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Study of the Current State, Problems and Potential of the Waste Management System Affecting the Development of the Green Economy of Kazakhstan

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Abstract:

The article explores the main factors hindering the solution of environmental problems with waste in Kazakhstan, in particular with industrial waste and consumer waste. The paper assesses the main directions of the world practice of waste management and the possibility of their application in the development of the domestic system. An analysis of the management of industrial waste and consumer waste in the industrial Pavlodar region of Kazakhstan was carried out. An analysis of the presence and formation of production and consumption waste shows that the region is in the zone of influence of accumulated waste. The predominantly resource-raw material system of nature management, without taking into account natural conditions and environmental restrictions when locating industrial enterprises, led to the formation of zones and regions of increased anthropogenic impacts. The article shows that at the initial stage of development of the green growth strategy in Kazakhstan, there should be an economic policy, fixed by regulatory legal acts, especially on the issues of production and consumption waste management. Such a policy should take into account that a successful transition to green growth and minimizing the environmental impact of production and consumption wastes will require more efficient use of them as secondary resources. In turn, this will be the basis for the involvement of waste in the sphere of market relations and the attractiveness of this area for domestic and foreign investors.

Keywords: waste; recycling; management; green economy; assessment; environmental protection; sustainable development.

JEL Classification: Q56; Q57; O13; O18; R11.

Introduction

The development of industry leads to the formation of more and more waste. Only the cities of the world annually emit up to 3 billion tons of solid industrial and domestic waste and more than 500 cubic kilometers of sewage into the environment. The first place in terms of the amount of polluting organic substances is occupied by industrial waste. Kazakhstan annually generates 5-7 billion tons of production and consumption waste.

The development of an economic waste management system is aimed at improving the environmental situation, increasing the number of industrial enterprises, and increasing the efficiency of using Kazakhstan's natural and energy resources. In the United States, 122,000 industrial enterprises operate in the waste recycling

sector, creating more than 1.6 million jobs, and in Germany, the volume of the recycling market reaches 80 billion euros per year.

A study of waste management in world practice shows that market relations alone are not able to effectively regulate the processes of formation, collection, disposal and processing of industrial waste and, first of all, the processes of resource conservation. In order for the direction of waste reuse to be effective in Kazakhstan, public administration is needed to develop and correct the legislative and regulatory framework in the field of waste management.

The article presents an assessment of the state and regulation of the management processes for the disposal and processing of industrial waste in Kazakhstan based on the materials of the industrial region, on the territory of which large industrial enterprises are located. The issues of the impact of industrial waste on the green economy are investigated, the benefits of effective management of recycling and disposal are determined.

1. Literature Review

A review of the literature on the management of industrial and municipal waste and the impact of these processes on the green economy shows that many countries on all continents are paying attention to research in this area (Aguilar-Hernandez *et al.* 2018). Waste-to-energy technologies, the use of waste in production processes link these processes with sustainable development and sustainable production, developing waste management and reclamation (Haas *et al.* 2015). At present, research into the circular economy in the field of waste management and recycling, taking into account the principles of sustainable development, is receiving attention in such areas as: bypass management; life cycle management; waste treatment and recycling; greenhouse gases and their impact on the environment (Bespalyy 2021). Governments set as one of the development goals of states the expansion and use of waste management practices, waste recycling, waste reuse (Bespalyy 2021). The countries of the European Union, China and other countries are following the 12 Sustainable Development Goals of the 2030 Agenda (UN 2015; UN 2019).

The work (Ghisellini *et al.* 2016) shows that there must be an interaction between the economic and ecological systems in waste management. Zhang and authors (Zhang *et al.* 2019) in their work point to waste management by analyzing the barriers in China associated with effective waste management, such as: lack of environmental education; lack of strict control by regulatory authorities; lack of requirements for waste management and pressure from market mechanisms. In the scientific literature, authors from the countries of the European Union on waste management have shown that effective waste management measures have been taken since 2015, including monitoring of the measures taken, while there are problems, as well as directions for the development and improvement of this research topic (Geissdoerfer *et al.* 2017; European Commission 2021). In Kazakhstan, the state policy and the policy of regional authorities are also aimed at the implementation of the Sustainable Development Goals (Bespalyy 2021), and specifically related to the disposal, storage and processing of waste, but there are not many studies on these topics.

A study of the literature on waste management and the impact of these processes on the green economy identified issues that are not explored but that affect the development of the green economy, such as the involvement of entrepreneurship in the use of waste in production value chains (Besaplyy *et al.* 2021), this could affect sustainable development, the development of sectors of the national economy using alternative energy sources, including those obtained from waste processing (Bespalyy 2021). To ensure sustainable development and promote the green economy, the use of waste lifecycle management tools is necessary (Tseng *et al.* 2020). The concept of a circular economy should be one of the tools with which it is possible to implement sustainable development scenarios, given the growth of industrial and domestic waste (Wuyts *et al.* 2020). The results of this study illustrate the challenges associated with recycling, recycling and waste management, as well as the need to contribute to sustainable development, as well as to the revitalization of the green economy.

2. Methodology

The main goal of the study consists of two main stages:

- the first stage includes the study of the theory and applied practices of municipal solid waste and industrial waste management;
- the second stage includes the identification of features and factors affecting waste management in the Republic of Kazakhstan and the Pavlodar region, in which a large number of large and medium-sized industrial enterprises are concentrated, using a comparative analysis, as well as forecasting and planning methods to assess the management of waste disposal and processing in the Pavlodar region;

- at the third stage, measures for the development of a green economy and a circular economy using waste are proposed.

