-block harvesting has become widespread. The population participating in the collection of glass containers is notified with an advertising leaflet and letters indicating the date of collection [10, 12].

## **3 Extraction of glass waste from dumps**

The extraction of glass waste from dumps presents significant difficulties. In some cases, manual labor is used to separate glass from other secondary material resources from landfills and landfills of solid household waste. So, for an eight-hour working day, a team of 20 people manages to pull about two tons of processed raw materials [1,13]. Special automatic sorting plants are also used to separate solid household waste. Sorting lines for incoming waste are installed at landfills, where garbage gets onto a moving conveyor, and landfill workers in protective equipment (gloves and respirators) sort it out. Naturally, the use of manual labor when extracting cullet from dumps and the flow of solid household waste is extremely

undesirable and, in some cases, dangerous for workers. It should be noted that the share of glass in the composition of solid household waste is 3% [6, 14].

## 4 Sorting of glass waste

Sorting of glass waste is most effective according to the principle of the former purpose of the product made from it. All glass waste collected or extracted from dumps (taking into account the chemical composition) for their subsequent rational use in the production of building materials and products, we propose [1, 11] to be divided into ten groups:

- Group I – construction sheet glass (boat, non-boat), polished float method, profile alkaline;
- Group II – alkali-free profile glass, glass pipes, foam glass;
- Group III – varietal ordinary, artistic, colored leaf, patterned, marblite, lighting;
- Group IV – crystal, crowns, flints;
- Group V – tarnish (by type: white, semi-white, green, amber);
- Group VI – electrical, thermometric;
- Group VII – electric vacuum;
- Group VIII – chemical and laboratory;
- Group IX – medical (by type: colorless and orange);
- X group – quartz (by type: opaque, technical transparent, optical transparent, pyrex, quartzoid, water-proof).

Glass waste, as a secondary raw material, can form the basis for the production of many useful and necessary products. So, glass waste can be used in production:

- ceramics – I, II, V, X groups;
- glazes and enamels – I, III, IV, V, VII X groups;
- glasses – all groups;
- foam glass – groups I, V, IX;
- glass silica – I, III, IV, V, IX groups;
- glass-ceramic - I, III, IV, V, IX, X groups;
- sitallov – VI, X groups;
- concrete (as a filler) – I, II, V-X groups.

## 5 Recycling of glass waste into ready-to-use material.

Recycling of glass and its recycling is a very important direction in the entire industry of working with industrial waste and human activity.

It is necessary to protect the nature around us, to save non-renewable natural chemical elements and resources.

The processing process includes the following steps:

- The first stage is the primary washing and sorting by class at the processing plant. Sorting is the most time-consuming work, since it is performed manually on a moving conveyor.
- The second stage is grinding in crushing units and sieving with sorting by fractions.
- The third stage is the melting of the prepared raw materials in special melting furnaces, where at high temperature the waste turns into a homogeneous glass mass of a certain color. From this mass, new glass products are formed [1,6].

## 6 Conclusion

Collection and disposal of glass waste is a necessary condition for the ecological well-being and safety of the regions. This is not only an environmental event, but also an extremely important area for scientific research and practical use of waste in the production of materials such as ceramics, glazes, enamels, glasses, glass-crystalline substances.

When analyzing various methods of collecting glass waste, it can be argued that the collection and sorting of glass waste at the place of their formation is the most rational of the existing methods of collecting glass waste. At the same time, it is better to sort glass waste according to the principle of the former purpose. To do this, we have developed a classification of glass waste, including ten groups, which will allow their rational use in the production of building materials and products. This procedure will help to improve their quality and reduce the cost in the future.

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