Код МРНТИ 87.35.91:67.09.05

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HIGH LAG FOR THE «GREEN KAZAKHSTAN» PROJECT

Abstract. Article examines key trends in implementation of the Green Kazakhstan project and the Concept for country's transition to a green economy. It provides overview of current situation regarding solid industrial waste management, with a focus on large industrial centers, which are the main sources of this waste. As potential solutions for closing waste loops, recovering secondary material resources, and developing industrial waste management system, article proposes establishment of production and technical complexes for waste processing. It also summarizes preliminary results of research conducted by Satbayev University on resource conservation and development of new technologies for producing in-demand materials. Utilization of waste from mining and metallurgical complexes is highlighted as a means of reducing environmental impact and ensuring efficient use of secondary raw materials.

Key words: *green Kazakhstan, sustainable development, mining and metallurgical complex, production waste, processing, resource saving, new technologies, building materials.*

«Жасыл Қазақстан» жобасының жоғары жолағы

Аңдатпа. Мақалада «Жасыл Қазақстан» жобасын іске асырудың негізгі тенденциялары және мемлекетіміздің осы экономикаға көшу Тұжырымдамасы қарастырылған. Қатты тұрмыстық қалдықтарды басқару саласындағы қазіргі жағдай ұсынылған, олардың көздері ірі өнеркәсіптік орталықтарда шоғырланған. Қалдықтар ағындарының жабылуын қамтамасыз етудің перспективалық шаралары ретінде қайталама материалдық ресурстарды алу, қалдықтарды қайта өңдеудің өндірістік-техникалық кешендерін құру арқылы өндірістік қалдықтарды басқару схемасын әзірлеу ұсынылады. Сатпаев Университетінің ресурстарды үнемдеу және сұранысқа ие құрылыс материалдарын алудың жаңа технологияларын әзірлеу бойынша жүргізген жұмыстарының алдын ала нәтижелері жинақталған. Тау-кен металлургия кешендерінің қалдықтарын қайта өңдеу қоршаған ортаға антропогендік жүктемені азайтуға және қайталама шикізатты ұтымды пайдалануды қамтамасыз етуге мүмкіндік береді.

Түйінді сөздер*: жасыл Қазақстан, тұрақты даму, тау-кен металлургия кешені, өндіріс қалдықтары, қайта өңдеу, ресурс үнемдеу, жаңа технология, құрылыс материалдары.*

Высокая планка проекта «Зеленый Казахстан»

Аннотация. В статье расмотрены основные тенденции реализации проекта «Зеленый Казахстан» и Концепции перехода нашего государства к этой экономике. Приведена текущая ситуация в сфере обращения с твердыми промышленными отходами, источники образования которых сосредоточены в крупных промышленных центрах. В качестве перспективных мер, обеспечивающих замыкание потоков отходов, получение вторичных материальных ресурсов и предлагаются развитие схемы обращения с промышленными отходами за счет создания производственно-технических комплексов по переработке отходов. Подведены предварительные результаты работ, проводимые Сатпаев университетом по ресурсосбережению и разработке новых технологий по получению востребованных материалов. Утилизация отходов горно-металлургических комплексов позволяет снизить техногенную нагрузку на окружающую среду и обеспечить рациональное использование вторичного сырья.

Ключевые слова: *зеленый Казахстан, устойчивое развитие, горно-металлургический комплекс, отходы производств, переработка, ресурсосбережение, новая технология, строительные материалы.*

Introduction

«Green» does not mean the spring color of awakening nature, «green» is not a reminder of the national currency of the United States, casually called «green» by the people. Here, it seems, everything comes together – it means young. In fact, the «green» economy deserves other definitions, more responsible and balanced in spiritual and moral terms: clean, like a newborn child, wise, like a mature and useful scientist for society, and finally, its main advantage is seen in the fact that it is the most reliable friend and partner of the environment.

Maybe you will say that such miracle in the totality of all above qualities does not exist in nature. Maybe we have really raised the bar for «Green Kazakhstan», but introduced the National Projects of the Republic, such as «Quality and affordable healthcare for every citizen «Healthy Nation», «Quality education», «Educated Nation», «Technological breakthrough through digitalization, science and innovation», «Strong regions are the driver of the country's development», «Sustainable economic growth aimed at improving the well-being of Kazakhstanis», «Green Kazakhstan», «Quality education «Educated nation», and you will understand what these projects represent.

