INVENTORY OF MUNICIPAL SOLID WASTE AND INDUSTRIAL WASTE AND ITS DISPOSAL

Keldiyarova Gulmira Farxadovna [1]

A B S T R A C T

This article examines the assessment of the impact of industrial enterprises on the environment, the municipal solid waste generated in production processes, and their inventory, recuperation, and use of waste as a secondary product. In addition, the cement production process and issues of its disposal are considered. During the operation of a cement plant, household waste is generated. The process examines the environmental status of the cement production enterprise and measures for the formation and elimination of waste. The main purpose of the enterprise is the organization of cement production by dry method. During the research, qualitative and quantitative standards of expected impacts on atmospheric air were determined, sources and volumes of waste generation, their toxicity class were determined, waste generation standards and proposals for their further disposal and disposal were developed, and the impact of installed equipment on surface and groundwater was assessed. Draft standards for maximum permissible emissions (MPI) and production waste generation have been developed based on an inventory of their sources.

1. INTRODUCTION

In order to ensure the implementation of the Resolution of the President of the Republic of Uzbekistan dated April 17, 2019, "On measures to further improve the efficiency of work in the field of waste management" [relating to] the Legislative Chamber of the Oliy Majlis of the Republic of Uzbekistan, regional, district and city Councils of People's Deputies for the period 2019-2028," specialists from the Scientific Research Institute of Environmental Protection Technologies of the Ministry of Natural Resources are conducting scientific research aimed at increasing the ecological culture of the population in sorting solid production waste within the districts of Olmazor and Yashnobod in our capital city, in the city of Chirchik in the Tashkent region. It should be noted that sorting domestic waste is the first step in cleaning our planet from waste (Rakhmatullayev et al., 2020; Tursunov et al., 2024).

The volume of obsolete products has increased 246 times in the last 20 years. If waste is evenly distributed over the globe, it will form a solid layer 2 cm thick. At present, it is important to implement a continuous, progressive system of environmental education (Carpenter, 2023). Future highly educated specialists should not only study today's environmental problems. They need to be able to foresee the consequences of existing environmental problems and organize their activities accordingly. The industrial and transport complex is currently having an increasing impact on ecosystems. Automobile transport uses 60% of the economy's energy reserves and, at the same time, 60-80% of environmental pollution is attributed to automobile transport (Gómez et al., 2015; Uzakova et al., 2016). In densely populated and

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[1] Corresponding author: Keldiyarova Gulmira Farxadovna
  Email: guli_d@inbox.ru

industrialized areas, air pollution, the impact of harmful substances released from enterprises on public health and the plant world, improper organization of production, and other factors are constantly increasing the pollution of the atmosphere, soil, and water bodies (Narmyrzaeva et al., 2024). The integration of environmental knowledge enables future specialists to foresee the impact of their production activities on the biosphere, and to develop engineering measures to preserve and ensure the rational use of natural resources and a favorable environment. Although the progress of science and technology can do great things to save the biosphere, scientists and statesmen are constantly "sounding the alarm" about the threat to the lives of all living beings (Keldiyarova et al., 2024).

While Mother Nature, with all her beauty and freshness, invites us all to be amazed and urges us to be vigilant, the pollution of the environment across countries and continents, the destruction of living beings, and the processes of soil erosion and desertification unfortunately continue. Examples of such ecological disasters include the Chernobyl tragedy of the last quarter of the past century, the drying up of the Aral Sea, nuclear tests at Baikonur, and others. In addition, the contamination of water bodies, air, and soil with toxic substances due to human pressure, the decline of rare species of flora and fauna, pose a great threat to human life, as well as cause the widespread occurrence of extremely serious diseases (Groll et al., 2015; Zhan et al., 2022).

As a result, "a certain region, country, and all of humanity are exposed to a very great ecological danger. This transcends national and regional boundaries and becomes a universal problem. Considering that ecological disasters know no borders, it is necessary to focus the attention of the world community on regional ecological problems (Smith, 1995; Song et al., 2023). Waste refers to raw materials, materials, semi-finished products, other product residues, or items generated during the production and consumption process, as well as products (goods) that have lost their marketability. Consumption waste refers to materials and products that have lost their consumer properties as a result of moral and physical obsolescence. Production waste refers to raw materials, materials, semi-finished products generated in the production of product, energy, performance of work (provision of services), as well as unused residues generated during the production process, agricultural waste, by-products, unusable substances generated when extracting minerals, which have completely or partially lost their consumer properties (Vambol et al., 2024).

This term "waste-free technology" has become widespread both in our country and abroad. However, sometimes the terms "clean" or "somewhat cleaner technology" are also used instead of the term "low-waste and waste-free technologies." Because the term "waste-free technology" is conditional. Agriculture and nature are one. Therefore, it would not be an exaggeration to say that we cannot imagine them separately. However, in recent years, due to the increase in the volume and rate of

use of natural resources, the impact of humans on nature has been increasing. This, in turn, leads to a number of problems. In particular, as in the whole world, the implementation of work related to solid waste management is a pressing issue in Uzbekistan. The growth in the number of retail networks (supermarkets, hypermarkets, etc.) coincides with an increase in product production per capita, which in any case also includes agricultural products. Urbanization also contributes to waste generation, with urban residents generating more waste than rural residents. The processing of solid waste remains an unresolved problem in the places of its generation. Every day, a large amount of unnecessary materials (items) is generated. These mixtures contain valuable components such as metals, paper, glass, and plastics.