The article provides an analysis of international studies on empirical studies of waste management, an analysis of statistical information on the dynamics of changes in indicators and criteria for the management of household and industrial waste. Recommendations for the effective management of waste disposal and recycling in the Pavlodar region will have a significant impact on the development of territories and the green economy.

The relevance of issues related to production and consumption waste accumulated during the period of unified state activity remains, increases every year and requires an immediate solution.

A special place is occupied by large-tonnage waste, which was formed because of many years of industrial activity of enterprises in the territory of the Republic of Kazakhstan and Pavlodar region. The predominantly resource-raw material system of nature management, without considering natural conditions and environmental restrictions when locating industrial enterprises, led to the formation of zones of increased anthropogenic impacts.

Solid waste is divided into 2 different groups: industrial waste and consumer waste. By production waste is meant that which was formed as a result of the functioning of the main industrial sectors - the extraction and processing of minerals, energy, metallurgy, chemistry, mechanical engineering, the construction industry, etc. This group accounts for 90% of solid waste. The remaining 10% are consumer waste, which, according to another classification, is called municipal solid waste.

In Kazakhstan, after secession from the USSR, some enterprises of the mining and processing industries were liquidated and the entire burden of problems with dumps, and abandoned mine workings, tailings, sludge ponds, substandard residues of mineral processing was assigned to the state.

For the most part, the waste situation has not changed much in recent years. There are still negative factors that negatively affect the solution of problems in the industrial waste market. In addition, the lack of measures to address waste problems is contrary to the national policy of transition to a "green" economy and adherence to the Sustainable Development Goals, designed to ensure environmental safety through the sustainable use of resources and increasing interest in the reuse and disposal of waste.

The central aspect of the transition and movement of the Republic of Kazakhstan towards a "green" economy should be the creation of a framework for attracting environmentally friendly technologies to waste management and the replacement of obsolete technologies with modern sustainable alternatives. All this can provide cost savings, improve human health, create green jobs and at the same time have a beneficial effect on the environment.

The waste recycling process is aimed at improving the environmental situation, increasing the number of small and medium-sized industrial enterprises, creating new jobs, and improving the efficiency of using natural and energy resources. Currently, the world produces an unprecedented amount of waste in the history of all mankind. Their total annual output is 3,100 million tons (Mt). Of which 1800 Mt is non-toxic industrial waste, 1200 Mt is municipal waste (household and other) and 100 Mt is toxic waste.

In France, the annual recycling of waste, mainly household waste (28 Mt), municipal waste (14 Mt) and industrial waste (90 Mt), which together amount to 132 Mt, represents only 16% of the total waste generated (849 Mt), including waste from agricultural and construction activities (717 Mt). However, France offers a better solution for the recycling process: in France, 38.7 million tons of material is extracted from the waste stream and converted into 31.9 million tons of raw materials. This sector is represented by 2,400 companies employing 31,500 people.

Recycling of production waste is an urgent problem that stands in the way of a balanced development of the world community. The importance of this problem is evidenced by the huge, constantly growing stocks of all kinds of industrial waste. This led to the adoption in the vast majority of countries of the world of legislative and by-laws aimed at regulating and comprehensively supporting activities related to the disposal and reuse of waste.

The experience of waste processing has shown that market relations alone are not able to effectively regulate the processes of generation, collection, disposal and processing of waste and, first of all, the processes of resource conservation. Most European countries solve the issues of resource saving and waste management in a combination of state and market mechanisms for regulating work with them.

In July 2004, at the G8 summit, the Japanese government launched the "3 R Initiative" in the field of waste management: Reduce - reduction, Reuse - reuse, Recycle - use as secondary resources. The leaders of other G8 countries supported the initiative. The first priority should be to minimize the accumulation of waste within the countries themselves and their transformation into useful products.

The problem of waste reduction is closely connected with the issues of sustainable economic development due to the ever-increasing demand for raw materials, while reducing the available reserves and finite exhaustibility of natural resources. The rational use of industrial and household waste is becoming critical for providing resources for social production.

The amount of accumulated waste in Kazakhstan is about 43 billion tons, of which only 5 percent is recycled, and the annual economic damage from environmental pollution is estimated at 10% of gross domestic product. In the developed industrial countries of the world, the level of use of industrial waste reaches 70-80%.

For example, in the USA in the last century, the share of secondary raw materials in the production of non-ferrous metals was 55% for copper, 28% for tungsten, and 25% for nickel; 20% of all aluminum, 33% of iron, 50% of lead and zinc, etc. are obtained from industrial waste. In the state of Montana, from the dumps of the Mandiski mine, containing 0.84 g / t of gold and 2.8 g / t of silver, annually 2 tons of gold and 4 tons of silver are obtained, and in the state of Michigan from tailings (copper content - 0.3%) 60% of copper is extracted. In Canada, 40% copper recovery is achieved from copper ore waste containing 0.45% copper due to new enrichment methods (heap acid leaching, heap pyrite and bacterial leaching).

At the same time, the analysis shows that the main method of disposal of newly generated waste continues to be their burial in landfills owned by enterprises, or the injection of polluted effluents into underground water sources, so the volume of their accumulation does not decrease.