«Green Kazakhstan» basically raises issues of efficient use of natural resources and improving the well-being of citizens through diversifying economy, creating new jobs, including: improving air quality, effective management of production and consumption waste, increasing the area of green spaces, instilling careful attitudes towards nature and wildlife, as well as modernization of ecological consciousness of the population [1].

The main content

By destroying the environment, modern society is destroying its own future. To ensure environmentally sustainable future, we first need:

- *monitoring the state of the natural environment;*
- *regulation and prevention of industrial emissions;*
- *development and implementation of waste-free and resource-saving technologies.*

According to the «Green Kazakhstan» Project, the key direction of economic development in the republic is to improve management system of technogenic mineral formations (TMF).

On the territory of the Republic, according to the State Cadastre, about 30 billion tons are stored in dumps, tailings ponds and storage tanks of mining enterprises. Industrial waste, including: 72% – dump rocks of overburden and substandard ores, 20% – dump tailings, 8% – other waste. With annual output of industrial waste of 1 billion tons no more than 100 million tons are usefully used. The rest pollutes the environment, gradually accumulating in it [2].

According to the bodies of State Control and Supervision of Natural Resources, share of waste used in the republic is 18-20%. For example, in 2007, the percentage of waste utilization was 16%, in 2008 – 18.98%, and in 2009 – 20%. However, this figure in the recent past in the industry of the former USSR was 29%. It remains extremely low compared to world practice. In Western Europe (France, Germany, Italy, England) this figure is up to 58%, in North America (USA, Canada) – up to 63%, in Japan – up to 87%, China – up to 37% [3].

Thus, accumulated waste is, on the one hand, the main environmental pollutant, and on the other hand, it represents valuable products that are potentially suitable for processing and reuse to produce commercial products with high added value. The main reason for progressive accumulation of waste in the country is the raw material orientation of our economy.

Currently, more than 22 billion tons of solid waste have been accumulated at 450 landfills in the country (Figure 1).

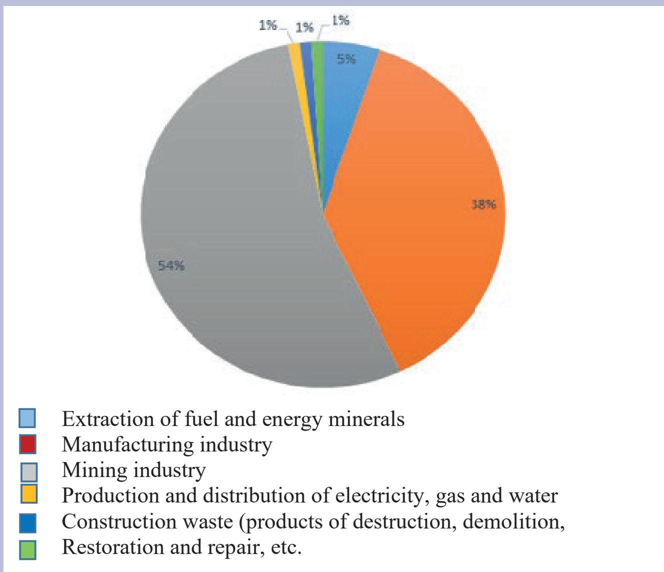

Figure 1. Main indicators of solid waste accumulated in the Republic by 2023.
Сурет 1. 2023 жылы республикада қатты қалдықтар жинақталуының негізгі көрсеткіштері.
Рис. 1. Основные показатели накопленных твердых отходов в республике к 2023 году.

Most of the technogenic mineral formations (TMF) are in Karaganda (29,4%), East Kazakhstan (25,7%), Kostanay (17%) and Pavlodar (14,6%) regions. Every year, the republic generates up to 20 million m^3 of domestic waste, about one billion tons of industrial waste, including more than 150 million tons of toxic waste.

Technogenic mineral formations (TMF) are accumulations of mineral substances on the surface of the Earth or in mine workings, formed as a result of their separation from natural massif and storage in the form of waste from mining, processing and metallurgical industries. The constant increase in the volumes of various types of waste generated in mining and processing industries and their storage in storage facilities and experience of using such objects in industry allows us to consider them as sources for obtaining secondary raw materials and building materials.