2. METHODOLOGY

To implement waste-free technologies in a production enterprise, the following five basic principles must be followed:

1. **Systematicity**, i.e., ensuring the interconnectedness and interdependence of natural, social, and production processes.
2. **Comprehensive use of raw materials and energy resources**, i.e., creating the possibility of using the waste of one enterprise in other enterprises on the scale of a regional production complex.
3. **Cyclicity of material flows**, i.e., creating closed water and gas circulation systems and limiting the impact of production on the natural environment. This greatly helps to protect fresh water, clean air, and the flora and fauna.
4. **Limiting the impact of production on the natural environment**, i.e., ensuring that the impact on the natural environment does not affect its quality indicators, or that even if the quality indicators of the natural environment change, they do not exceed permissible limits.
5. **Effectiveness of organizing waste-free production**, i.e., taking into account energy, technological, economic, social, and ecological factors, comprehensively using natural resources, ensuring the growth of production volumes, and preventing economic damage.

When starting to determine the standards for waste generated for a specific production, it is necessary to identify the sources of waste generation, determine the nomenclature of the generated waste, and give a brief recommendation on the production technology and technological equipment where the normalized waste is generated during the work process.At each section transition point, information conforming to the production process is provided in the form of a data sheet or block diagram. Each block diagram includes: the production operation; the source of materials and raw materials; a general description of their types; the product

obtained in this section and the waste generated. In addition, it is necessary to describe the system for accounting for raw materials, products, and waste used, and to provide information on the accounting of materials, as well as a list of standards and comparative indicators officially established for the specific enterprise that relate to the consumption of raw materials and the disposal of waste. The next stage is the analysis of the stated information and collected materials, from which the following conclusions are drawn:

- Raw material and material consumption standards for the production of a unit of product are normalized and can serve as a basis for determining waste generation standards;
- The amount of waste from the main primary raw material in percentages or other units of measurement recognized as an official standard is now essentially the waste generation standard;
- The branch-specific comparative indicators of waste can not be used as normalized quantities to determine the waste generation standards. It is possible to use the comparative indicators of enterprises based on the calculation of branch indicators as such quantities;
- There are technological processes for which it is not appropriate to determine waste generation standards due to the instability of their indicators.

In such cases, the normative value of indicators (relative amount of waste, etc.) is accepted, which is determined by accounting for the balance or by expert means. According to the results of the analysis, the possibility of determining the standards for waste generated in a specific production technological process is assessed and a decision is made on the work plan regarding the determination of the waste generation standards.

3. ANALYSIS

The object of the study is the organization of cement production plant by "Jomboy Yashil Chiroqlari" LLC on the territory of Farhad settlement of Samarkand city of Samarkand region. During implementation of the draft environmental impact statement (EIS) developed for "Jomboy Yashil Chiroqlari" LLC in the territory of

Farhad settlement of Samarkand city of Samarkand region, information from the draft EIA developed for this enterprise in 2021 was used. According to the draft EIA it was planned to organize a cement production plant. The technology envisages the scheme of cement production by dry method, which provides for crushing of raw materials with subsequent drying and joint grinding in ball mills. The technology proposed by the project will allow to provide production of high-quality cement, technical parameters of which meet modern requirements of consumers.

New modern high-tech equipment has been purchased from abroad to organize production within the framework of this project. Clinker kiln, cement mill and packing area will be located at the existing site.

Raw materials are purchased locally from licensed suppliers according to the concluded contracts.

The purpose of the final stage of the environmental impact assessment is to establish environmental standards for "Jomboy Yashil Chiroqlari" LLC on the territory of Farhad settlement of Samarkand city, Samarkand region.

The main purpose of the enterprise is organization of cement production by dry method. At performance of researches qualitative and quantitative norms of expected influences on atmospheric air are defined, sources and volumes of formation of wastes, class of their toxicity are defined, norms of formation of wastes and offers on their further placement and utilization are developed, an estimation of influence of the established equipment on surface and ground waters is carried out.

Draft standards for maximum permissible emissions (MPE) and production waste generation were developed on the basis of an inventory of sources of their generation. According to the inventory of emission sources:

37 emission sources were identified at the facility. 18 emission sources - organized and 19 - unorganized.

There are 5 waste storage sites identified at the enterprise, 4 of them closed and 1 open.

The total amount of waste generated at the enterprise is 67984, 62169 tons/year, and 67862,595 tons/year are reused in production.

There are 21 sources of waste generation, including:
1. MSW - 9,0 tons/year
2. Waste from territory cleaning - 66,0 tons/year. The amount of waste normalized at the enterprise is 67909, 62169 t/year , including west generation (Table 1):

Table 1. Waste-generating at the enterprise

№	Waste Name	Quantity, t/year	contribution to general waste generation %	Place of disposal
		Waste of the 2nd class		
1	Spent/Used Batteries	0,115	0,0002	Handed over to the Samarkand branch of 'Toshkentranglimetall'.
2	Spent Motor Oil or Used Motor Oil	0,25	0,0004	Sent to the 'Marokand' Oil Depot for Recycling
3	Spent Lubricating Oil from Conveyor Belt	0,45	0,0007	Handed over to the 'Marokand' Oil Depotj
4	Spent Transformer Oil or Used Transformer Oil	0,08	0,0001	Handed over to the 'Marokand' Oil Depot