For Kazakhstan, a country that produces a significant share of mineral products, the problem of industrial waste disposal is of paramount importance. This is due to the fact that the current state of the resource bases of many of the most important mining regions and operating enterprises of our countries has deteriorated sharply due to the depletion of reserves, a decrease in their quality and economic characteristics, and the complication of mining conditions as a result of long-term and intensive exploitation of previously developed deposits.

At present, at many mining enterprises, especially in old, long-developed ore areas, the availability of explored reserves has reached a critically low level, and the reserve of reserves of many types of minerals in exploited deposits is insufficient. The situation is aggravated by the fact that for most types of minerals there is a significant curtailment of exploration work. This trend is indicated in the Concept for the development of the geological industry of Kazakhstan until 2030. It was noted that the stocks of non-ferrous and precious metals, which currently make up a significant share of exports, are limited and can be worked out in 12-15 years. At the same time, this document does not see a significant rate for replenishing the mineral resource base at the expense of TMT.

State policy in the field of stimulation of waste processing. In the conditions of Kazakhstan, one of the important points identified by the analysis of the results of the discussion of the problem of waste management at different levels and in different periods is the lack of consistency in the implementation of decisions. Numerous instructions and the adoption of protocol decisions basically end with a simple reply from the parties involved in the process. In the future, at the end of the execution period, the results are poorly controlled. The main reason is the still existing fragmented system of departmental waste management in Kazakhstan. Despite repeated intentions and instructions to create a unified Waste Management Center, the issue remained open.

As a result, the problems of waste management remain relevant, although many plans and programs of national companies and government bodies contain measures for their development.

It should be noted that the same situation has developed in almost all CIS countries. The analysis shows that the formation of a favorable business environment for the involvement of waste as secondary resources is possible only with the development of state regulation tools. They should include the following items:

1. Regulatory support for the consistent implementation on the territory of Kazakhstan of the principle of responsibility of the producer and / or owner and equally the supplier of certain types of goods for the collection and processing of their products after their use.

2. Development of a mechanism for economic incentives for the use of waste as secondary raw materials.

3. Formation of demand for secondary resources, as well as for products made from secondary raw materials, including by establishing restrictions and incentives that encourage the use of secondary resources instead of primary ones.

4. The use of a deposit value mechanism to stimulate the collection, processing and disposal of certain types of products after use.

5. Information support of business entities (creation of databases on the sources of formation of secondary resources; on the legal support of their collection, harvesting and processing; on advanced technologies and equipment for processing secondary resources; on enterprises engaged in the procurement and processing of secondary raw materials, and also related issues).

6. Widespread involvement of the population through the media, forums, training, advertising, with the provision of information on the impact of certain waste on their health and well-being.

7. Introduction of standardization and certification of waste, as well as certification of technologies and equipment for their processing.

In Kazakhstan, the most complete information is provided on industrial waste, the so-called man-made objects.

The analysis of the information showed that in Kazakhstan the generalization of information on technogenic mineral formations (TMF) has been carried out since the 80s of the last centuries. The first inventories "Cadastre of resources and prospects for the integrated use of non-ferrous metallurgy waste in Kazakhstan" and "Cadastre of resources and prospects for the integrated use of ores and waste of ferrous metallurgy" were compiled by the Council for the Study of Production Forces under the Academy of Sciences of the Kazakh SSR in 1986 and 1989, respectively. Since 1992, in the Republic of Kazakhstan, Passports of the form “0” for technogenic mineral formations were introduced, which in 2002 were revised with the introduction of environmental parameters: indicators of climatic conditions for storage and storage inherent in the region of accumulation of technogenic mineral formations, and qualitative and quantitative characteristics, and also background indicators of the most toxic components.

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According to the Committee of Geology and Subsoil Use of the Ministry of Ecology, Geology and Natural Resources of the Republic of Kazakhstan, the cadastre includes information on 906 objects (dumps, tailings and storage facilities of mining enterprises in Kazakhstan) with a volume of 611 km2 of solid waste stored on an area of 36.2 billion tons.

It has been established that the largest volume of HMT (more than 5.0 billion tons) has been accumulated in areas with developed mining, processing and metallurgical industries (Karaganda, Pavlodar, East Kazakhstan regions). The smallest amount of HMT has been accumulated in the Kyzylorda and Mangystau regions (less than 1.0 million tons). In quantitative terms, in terms of placement of TMF, the East Kazakhstan region is in the lead - 247 objects of TMF, Karaganda region - 225 objects of TMF and Aktobe region - 147 various objects of TMF. The smallest number of TMTs is found in Mangystau, West Kazakhstan and Kyzylorda regions (resp. 6.5 and 1).

Among the accumulated TMTs, objects formed before May 30, 1992 (the Law of the Republic of Kazakhstan "On Subsoil and Subsoil Use"), after it, as well as TMTs, the formation of which began before the specified date and ended after, or is still ongoing, are taken into account. That is, today the legal norm for TMF is defined as purely state property (accumulated before the specified period), mixed - private enterprises (organizations) store TMF at the accommodation facilities operating at the time of privatization (tailing, sludge-ash storages and dumps) and private - enterprises (organizations) store solid waste at newly built/allocated locations.