Purpose of the work is to consider possibility of integrated use of TMF in areas where mining waste is located based on their integrated use as secondary raw materials. Integrated use of raw materials and industrial products progress of metallurgical, mining and construction enterprises is pressing problem not only in Kazakhstan, but also in any economically developed state. As practice has shown, waste from these particular industries is produced in small quantities and poses a serious economic threat. In these conditions, problem of environmentally rational use of industrial waste as secondary raw materials and development of scientific principles in the creation of new technological regulations for production of marketable products from industrial household waste becomes particularly acute. Thus, the introduction of environmentally friendly technology to produce building materials based on waste from mining and metallurgical complex is relevant for Kazakhstan.

To develop and implement effective environmental protection measures for waste management, it is necessary to have reliable information about their impact on natural ecosystems: surface, groundwater, air and land disturbance on an industry scale with increasing production volumes. The summarized materials will make it possible to obtain objective information about state of ecosystems in the region under study and to outline priority environmental protection measures, implementation of which will help reduce harmful impact on environment.

Intensification in this direction involves use of industrial waste instead of primary natural resources to reduce cost of building materials Project [4, 5]. In this direction, KazNRTU employees are conducting a large amount of research on production of building materials based on ash and slag waste.

Purpose of the work is to consider possibility of integrated use of TMF in areas where mining waste is located based on their integrated use as secondary raw materials.

Job objectives:

✓ *surveying of solid waste to create cadastral maps and determine their actual volumes;*

✓ *sampling of solid waste to study their composition with the participation of the customer;*

✓ *conducting research on solid waste in order to determine the direction of their disposal;*

✓ *improvement and implementation of technologies for the development of solid waste with complex extraction of valuable components.*

✓ *development of technology for producing effective building materials, such as: obtaining a silica component to produce portland cement; production of cinder blocks; production of cellular concrete; obtaining decorative and facing building materials; creation of foundations for highways.*

By burning coal, thermal power plants receive thermal energy and generate electricity. Negative side of this process is formation of by-products of coal combustion – fly ash and slag.

Composition of ash and slag material was determined by quantitative ratio of its constituent minerals, which depend on mineralogical composition of original part of fuel.

On the X-ray diffractometer DRON-3, X-ray diffraction pattern of the CHP-3 ash was obtained, which is shown in Figure 2.

As a result of the interpretation of this X-ray diffraction pattern, the following minerals were identified in the following amounts, in % of the crystalline phase: hematite Fe_2O_3 – 12.1%, quartz SiO_2 – 32.4%, sillimanite Al_2SiO_5 – 25.9%, mullite $Al_{4,95}Si_{1,05}$ – 29.6%.

Results of chemical analysis of ashes of TPP dumps from combustion of Ekibastuz coal are presented in Table. 1.

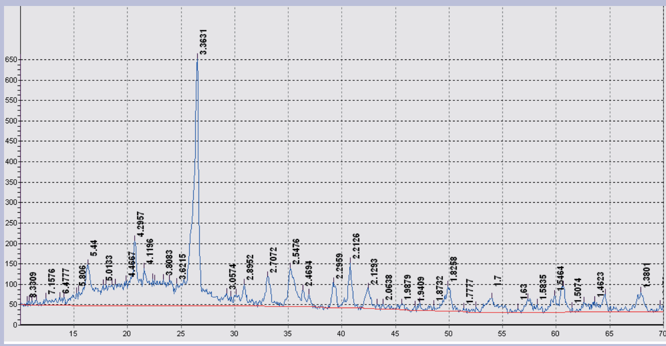

Figure 2. X-ray ash CHP-3.
Сурет 2. ЖЭО-3 рентген күлі.
Рис. 2. Рентгеновская зола ТЭЦ-3.

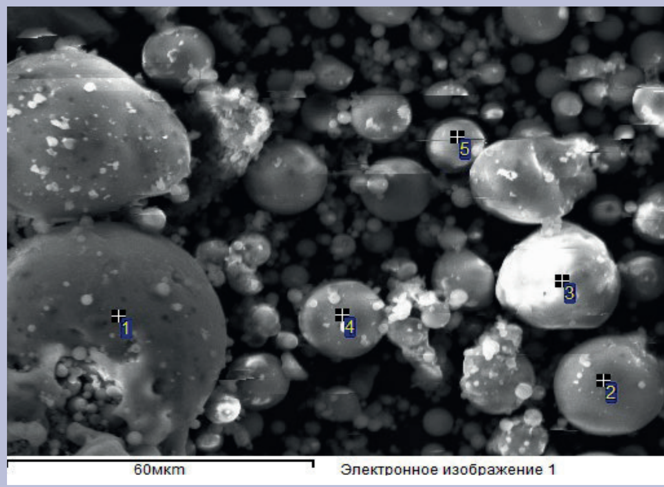

Figure 3. Microphotograph of ash fractions in a scanning electron microscope.
Сурет 3. Күл фракцияларының электронды микроскоптағы микрофотографиясы.
Рис. 3. Микрофотография зольных фракций в электронном микроскопе.