5	Oil Sludge	0,5	0,0008	Handed over to the 'Marokand' Oil Depot
6	Used coolants	0,2	0,0003	Handed over to the 'Marokand' Oil Depot
	Total:	**1.595 tons/year**		
Waste of the 3rd class				
7	Отход уловленной пыли	67862,595	99,8	Reused in production
	TOTAL:	**67862,595 tons/year**		
Waste of the 4rd class				
8	Waste Conveyor Belt	3,52	0,0055	Handed over to "Ikkilamchi Resurs" (Secondary Resources)
9	Waste Special Clothing/Gloves	3,77	0,006	Disposed of at landfill
10	Waste Safety Helmets	0,00794	0,00001	Handed over to "Ikkilamchi Resurs" (Secondary Resources)
11	Waste Car Tires	0,18	0,0003	Handed over to "Ikkilamchi Resurs" (Secondary Resources)
12	Waste Lube Container	0,035	0,00005	Handed over to "Ikkilamchi Resurs" (Secondary Resources)
13	Waste LED Lamps	0,00375	0,000006	Handed over to ASP "Selta"
14	Waste Oily Rags	0,1	0,00015	Disposed of at landfill
	TOTAL:	**7,61669 tons/year**		
15	Waste Refractory Brick	36,0	0,05	Transferred for disposal/recycling
16	Waste Ferrous Metals	0,1	0,00015	OOO "Samarkandkora Metall"
17	Waste Welding Electrodes	0,015	0,0002	OOO "Samarkandkora Metall"
18	Waste Paper	0,026	0,00004	Handed over to "Ikkilamchi Resurs" (Secondary Resources)
19	Food Waste	1,674	0,002	Waste is not accumulated. Given to interested parties as animal feed
	TOTAL	**37,815 tons/year**		

The research involves the organization of a cement production plant by "Jomboy Yashil Chiroqlari" LLC in the village of Farkhad, city of Samarkand, Samarkand region.

The address of the considered site is: Samarkand region, city of Samarkand, village of Farkhad.

The total area is 75,591.4 m^2.

The considered site is bordered by:

- North - land for agricultural use;
- East - the territory of "Sogda Zarofshon Suv Qurilish" LLC;
- South - highway, then a discharge collector;
- West - the territory of "Riso Production Business" LLC.

The nearest housing is located at a distance of about 300 m in the north-eastern direction from the boundary of the site (The Center for Sanitary and Epidemiological Supervision of the Samarkand region has no objections to the placement of the production workshop in this area (№03/286 dated January 31, 2022)).

The nearest major surface watercourse - the discharge collector - has a width of 3 m, a depth of 1.2 m, and a flow velocity of 1.5 m/s.

The surrounding area of the site under consideration mainly houses industrial enterprises.

The M-39 highway passes at a distance of about 2.7 km in the south-eastern direction.

Equipment for the production of cement using the dry method is installed on the allocated area.

The main consumers of the products will be enterprises of the construction industry. The annual capacity of the cement plant will be 180.0 thousand tons.

The technology proposed by the project will ensure the production of high-quality cement, the technical parameters of which meet the modern requirements of consumers (Figure 1).

To organize production within the framework of this project, new, modern, high-tech equipment was purchased from abroad. A clinker firing kiln, a cement mill, and a packaging area will be located on the territory of the existing site.

Raw materials are purchased from local producers with the appropriate licenses, according to concluded agreements.

As part of the implementation of the cement plant project, the organization of the following production sites is envisaged:

- Raw material and additive storage warehouse;
- Crushing department;
- Grinding and preparation area for raw materials;
- Mixing area for raw materials;
- Kiln department;
- Clinker warehouse;
- Cement grinding, storage, and packaging area;
- Cooling tower;
- Repair shop;
- Fuel and lubricants (POL) warehouse;
- Administrative and household complex;
- Canteen.

Figure 1. Production technology

Cements are a large group of hydraulic binders, the main constituent of which are calcium silicates and aluminates, formed as a result of burning before sintering of the raw material mixture of proper composition. Portland cement, Portland slag cement and alumina cement are the most common. Cement is used for the preparation of concrete mixtures, mortars, asbestos-cement products.

The fineness of cement grinding is characterized by the amount of residue on the sieve with a mesh set by standards and technical conditions number. The fineness of cement grinding affects the speed of its setting and hardening. The finer the ground clinker, the higher the strength of cement.

The company intends to produce Portland cement by "dry" method.

Portland cement is a binder hardening in water and in air. It is obtained by joint fine grinding of clinker and the necessary amount of gypsum binder added to regulate setting time.

Portland cement production can be divided into two sets of operations. The first involves the production of clinker, and the second involves the production of Portland cement by grinding clinker together with gypsum, active mineral and other additives.

Raw materials delivered to the enterprise are unloaded from dump trucks to the warehouse under a canopy into specially designated unloading concrete storage pits, from which inorganic dust is emitted into the atmosphere. Dosage of raw materials from bunkers-dozers is carried out by compressed air from the receiver with the help of special devices - controlled feeders with grate gate, located at the bottom of the hoppers. Sprinkling from all feeders of bunkers-dozers is made on one closed belt conveyor feeding pre-dosed mixture for primary crushing

in a jaw crusher, and then - in a single-rotor hammer crusher on a closed conveyor - for secondary crushing. When loading raw materials on the conveyor, when dumping raw materials into crushers and when crushing raw materials in crushers, inorganic dust is emitted.

Raw material is loaded into the raw material grinding mill. The crushed mixture after grinding from the mill goes to the separator, where the separation into fractions up to 0.08 mm and more than 0.08 mm. The fine fraction goes to the silos of averaging raw materials (raw material storage), and the coarse fraction by the belt conveyor of the mill is fed back to the additional grinding.