In connection with the introduction of the Waste Management Rules (Decree of the Government of the Republic of Kazakhstan No. ref: 403 dated: 30.03.2012) mandatory for users of natural resources of categories 1 and 2, it becomes necessary to develop a state program for the management of state-owned waste, *i.e.* it is necessary to solve, along with users of natural resources, the problem of their reduction and utilization. In this case, assigning responsibilities only to a business structure will not solve the environmental problems of the regions.

The state cadastre of technogenic mineral formations takes into account 202 HMT objects that undoubtedly belong to the category "HMT in state ownership", *i.e.* formed before May 30, 1992. Their composition and number by region are as follows, Table 1.

As can be seen from the above data, 67 objects, represented by overburden dumps, can only be in demand as raw materials for the construction industries. It is necessary to analyze all archival information on the development of initial deposits and conduct an environmental and economic assessment of the feasibility of further use of these HMTs. The data given in the table for 110 dumps of substandard and off-balance ores require a full-scale survey for their actual presence and a geological and economic assessment of their suitability. The same assessment should be carried out for tailings and other facilities for the primary processing of mineral raw materials.

If there is no demand for them as a building raw material in the future, 211 overburden dumps will move into the status of large-tonnage waste. The same is permissible for dumps of substandard and off-balance ores,

for storage facilities for waste from the primary processing of mineral raw materials.

It should be noted that in Kazakhstan, possible directions for the disposal of large-tonnage waste from the mining and processing industries were first summarized in the late 80s of the last century.

An analysis of stock materials on the development of the mining industry in Kazakhstan showed that the issues of disposal of man-made waste were relevant and sufficiently studied in those years. So, in 1988, the Academy of Sciences of the Kazakh SSR, the Council for the Study of the Productive Forces of the Ministry of Non-Ferrous Metallurgy of the Kazakh SSR, together with the Zhezkazgan Research Design Institute of Non-Ferrous Metallurgy, developed the Inventory of Resources and the prospects for the integrated use of waste from the production of non-ferrous metallurgy and ferrous metallurgy of Kazakhstan.

Table 1. Number of technogenic mineral formations under state ownership, 2020

Administrative regions	Types of TMT				Overall for the region
	Overburden dumps	Dumps of off-balance and substandard ores	Tailing dumps of processing plants	Slags from metallurgical industries and ash dumps	
Akmola	5	3	4	0	12
Aktobe	9	56	0	0	65
Almaty	6	0	2	0	8
Atyrau	10	9	0	0	19
East Kazakhstan	14	7	7	1	29
Zhambyl	3	20	1	0	24
West Kazakhstan	0	0	0	0	0
Karaganda	6	9	4	0	19
Kostanay	5	1	2	0	8
Kyzylorda	1	0	0	0	1
Mangystau	0	0	0	0	0
Pavlodar	2	1	0	0	3
North Kazakhstan	6	3	0	0	9
South Kazakhstan	0	1	3	1	5
Total:	67	110	23	2	202

Source: Authors.

In the cadastre for non-ferrous metallurgy waste, the main accumulated waste waste from 22 plants and independent non-ferrous metallurgy enterprises of the Kazakh SSR was considered. All these enterprises carried out ore mining, enrichment and metallurgical processing of mineral raw materials. The information block included three types of waste: associated mining waste (overburden, off-balance, substandard ores), enrichment waste and metallurgical processing waste. Moreover, in addition to general information, qualitative characteristics of waste, the cadastre contained a section: “Waste use direction”. This section included 13 indicators: indicators characterizing the actual volumes of the average annual use of solid waste; the name of the industry consuming the waste; brief description of the technology or conditions of waste processing; name of the received product; the purpose of the use of finished products and the annual volume of the recycled part of the waste; calculated indicators for assessing the completeness of the use of solid production wastes; the ratio of the volume of the used part to the total volume of accumulated waste. It determines the possible terms for the complete disposal of waste; complexity factor (this indicator was determined subject to the additional extraction of a number of valuable components contained in the waste); results of scientific developments, experimental and industrial tests on the use of production waste; the name of the organization that carried out scientific research, experimental and industrial tests; probable areas of possible use of industrial solid waste; general recommendations, suggestions based on the analysis of scientific institutions and industrial enterprises; expected economic efficiency of industrial waste disposal.

Analysis of the data for the indicated sections of the cadastre showed that practically all overburden (rocky, semi-rocky) rocks, based on studies of domestic and central research laboratories of various ministries, were offered as a building material: crushed stone for backfilling industrial roads; as a large concrete aggregate, and in road concrete of the lower layer of two-layer coatings; in concrete laid in the base of capital road surfaces; in the production of hot, warm and cold asphalt concrete of various types.

And even with such a certainty in the area of use of overburden rocks, section 12 recommended the constant continuation of research work to expand the range of products from these wastes. The main goal at the

same time is to replace traditional types of building materials extracted from quarries of common minerals.

As for enrichment wastes, depending on the content of accompanying components in them, for example, barite, pyrite, it was proposed to separate marketable products by re-enrichment, and use the newly formed secondary tailings as backfill materials for mine workings, mineral fertilizers, in the production of aerated concrete, etc. If they contain a technologically recoverable content of accompanying elements, for example, cobalt, bismuth, etc., hydrometallurgical processing methods were proposed, in which secondary waste (cakes), depending on the degree of knowledge, were recommended for the production of cement, pigments, etc.