In order to reduce dust emissions into the atmosphere, the air contaminated with inorganic dust after separation of the ground raw material is fed to the bag filter for purification (purification efficiency 99.7%), and then it is emitted into the atmosphere by means of a blowing fan.

The mill is cooled by water from a single circulation system. Water cools the following parts of the dry grinding mill: main bearing, sliding shoe bearing, mill gear oil station, main bearing lubrication station, sliding shoe lubrication station, low-viscosity oil station.

After grinding in the mill, the crushed raw material is firstly conveyed by air chute to the raw material averaging area - in three silos-dozers 20 m high, 10 m in diameter, with a loading of 3000 tons each with a storage period of 3 days.

The averaging section is designed for averaging the composition of the milled raw material mixture from the raw material grinding section before feeding it for firing. The system of raw mix feeding into averaging bunkers is equipped with a bag filter with cleaning efficiency of 99,7 %, after which the raw dust is discharged into the atmosphere.

The averaged milled raw materials from the dosing silos are fed to the rotary kiln. The raw materials are fired in a special rotary kiln designed for the production of clinker in cement plants. The temperature in the clinker kiln reaches 1700 0C, so its inner surface is covered with lined material - refractory bricks.

While the material loaded from above is being lowered through the kiln, it is dried, heated and sintered into clinker. Cleaning of flue gases from inorganic dust is carried out in an electrostatic precipitator (cleaning efficiency 99.9%). The captured dust from the filter will be fed to the raw material averaging hopper. The dust-free exhaust gases from natural gas combustion will be discharged into the atmosphere by means of a 55-meter high chimney.

The fired clinker is cooled and discharged from the kiln by a rotating grate at the bottom of the kiln through a triple air duct device. Air is supplied from the bottom of the kiln to ensure combustion (firing) and also serves to cool the clinker. The cooled clinker is conveyed via an air chute to the clinker storage silos. The clinker feeding system to the storage silos is equipped with a bag filter with a cleaning efficiency of 99.7 %. From the storage silos, the clinker and the captured clinker dust are fed to the cement mill for test grinding. During clinker grinding,

the released clinker dust passes through a bag filter (cleaning efficiency 99.7%).

Cement from the mill is conveyed to the cement storage silos via an aerial chute; the exhaust air from cement loading into the silos is also purified in bag filters with a purification efficiency of 99.7%

Cement packaging will be performed by a packaging machine with an automatic manipulator for bagging, which is equipped with a bag filter.

Cement is fed to the packing machine from cement silos by pneumatic conveying through cyclones - unloaders and screening augers into hoppers. Cement from the hoppers is fed to the packing machine by screw feeders. Packing bags by flat belt conveyors of 800 mm width are fed to stationary belt conveyors for loading of bags on motor transport. A storage area is constructed to stock the packed cement. For realization of cement by motor transport automobile scales with load-carrying capacity of 60 tons are provided.

Consumption of basic raw materials according to the data of "Jomboy Yashil Chiroqlari" Ltd. at productivity of 180 000 tons per year makes 209535 tons, from them ready raw mix - 181456 tons (limestone 127020 tons, loess 29335 tons, iron ore - 25 101 tons), gypsum - 7123 tons, glees - 20956 tons per year.

Wastes of the enterprise are divided into domestic and industrial.

There are no motor transport units on the balance sheet of the enterprise.

I. Industrial waste

1. Waste of captured dust (class 3). It is formed in the process of filter cleaning.
2. Refractory brick waste (5th class).
3. Conveyor belt waste (class 4). Conveyor belt waste is generated in the process of replacing worn-out belts on conveyors installed at the plant.

II. By-product waste

4. Waste of overalls and cloth gloves (class 4) is generated in the process of wear and tear by employees.
5. Waste of safety helmets (class 4) is generated in the process of wear and tear by employees.
6. Waste of used tires (class 4). Generated in the process of tire replacement.
7. Waste of used batteries (class 2). It is generated in the process of wear and tear of motor vehicle batteries.
8. Waste of used motor oil (class 2). It is generated in the process of oil change in vehicles.
9. Waste used lubricating oil (class 2). Generated in the process of used lubricating oil.
10. Waste transformer oil (class 2). It is generated in the process of oil change in transformer oil.
11. Waste oil sludge (class 2). It is formed in the process of tank cleaning in diesel fuel tanks
12. Waste oil sludge (class 2). It is generated in the process of treatment.
13. Lubricant container waste (class 4). It is formed in the process of rasterization of lubricants used for lubrication of molds for pouring aerated concrete.
14. Waste ferrous metal (class 5). Waste ferrous metal is formed from worn-out parts and equipment that cannot be repaired and restored.
15. Welding electrode waste (class 5). It is generated in the process of welding machine operation.
16. LED lamp waste (class 4). Generated in the process of lamp replacement.
17. Wiping Rags (Class 4). Waste rags are generated in the process of wiping industrial equipment, with 30% of the rags lost due to wear and tear.
18. Waste Paper (Class 5) is generated in the process of using paper for printing manuals and documents. It is used as writing paper for copying documents and for many other purposes.
19. Food Waste (Class 5). Food waste is generated as a result of the operation of the canteen.
20. Municipal Solid Waste (Class 4). Generated during the daily activities of the enterprise's personnel.
21. Sweepings (Class 4). Generated as a result of cleaning the territory

Calculation of waste generation

Production shops: Production activities generate waste in the form of:

Captured dust waste (class 3).

This type of waste is generated in PGOU systems, by capturing dust (dust of raw materials, clinker dust, cement dust) during cement production. According to the estimated data for a year at the enterprise will be collected about 67862,595 tons of dust of raw materials, clinker dust, cement dust.

The waste will be returned to production.

Refractory brick waste (class 5).

Refractory bricks are used in the lining of the high-temperature zone of the kiln. The total amount of refractory bricks used is about 25000 pcs. One brick weighs 4.8 kg, i.e. 120 tons. The waste is generated as a result of repair works (once a year) and replacement of destroyed bricks. The amount of waste generation is 30%. Thus the waste will amount to 36 t/year.

Refractory brick waste will be delivered to specialized enterprises for further processing.

Conveyor belt waste (class 4).

According to the customer's data, 100 meters are changed per year. The width of the conveyor belt is 2 meters. The conveyor belt is of TK-300 type. Its weight per 1 m2 is 17.6 kg.

The belt waste is: 100*2*17,6/1000 = 3,52 т.

The waste is collected in a special container and transferred to "Secondary Resource" for utilization.

Waste of auxiliary production Waste of special clothing (class 4).

The average weight of special clothing per 1 worker is 27.55 kg per year. Special clothing is issued to 137

workers. Then: 137*27,55= 3 774,35 kg/year or 3,77 tons/year.

Waste is collected in special containers and as it accumulates is taken to the garbage dump.

Waste of safety helmets (class 4)

According to the data of the enterprise 20 helmets are written off per year. The weight of one helmet is 397 g. Then: 397*20/1000= 7.94 kg/year or 0.00794 t/year

Waste is collected in a special container and delivered to "Secondary Resource".

Waste of used car tires (class 4)

Approximately 4 pieces of used car tires will be generated per year.

Weight of truck tires 45 kg*4=180,0 kg or 0,18 t/year

Waste is collected manually. It is placed on a special concreted platform in the warehouse. As it accumulates, it is delivered to "Secondary Resource". Motor farm The

total number of motor vehicles on the balance sheet of the enterprise is 2 pcs.

As a result of the operation of the auto farm waste is generated in the form of:

- waste accumulators;
- waste oils;
- waste tires;

According to literature sources, the normative service life of an accumulator is 2 years. Batteries are installed on 11 units of motor vehicles. The norm of formation of used batteries will amount to - 5 pcs.

Data on weight characteristic by battery brands is presented in Table 2.

Information on Battery Composition is presented in table 3.

Table. 2. Data on weight characteristic by battery brands.

No.	Battery Model	Quantity (pieces)	Weight per Battery (with lead, kg)	Total Battery Weight (tons)
1	6 CT-60	0	19,5	0
2	6 CT-90	1	27,12	0,02712
3	6 CT-190	4	50,7	0,2028
	Итого:	5		0,22992

Table 3. Information on Battery Composition.

No. (п/п)	Battery Model	Quantity (Units).	Weight of Lead Plates per Battery (kg)	Total Weight of Lead Plates (kg)	Weight of Plastic Casing per Battery (kg)	Total Weight of Plastic Casings (kg)	Weight of Electrolyte per Battery (kg)	Total Weight of Electrolyte (kg)aha
1	6 CT-60	0	11,5		4,2		3,8	
2	6 CT-90	1	16,3	16,3	5,82	5,82	5,82	5,82
3	6 CT-190	4	37,2	148,8	7,0	28,0	6,5	26,0
	Total::	5		165,1		33,82		31,82

Generation Rate of Spent Lead-Acid Batteries (Class 2)

The generation rate of spent lead-acid batteries (Class 2) is: 0.22992 : 2 = 0.115 tons/year.

The waste is collected in a special container and handed over to the Samarkand branch of "Tashkent non-ferrous metal" LLC.

Spent Motor Oil Waste (Class 2)

It is estimated that approximately 250 kg of spent motor oil waste will be generated per year. The generation rate of spent motor oil is 0.25 tons/year.

Spent oils are collected in a separate 200 L container. Petroleum waste is transferred for recycling to the "Marokand" oil depot.

Spent Lubricating Oil Waste (Class 2)

It is estimated that approximately 450 kg of spent lubricating oil waste will be generated per year. The generation rate of spent lubricating oil is 0.45 tons/year

Spent oils are collected in a separate 200 L container. Petroleum waste is transferred for recycling to the "Marokand" oil depot.

Spent Transformer Oil Waste (Class 2)

It is estimated that approximately 80 kg of spent transformer oil waste will be generated per year. The generation rate of spent transformer oil is 0.08 tons/year.

Spent oils are collected in a separate 200 L container. Petroleum waste is transferred for recycling to the "Marokand" oil depot.

Oil Sludge Waste (Class 2)

According to the "Collection of Specific Indicators of Waste Generation from Production and Consumption", Moscow, 1999, the rate of oil sludge generation is 10 kg per 1 ton of petroleum products. Therefore: 0.01 * 50 = 0.5 tons/year.

The waste is collected in special barrels and transferred for processing.

Working Fluid Waste (Class 2)

It is estimated that approximately 200 kg of working fluid waste will be generated per year. The generation rate is 0.2 tons/year.

The working fluid is collected in a separate 200 L container. Petroleum waste is transferred for recycling to the "Marokand" oil depot.

Waste Packaging from Lubricating Materials (Class 4)

The weight of the empty container is 7 kg. About 5 pieces are generated per year.

Motx = 5 pieces * 7 kg = 35.0 kg or 0.035 tons/year.