It should be especially noted that the cadastre planned to carry out research work on the old tailings of 1927-1953 in order to quickly involve them in the additional extraction of metals and the subsequent use of secondary waste in backfilling operations. In a number of cases, heap leaching methods have been proposed for the purpose of additional extraction of valuable components and subsequent final reclamation of depleted secondary waste.

Thus, the general directions and foundations for waste processing have already been determined, to a sufficient extent, by the domestic science of past years. An analysis of modern developments of domestic scientists shows that there are no fundamentally new technologies that comprehensively take into account the solution of technological, energy-economic and environmental problems.

Analysis of the use of involving solid emissions and existing dumps in industrial circulation in the Pavlodar region. The Pavlodar region is one of the most polluted on the territory of Kazakhstan, due to high man-made pollution caused by the economic activities of large sectors of the economy, such as energy, metallurgy, mining, oil refining and chemical industries.

The development of industry and production entail additional sources of emissions, in terms of the formation of industrial waste, increasing the burden on the ecological state of the region. Currently, about 6 billion tons of industrial waste has been accumulated in the region.

In the region, the volume of accumulated industrial waste by sectors of the economy is 5 billion 979 million 714 thousand tons, of which overburden of the mining, coal, non-ferrous industries occupy 5 billion 038 million 615 thousand tons. The following has been accumulated in Pavlodar region: non-ferrous metallurgy waste - 208,721.92 thousand tons; ferrous metallurgy waste - 7019.0 thousand tons; heat power waste - 178396.0 thousand tons; mining industry waste - 5524565.9 thousand tons.

Due to long-term storage and ongoing chemical and biological processes, changes in the quality of animal waste have occurred. From the category of "waste" animal waste products moved into a new category of "humus", which was used in agriculture as a biologically active fertilizer. As a result, the amount of agricultural waste has been significantly reduced.

In the Pavlodar region, the main contribution to the generation of waste is made by coal mines (90-92%), thermal power plants (5-6%), 4-5% of the waste is made by small, medium and large businesses.

Air emissions. The gross emission of pollutants into the atmospheric air is formed from industrial enterprises located in three cities of the region, so 37% of emissions are formed in the city of Ekibastuz, 35% - in the city of Aksu and 26% in the city of Pavlodar. In turn, the activities of large nature users concentrated in three cities are accompanied by a significant amount of emissions into the atmosphere.

Sources of emissions that have the bulk of emissions into the environment in the form of emissions in the Pavlodar region are enterprises of the I category of environmental hazard (1 and 2 classes of sanitary hazard), namely thermal and power plants operating on high-ash coals, the gross emissions of which form 85-86 % of the total mass of emissions of the Pavlodar region, the share of formation of gross emissions of other large nature users of the same category varies in the 10% zone.

The remaining 4% of emissions are formed as a result of the economic activities of enterprises of II, III, IV categories of environmental hazard, it is necessary to note the annual trend of increasing emissions of pollutants into the air from users of this category, due to the growth in production and the number of newly opened production shops and sites.

In 2021, the emission of harmful substances into the atmosphere from stationary sources of large enterprises amounted to 532.2 thousand tons. Emissions, taking into account enterprises of II, III, IV categories, amount to 568.3 thousand tons.

For the same period last year, emissions from large enterprises amounted to 581.5 thousand tons. Emissions, considering enterprises of II, III, IV categories, amounted to 620.8 thousand tons. As the analysis shows, the total mass of pollutant emissions shows a downward trend.

The main reason for reducing the total mass of emissions into the environment of the Pavlodar region is the reduction in the volume of electricity generation at power plants in the region, such as: Ekibastuzskaya GRES

1 LLP, Ekibastuzskaya GRES 2 Station JSC, Aksuskaya Power Plant of Eurasian Energy Corporation JSC, Pavlodarenergo JSC.

Information on pollutant emissions (thousand tons/year), including for some ingredients, is presented in Table 2, Table 3.

Table 2. Information on pollutant emissions in the Pavlodar region in 2020-2021

Name of pollutants	The volume of total industrial emissions (thousand tons)	
	2020	2021
Total	581,5	532,2
sulfur dioxide	262,9	246,1
nitrogen dioxide	98,3	85,5
particulate matter	124,4	109,1
carbon monoxide	67,8	66,6

Source: Authors.

Table 3. Information on pollution in the Pavlodar region in 2020-2021

Pollution Information	for 2020	for 2021
Emissions from gas flaring, thousand tons	2,8	3,2
The volume of industrial emissions into the atmospheric air without purification, thousand tons	155,7	167,4
Including the volume of accidental releases, thousand tons	-	0,179

Source: Authors.

As the dynamics of waste accumulation shows, many enterprises are not interested in improving recycling technologies. In this regard, direct participation and interest of industrial enterprises in an integrated approach to the deep processing of secondary raw materials is necessary, which will make it possible to create environmentally friendly technologies.

An analysis of current information about the objects of technogenic formations of primary processing of polymetallic ores at deposits indicates that the indicators of the content of metals in TMF are initial according to the technological balances of concentrating plants and represent the average for the entire period of storage of enrichment tailings, for example, for 15-20 years. At the same time, such purely internal production measures are not taken into account, when sewage and all other liquid production wastes were discharged into the same tailings, *i.e.* there was an unintentional impoverishment of the deposited enrichment waste. In addition, some of the metals in the lower part of the tailings were spontaneously leached during the storage period.