The waste is collected in a special container and transferred for disposal to "Secondary resource".

Ferrous Metal Scrap (Class 5)
According to the "Collection of Specific Indicators of Waste Generation from Production and Consumption", 0.1 tons/year of ferrous metal scrap is generated per year.

Welding Electrode Waste (Class 5)
The enterprise uses 150 kg of welding electrodes per year. Electrode residues account for up to 10% of the total mass of electrodes used. The rate of formation of ferrous metal scrap in the form of welding electrode residues will be: $150 * 0.1 = 15.0$ kg/year $= 0.015$ tons/year.
The waste is collected in special containers and sent for disposal to "Samarkand non-ferrous metal" LLC.

Waste Spent LED Lamps (Class 4)
Lighting for production and domestic premises is provided by LED lamps LED lamp Ba15S 10-30v - 200 units. The calculation of the normative formation of spent lamps at the enterprise was carried out based on the nominally embedded operating capabilities of the lamps. The lamp life is 30,000 hours. The average lamp operating time per year is 7440 hours. The standard for the formation of spent fluorescent lamps per year is: $7440/30000 = 0.248$
Then the annual number of spent lamps at the enterprise will be: LED lamp Ba15S 10-30v - 200 x 0.248 = 50 units
The weight of one LED lamp Ba15S 10-30v is 0.075 kg, then: $M = 50$ x $0.075 = 3.75$ kg $= 0.00375$ tons/year
Spent lamps are collected in a special container and transferred for deimmunization to ASP "Selta".

Waste Wiping Rags (Class 4)
According to the "Collection of Specific Indicators of Waste Generation from Production and Consumption," the waste of rags for cleaning premises is 100 kg/year.
The waste will be: 0.1 tons/year.
The waste is collected in special containers and taken to the waste disposal site as it accumulates.

Waste Paper (Class 5)
Paper will be used in printing manuals, documents, as writing paper, for copying documents, and for many other purposes. The usage rate of writing paper is 87%. Therefore, when using 200 kg of paper materials per year, waste is generated:
$M_{otx} = 200 * 0.13 = 26.0$ kg or 0.026 tons/year.
The generated waste is given to waste paper collection points.

Food Waste (Class 5)
The average daily formation of waste from the canteen per dish is - 0.01 kg.
The number of visitors to the canteen is - 180 people. 3 dishes are prepared per person per day. Then: $0.01 * 180 * 3 * 310 = 1674.0$ kg/year or 1.674 tons/year.
The waste is collected in special containers and immediately sold to the population as feed for livestock.

MSW (Class 4)
Generated during the daily activities of the enterprise's personnel.
The rate of formation of household waste is derived based on SanPiNRUz №0068-96. According to the above resolution, the estimated rate of formation of solid household waste per employee is 50 kg per year. According to the staff schedule at the time of the inventory, 180 people work at the enterprise. The rate of formation of household waste is $50 * 180 / 1000 = 9.0$ tons/year.

Sweepings (Class 4)
The annual rate of formation of waste from cleaning the territory with asphalt pavement is 6 kg per 1 m². The area to be cleaned is 500.0 m². Waste generated: $500.0 * 6 * 10^{-3} = 3.0$ tons/year
The rate of formation of waste from cleaning the territory with soil cover is 14 kg per 1 m². The area to be cleaned is 4500.0 m².
Waste generated: $4500.0 * 14 * 10^{-3} = 63.0$ tons/year.
The total rate of formation of household waste is $3.0 + 63.0 = 66.0$ tons/year.
The waste is collected in a container in a specially designated area on the territory and taken to the landfill.

4. RESULTS

Proposals for Waste Generation and Placement Standards
The enterprise does not have special areas and landfills for the accumulation and disposal of generated waste.

Trapped Dust Waste (Class 3).
This type of waste is generated in PGOU systems by trapping dust (dust of raw materials, clinker dust, cement dust) during the production of cement. According to estimated data, approximately 67862.595 tons of dust from raw materials, clinker, and cement will be trapped per year at the enterprise.
The waste generation rate is:
$67862.595/180000 = 0.377$ tons/ton of product

Waste Refractory Brick (Class 5). Refractory brick is used in the linings of the high-temperature zone of the firing kiln. The total amount of refractory brick used is approximately 25000 pieces. One brick weighs 4.8 kg, i.e., 120 tons. The waste is generated as a result of repair work (once a year) and replacement of damaged bricks. The amount of waste generation is 30%. Thus, the waste will be 36 tons/year.
The waste generation rate is:
$36.0/180000 = 0.0002$ tons/ton of product

Waste Conveyor Belt (Class 4)
According to customer data, 100 meters are changed per year. The width of the conveyor belt is 2 m. The conveyor belt is of type TK-300. Its weight per 1 m² is 17.6 kg.
The belt waste is: $100 * 2 * 17.6 / 1000 = 3.52$ tons.
The waste generation rate is:
$3.52/180000 = 0.00002$ tons/ton of product

Auxiliary Production Waste

Waste Special Clothing (Class 4)
The average weight of special clothing per 1 worker is on average 27.55 kg per year. Special clothing is issued to 137 workers. Then: $137 * 27.55 = 3774.35$ kg/year or 3.77 tons/year.
The waste generation rate is:
$3.77/180 = 0.021$ tons/person

Waste Protective Helmets (Class 4)
According to enterprise data, 20 helmets are written off per year. The weight of one helmet is 397 grams. Therefore: 397 * 20 / 1000 = 7.94 kg/year or 0.00794 tons/year.
The waste generation rate is:
0.00794/180 = 0.000044 tons/person

Waste Used Tires (Class 4)
It is estimated that approximately 4 units of waste used tires will be generated per year.
The weight of truck tires is 45 kg * 4 = 180.0 kg or 0.18 tons/year
The waste generation rate is:
0.18/213.0 = 0.000845 tons/thousand km mileage

Motor Transport Department
The total number of vehicles on the enterprise's balance sheet is 2 units.
As a result of the operation of the motor transport department, waste is generated in the form of:
- Spent batteries;
- Spent oils;
- Spent tires.

According to literature sources, the normative service life of a battery is 2 years. Batteries are installed on 11 units of vehicles. The rate of formation of spent batteries will be - 5 units.

Waste Generation Data and Standards
Spent Lead-Acid Batteries (Class 2)
Waste Generation Rate: 0.22992 / 2 = 0.115 tons/year.
Waste Generation Standard:
0.115 / 213.0 = 0.00054 tons/thousand km of mileage

Spent Motor Oil (Class 2)
Estimated Annual Generation: 250 kg.
Waste Generation Rate: 0.25 tons/year.
Waste Generation Standard:
0.25 / 213.0 = 0.00117 tons/thousand km of mileage

Spent Lubricating Oil (Class 2)
Estimated Annual Generation: 450 kg.
Waste Generation Rate: 0.45 tons/year.
Waste Generation Standard:
0.45 / 180000 = 0.0000025 tons/ton of product

Spent Transformer Oil (Class 2)
Estimated Annual Generation: 80 kg.
Waste Generation Rate: 0.08 tons/year.
Waste Generation Standard:
0.08 / 180000 = 0.0000004 tons/ton of product

Oil Sludge (Class 2)
According to the "Collection of Specific Indicators of Waste Generation from Production and Consumption," Moscow, 1999, the oil sludge generation rate is 10 kg per 1 ton of petroleum products. Therefore: 0.01 * 50 = 0.5 tons/year.
Waste Generation Standard:
0.5 / 180000 = 0.0000028 tons/ton of product

Used Oil Emulsion (Class 2)
Estimated Annual Generation: 200 kg.
Waste Generation Rate: 0.2 tons/year.
Waste Generation Standard:
0.2 / 180000 = 0.000001 tons/ton of product

Waste Packaging from Lubricants (Class 4)
The weight of empty packaging is 7 kg. Approximately 5 units are generated per year.
Moth = 5 units * 7 kg = 35.0 kg or 0.035 tons/year.
Waste Generation Standard:
0.035 / 180000 = 0.00000019 tons/ton of product

Ferrous Metal Scrap (Class 5)
According to the "Collection of Specific Indicators of Waste Generation from Production and Consumption," 0.1 tons/year of ferrous metal scrap is generated.
Waste Generation Standard:
0.1 / 180000 = 0.00000055 tons/ton of product

Waste Welding Electrodes (Class 5)
150 kg of welding electrodes are consumed annually at the enterprise. Up to 10% of the total mass of consumed electrodes becomes waste. The generation of ferrous metal scrap in the form of welding electrode residue will be: 150 * 0.1 = 15.0 kg/year = 0.015 tons/year
Waste Generation Standard:
0.015 / 180000 = 0.00000008 tons/ton of product

Waste Generation Data and Standards (Continued)
Waste Spent LED Lamps (Class 4)
Lighting: Production and domestic premises are lit with LED lamps (LED lamp Ba15S 10-30v - 200 units).
Calculations: Waste generation is calculated based on the rated lifespan of the lamps.
Lamp Lifespan: 30,000 hours.
Average Annual Operating Time: 7,440 hours.
Annual Replacement Rate: 7440/30000 = 0.248
Number of Lamps Replaced Annually: 200 * 0.248 = 49.6 lamps (approx. 50 lamps)
Weight per Lamp: 0.075 kg.
Total Annual Waste: 50 * 0.075 = 3.75 kg = 0.00375 tons/year
Waste Generation Standard:
0.00375 / 7440 = 0.0000005 tons/hour of operation

Waste Wiping Rags (Class 4)
According to the "Collection of Specific Indicators of Waste Generation from Production and Consumption," waste rags for cleaning premises amount to 100 kg/year.
Waste Generated: 0.1 tons/year
Waste Generation Standard:
0.1 / 180 = 0.00055 tons/person

Waste Paper (Class 5)
Paper Usage: Used for manuals, documents, writing, photocopying, and other purposes.
Paper Usage Rate: 87%. Therefore, with an annual usage of 200 kg of paper materials, waste is generated: Moth = 200 * 0.13 = 26.0 kg or 0.026 tons/year
Waste Generation Standard:
0.026 / 180 = 0.00014 tons/person

Food Waste (Class 5)
Average Daily Waste per Dish: 0.01 kg.
Number of Canteen Visitors: 145 people. 3 dishes are prepared per person per day. Therefore: 0.01 * 145 * 3 * 310 = 1348.5 kg/year or 1.3485 tons/year. *Waste Generation Standard:
1,3485/180 = 0,0075 tons/person

Municipal Solid Waste (MSW) / Household Waste (Class 4)

Generated by the activities of company personnel.

Waste Generation Rate: Based on SanPiNRUz No. 0068-96. According to this regulation, the estimated rate of solid waste generation per employee is 50 kg per year. There are 145 employees at the time of the inventory. Solid waste generation amounts to $50 * 145 / 1000 = 7.25$ tons/year, the provided number had used the employee count of 180, calculating the more accurate one for this section using the number 145. *Waste Generation Standard: 0,05 tons/person for the employee number used (180). The waste generation rate has been corrected for the 145 amount of employees.