In official documents and other materials, it is generally believed that with the total accumulation of HMT, metal reserves seem to be quite comparable with small deposits. However, during the actual geological and technological mapping and testing of tailings, sludge reservoirs, slag reservoirs, lower contents of useful elements can be established. Recycling them by existing methods is not profitable, since the technical and economic assessments of HMT take into account the recoverable value of the contained useful components, the costs of recycling, transportation, grinding (the recoverable value of useful components is determined in the process of calculating reserves by conducting a geological and economic assessment of the HMT object) .

A constraining factor in the industrial development of HMT is the presence of toxic components (beryllium, arsenic, mercury, and others) in technogenic mineral formations, without preliminary extraction of which, their use is impractical or dangerous. Complete disposal of HMOs is practically impossible, and the waste remaining after their processing can be environmentally hazardous. Thus, HMT can be considered as a mineral raw material only if there is an environmentally friendly technology for their use and an increased demand for recoverable metals.

Let us present the most studied technologies and methods proposed for the processing and disposal of technogenic large-tonnage raw materials in terms of the environmental friendliness of their use and economic benefits.

1. Processing of off-balance coals to obtain ferrosilicoaluminum. Scientists of the National Center for Complex Processing of Mineral Raw Materials under the Ministry of Energy of Kazakhstan have developed a method for obtaining a metal form of an alloy of ferrosilicoaluminum (FSA) - a universal deoxidizer that is used in metallurgy to produce high-quality steel grades. The main raw material for obtaining FSA was off-balance coal from Kazakhstan coal deposits. The need for FSA is not limited. Only Russia is ready to buy up to 200 thousand tons of FSA annually.

2. Use of waste as backfill material. Kazakhstan has accumulated extensive experience in the use of solid production waste for the preparation of backfilling of mine voids, worked-out quarries, subsidence of the earth's surface.

At the same time, filling mixtures allow the use of materials with various properties. But at the same time, the use of industrial process wastes with different physical-mechanical and chemical-mineralogical properties does not allow automatically transferring the found optimal proportions for some materials to others (for example, tailings from various processing plants, slags, etc.).

Research conducted by various domestic research institutes has made it possible to develop a whole range of compositions for multicomponent backfill mixtures using non-traditional waste from production processes.

It has been experimentally proven that rocks from tunneling operations, classified by their chemical and mineralogical composition as prone to spontaneous combustion (for example, pyritized coal shale), can be used as a component of the hardening stowing mixture. However, the volume of input of such rocks into the hardening mixture must be set taking into account both the strength and thermophysical factors in order to maintain a balance between the potential heat content of the input rock from penetration and the possible heat absorption during dissociation of the backfill aggregate.

According to the results of studies by leading institutions, mining waste, tailings from processing plants and almost all waste from metallurgical production, fuel energy, and fertilizer production can be used after additional extraction of useful components from them in the construction industry.

3. Use of waste as building materials. One of the most promising industries where large-tonnage waste is in demand is the building materials industry. At least 30% of overburden and enrichment waste and most of the waste from deep processing of minerals are suitable for the production of building materials. Various slags, ashes, etc. can replace almost all known types of building materials, can be used to create new types of materials with high performance, economic and aesthetic characteristics.

3.1. Utilization of metallurgical slags. They are used to produce cement, concrete, mineral wool, slag casting, slag pumice (thermosite) and other products, serve as high-quality raw materials for the production of crushed stone, sand and crushed stone-sand mixture. Slag crushed stone in road construction is in many cases preferable to natural due to its higher frost resistance and roughness. Slag silicates are effective structural and finishing materials. They have very high compressive strength, and in bending strength they approach cast iron.

3.2. The use of fly ash as a filler in the production of building materials, including heat-insulating materials. Fly ash is formed as a result of coal combustion at thermal power plants and is captured by electrostatic precipitators, after which it is taken in a dry state using an ash collector for production needs, or sent to an ash dump together with water and slag. It is a finely dispersed material, consisting, as a rule, of particles ranging in size from fractions of a micron to 0.14 mm. It has been established that ash, depending on the quality indicators and the scope of application, is divided into 4 types:

I - for reinforced concrete structures and products made of heavy and light concrete;

II - for concrete structures and products made of heavy and light concrete, mortar;

III - for products and structures made of cellular concrete;

IV - for concrete and reinforced concrete products and structures operating in especially difficult conditions (hydraulic structures, roads, airfields, etc.).

However, in this classification there is no scope for their use as a filler in the production of heat-insulating materials.

The creation of a heat-insulating material based on them contributes to the achievement of several goals.

The first goal is environmental protection, which consists in the disposal of large-tonnage waste from industry and thermal power engineering, which are used in the production of new products as a feedstock, as well as in the preservation of significant volumes of primary natural raw materials due to this.

The second goal is scientific and technical, which consists in the implementation of high technologies, namely the production of new materials for the construction industry, which have a number of unique properties.

The filler - fly ash - reduces the cost of production, reduces the ability to spread the flame over the surface and the smoke-generating ability, that is, the properties that apply to the fire safety of building materials, including heat-insulating and finishing materials.

The integrated use of technogenic raw materials and products makes it possible to increase the output of many types of products by 25-30%, to reduce their cost by 2-4 times.

3.3. The use of large-tonnage wastes of water treatment of thermal power plants in the production of gypsum at the enterprises of the construction industry.