Street Sweepings (Class 4)

Annual waste generation rate for cleaning asphalted areas is 6 kg per 1 m2. The area cleaned is 500.0 m2. Waste generated: $500.0 * 6 * 10^{-3} = 3.0$ tons/year

Annual waste generation rate for cleaning soil areas is 14 kg per 1 m2. The area cleaned is 4500.0 m2.

Waste generated: $4500.0 * 14 * 10^{-3} = 63.0$ tons/year

Total annual street sweepings: $3.0 + 63.0 = 66.0$ tons/year.

Waste Generation Standard: 0.006 (if that comes from tons/m2 for Asphalt area)/ M2+ 0.014Tons\M2 (that comes from Tons \m2 from soil area) = the totals has to be calculated for each M2.

5. CONCLUSION

As a result of the research, an analysis of the production activities of this enterprise was conducted. An inventory of the generated industrial and municipal waste, its classification by toxicity, and its movement were carried out. Sixteen types of waste were identified at the enterprise.

For the temporary storage of waste on the enterprise's territory, specially designated areas are provided, equipped according to sanitary standards and in accordance with the hazard classes of the waste.

The characteristics of storage locations are presented by type of waste generated. An inventory of production and consumption waste was carried out, and limits for their placement were calculated. It was established that 21 types of waste are generated in the production activities of the enterprise, of which 19 are regulated waste types. The total amount of waste generated at the enterprise is 67984.62169 tons/year, with 67909.62169 tons/year being reused in production.

There are 21 sources of waste generation, including:

A passport has been created for each waste type, a standard and hazard class have been determined, and placement locations and disposal methods have been proposed.

The research proposes monitoring the state of atmospheric air, the quantitative and qualitative state of industrial wastewater, and a schedule for monitoring compliance with maximum permissible emission (MPE) standards.

It is necessary to establish environmental standards for maximum permissible emissions, water consumption and discharge rates, and specific indicators of waste generation. Waste, wastewater, and industrial solid waste should be recovered.

The recovery of solid household waste generated at production enterprises, including solid, liquid, and gaseous waste, should be established for the purpose of widespread use as a secondary product.

References:

Carpenter, F. (2023). *Education and Development in Central Asia: a case study on social change in Uzbekistan*. Brill.

Gómez, A., Dopazo, C., & Fueyo, N. (2015). The future of energy in Uzbekistan. *Energy*, *85*, 329-338.

Groll, M., Opp, C., Kulmatov, R., Ikramova, M., & Normatov, I. (2015). Water quality, potential conflicts and solutions—an upstream–downstream analysis of the transnational Zarafshan River (Tajikistan, Uzbekistan). *Environmental Earth Sciences*, *73*, 743-763.

Keldiyarova, G., Boboeva, G., Dadayev, M., & Rakhmanova, N. (2024). Issues of increasing the economic efficiency of manufacturing enterprises on the impact on the environment. In *E3S Web of Conferences* (Vol. 486, p. 01003). EDP Sciences.

Narmyrzaeva, N. B., Rakhimova, S. M., & Rakhmatova, S. M. (2024). Environmental problems of uzbekistan and solution to their problems. *Western European Journal of Modern Experiments and Scientific Methods*, *2*(5), 76-88.

Rakhmatullayev, F. N., Turabjanov, S. M., Ponamaryova, T. V., Rakhimova, L. S., & Abdullaev, U. S. (2020). Investigation of morphological composition and evaluation of the effectiveness of municipal solid waste recycling methods in Uzbekistan. *Technical science and innovation*, *2020*(2), 49-56.

Smith, D. R. (1995). Environmental security and shared water resources in post-Soviet Central Asia. *Post-Soviet Geography*, *36*(6), 351-370.

Song, S., Chen, X., Liu, T., Zan, C., Hu, Z., Huang, S., ... & Sun, Y. (2023). Indicator-based assessments of the coupling coordination degree and correlations of water-energy-food-ecology nexus in Uzbekistan. *Journal of environmental management*, *345*, 118674.

Tursunov, O., Karimov, I., Śpiewak, K., Hu, X., Zhou, Y., Kustov, A., ... & Uvarov, R. (2024). Comprehensive study on social, compositional and thermal aspects of household solid waste for waste-to-energy potential estimation in Tashkent city. *Energy Reports*, *12*, 430-441.

Uzakova, V., Roman, C., Aslanova, D., & Zuxra, S. (2016). Transportation system in the development of Uzbekistan. *ACADEMICIA: An International Multidisciplinary Research Journal*, *6*(1), 120-134.

Vambol, S., Markina, L., Vambol, V., Mazur, A., Ziarati, P., Martin-Cervantes, P. A., ... & Vlasenko, O. (2024). Type of industries, waste options, and their potential. In *Advances in Energy from Waste* (pp. 175-221). Woodhead Publishing.

Zhan, S., Wu, J., & Jin, M. (2022). Hydrochemical characteristics, trace element sources, and health risk assessment of surface waters in the Amu Darya Basin of Uzbekistan, arid Central Asia. *Environmental Science and Pollution Research*, *29*(4), 5269-5281.

Keldiyarova Gulmira Farxadovna
Samarkand State University,
Samarkand, Uzbekistan.
guli_d@inbox.ru
ORCID: 0000-0002-2911-4496