In the production of electrical and thermal energy, as a result of the preparation of large volumes of water to make up for losses associated with the release of process steam for production, significant volumes of wastewater treatment - chemical water treatment sludge (CWT) are formed. These sludges are formed at the stage of preliminary water treatment, which includes clarification of water, as well as a decrease in alkalinity and its partial softening. Sludge from clarifiers with a moisture content of 90% is removed as a result of continuous blowing in the form of pulp, which is sent to sludge dumps for sedimentation and sludge dehydration. Large volumes of accumulated sludge pose a serious problem, since the cleaning of sludge dumps and the disposal of large-tonnage waste from water treatment are associated with a number of economic and environmental difficulties. In the energy sector, traditionally, chemical water treatment sludge is stored and temporarily accumulated in sludge dumps. After the sludge dumps are filled to the design level, the discharge of sludge water is stopped, the sludge dump is left for sludge dehydration for the purpose of its subsequent cleaning and preparation for further temporary accumulation of waste. In this regard, the biggest problem in the energy sector is the formation and disposal of a large amount of chemical waste sludge, which accumulates for several years in sludge dumps. The analysis shows that at present there is no universal method for the treatment and disposal of sludge. In many enterprises, roasting or drying of sludge is one of the main methods of disposal of these wastes. Such methods are environmentally unsafe, since it is necessary to clean the emitted gases from pollutants, and difficulties are created with additional purification of the suspensions formed in the gas washing system. The energy consumption is significant, but the problem of waste disposal remains, since the mineral part of the sludge remains.

According to its functional purpose, the sludge from chemical water treatment of thermal power plants can be recommended as a raw material for the production of binders (gypsum), since it contains a large amount of compounds based on calcium ions, which are the basis for the production of most mineral binders. It is proposed to transfer the calcium compounds present in the sludge into the sulfate phase, since the sludge from chemical water treatment of thermal power plants consists of 65-75% of these minerals capable of being neutralized with sulfuric acid (sulfuric acid waste). To obtain gypsum based on calcium sulfate hemihydrate, two main methods are known: firing in air and autoclaving. Based on these studies, the following heat treatment parameters are recommended: temperature - 1390C, pressure - 0.25 MPa, treatment time - 2.0...2.5 hours. According to the proposed technology, chemical water sludge after neutralization with sulfuric acid (waste sulfuric acid from batteries) is subjected to autoclave treatment according to the above regimes, after which it is mechanically dehydrated and dried in a dryer. The optimal consumption of sulfuric acid is its amount of 75.100% of the stoichiometry.

In the case of chemical activation of the sludge, it is possible to use waste products from the production of sulfuric acid of low concentration, which makes it possible to utilize this product as well. The resulting gypsum can be used as a mortar for plastering and complies with GOST 28013-98, as well as a binder in masonry mortars. The cost of gypsum based on chemical waste sludge and spent battery sulfuric acid is 65% lower than for a similar product made from natural raw materials. Application of the technology of gypsum binders, disposal of CHP sludge will be carried out rationally and carried out according to energy-saving, low-waste technology, which meets the geo-ecological aspects of the use of natural and man-made raw materials.

According to scientists, the savings from the exclusion of payments for the placement of 135 thousand tons of chemical waste sludge accumulated in the sludge dumps of one of the thermal power plants at the landfill will amount to 540 thousand US dollars.

The use of local large-tonnage mineral secondary raw materials can and should fill the existing regional niche in the building materials industry.

Thus, the main problems of waste management in the industrial regions of Kazakhstan are:

- lack of a well-functioning accounting system by enterprises and regulatory authorities for the generation and disposal of waste;
- imperfection of the system of collection and disposal of production waste;
- lack of landfills equipped according to modern requirements, sludge collectors, rock dumps, ash collectors;
- significant clutter with industrial and household waste, motor vehicle waste in settlements, river floodplains, areas near industrial enterprises and the private sector;
- insufficiently active introduction of advanced technologies for waste processing at industrial enterprises.

Based on the variety of accumulated technogenic raw materials in Kazakhstan, the decisive factor in involving them in the development should be economic feasibility, which is possible only if the development and industrial use of advanced innovative technologies for the processing of secondary material affecting the

development of a green economy.

It is necessary to prepare and implement investment projects for a number of the most promising facilities, the involvement of which in the economic turnover has an economic, environmental, social or other priority. To solve this problem, you must perform the following steps:

- conduct a detailed inventory and classification of man-made waste, taking into account all available information;
- to conduct a general assessment of the mineral and raw material potential of man-made waste;
- identify priority facilities for possible exploitation;
- perform a geological, economic and cost assessment of the priority man-made deposits involved in the development;
- develop proposals for the creation of geological, economic and legal foundations for the preparation of man-made deposits for industrial development.

Technologies are needed that will allow quickly and efficiently create competitive products from production and consumption waste.

Conclusion

The involvement of waste in the sphere of market relations and the attractiveness of this sphere for domestic foreign investment is not ensured, since:

- there is no normative definition of the status of secondary resources with the establishment of a list of priority wastes for which an immediate organization of work is required to involve them in the market;
- there is no regulatory and technical documentation on the organization and development of a system for the collection and use of secondary resources;
- there are no criteria for determining possible markets for demand for products from secondary raw materials, creating conditions for entrepreneurial activity in this area;
- the responsibility for the practical implementation of the state policy on the use of secondary resources, statistical monitoring of the use of production and consumption waste as secondary resources is not defined.

Thus, at the initial stage of development of the green growth strategy in Kazakhstan, there should be an economic policy, fixed by regulatory legal acts, especially on the issues of production and consumption waste management. Such a policy should take into account that a successful transition to green growth and minimizing the environmental impact of production and consumption wastes will require more efficient use of them as secondary resources. In turn, this will be the basis for the involvement of waste in the sphere of market relations and the attractiveness of this area for domestic and foreign investments. Based on this, in order to form a separate industry in the field of waste management, it is necessary, within the framework of the work carried out by the Government of the Republic of Kazakhstan and the Ministry of Ecology, Geology and Natural Resources, to develop and implement a green economy, to provide for two main points:

- development of the state waste management policy;
- introduction of special conditions for subsidizing traditional methods of state regulation of entrepreneurial activity through a number of benefits:

- on income tax invested in the creation of production waste processing as secondary material resources or technical re-equipment in this area;
- on the land tax of production and procurement enterprises and collection points for the most common types of secondary raw materials;
- reduction of the depreciation rate for equipment for the collection and recycling of solid waste, plastic container and packaging waste, aluminum cans, cullet, used car tires, mercury-containing lamps and galvanic cells;
- at tariffs for rail transportation of large-tonnage types of waste intended for use as secondary raw materials;
- creation of the Waste Exchange, which will provide an information cadastral database on all types of waste to potential investors, will ensure constant study of the waste market as a secondary resource. At the same time, due to the reduction of transport and overhead costs, due to the close location of production to consumers and the absence of intermediaries, the Exchange will offer products to enterprises at a more favorable price in the future. This will create new jobs and make additional tax revenues to the budget. The waste exchange will study and regulate the supply and demand market for all other types of large-tonnage waste, both at the domestic and foreign levels.

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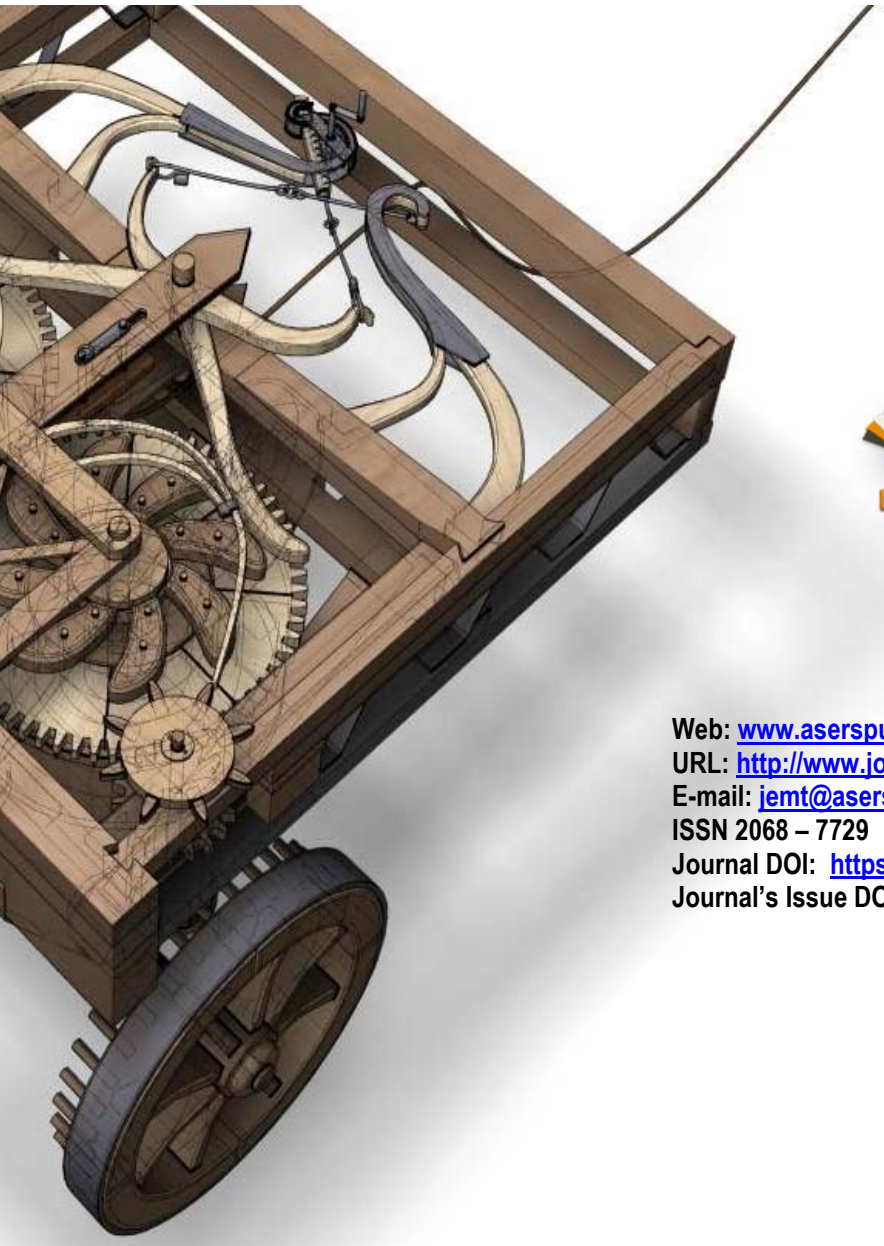

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