Table 1 clearly shows that main component contained in the ash is silicon and aluminum oxide (from 57.7 to 63.9%), there is also a high content of iron oxide, calcium oxide in samples from the ash dump is much less than in samples from the electrostatic precipitator. Most likely, free calcium oxide was converted into calcium carbonate by reaction with carbon dioxide dissolved in water, which washes away the ash through the slurry pipeline.

On figure 3 shows electromicroscopic image of fly ash, from which one can see:

• *that particles are spherical, vitreous and hollow, ranging in size from 1 μm to 50 μm;*

• *that large particles contain smaller spherical particles in their cavities (shown by arrow);*

• *that on the surface of large particles there are, as a rule, tightly «glued» tiny granular balls.*

One of the main indicators of raw materials is their granulometric composition.

Granulometric composition of the Ekibastuz SDPP by fractions is distributed as follows: up to 0.5 mm – 0.14%; 0.45 mm – 2.26%; 0.25 mm – 3.6%; 0.1 mm – 25.8%; 0.09 mm – 0.84%; 0.08 mm – 12.12%; 0.06 mm – 4.5%; 0.05 mm – 21.46%; 0.045 mm – 21.38%; 0.04 mm – 7.9%. In this case, piercing loss (LPP) is about 3% [6]. Table 2 shows distribution of phase composition of fly ash depending on its fractional composition.

Knowledge of chemical composition of ASW is necessary condition for judging its properties and resolving issue of possibility of using it in various sectors of national economy. To determine chemical composition of ASW, ash samples were taken from electrostatic precipitators and ash disposal sites according to the methodology RD 34.09.603-88 «Guidelines for organizing control of the composition and properties of ash and slag sold to consumers by thermal power plants». Analysis of chemical composition of Ekibastuz ash gives idea of composition of mineral substances of coal, which is necessary to resolve issue of possibility of using it in various sectors of national economy. Data obtained indicate that ash and slag wastes belong to acidic type of ash. Acid ash has unstable chemical composition. They also do not have independent astringent properties, but when hardening intensifiers are added, they become astringent. Conducted studies confirmed production of ash-containing binder in the following content of ingredients, wt. %: Portland cement – 70-30, fly ash – 30-70, NeoLit-400 superplasticizer (top) – 0.3%.

Table 1

Results of chemical analysis of TPP ash dumps

Кесте 1

ЖЭС күл үйінділеріне химиялық талдау нәтижелері

Таблица 1

Результаты химического анализа золоотвалов ТЭС

Name of TPP, ash dumps and their elements	content, %							
	SiO_2	Al_2O_3	CaO	Fe_2O_3	MgO	K_2O	TiO_2	SO_3
Ekibastuz TPP	56,6	23,64	3,41	4,73	1,54	1,22	0,79	3,05
Ekibastuz State District Power Plant (SDPP)	63,9	25,50	0,80	5,70	0,10	0,90	1,20	0,20
Pavlodar CHPP	57,7	25,26	2,48	10,1	1,66	0,50	0,02	0,07
Almaty CHPP-3	57,7	29,6	1,1	6,24	0,35	0,03	-	1,3

Table 2

Distribution of phase composition of fly ash depending on its fractional composition

Кесте 2

Күлдің фракциялық құрамына байланысты фазалық құрамының таралуы

Таблица 2

Распределение фазового состава золы-уноса в зависимости от ее фракционного состава

Grid number sieves	Particle size, μm	Fraction maintenance on a sieve, %	Distribution of phase composition depending on fraction, %				
			Mullit	α- quartz	Sillimanite	Carbon	glass phase (occupied area, cm^2)
0,5	500	0,14	28	54	–	18	6
045	450	2,26	44	21	24	11	14
025	250	3,36					
01	100	25,8	46	18	28	8	14,5
009	90	0,84					
008	80	12,12	42	20	31	7	18
0063	63	4,5	47	17	29	7	20
005	50	21,46	50	21	29	–	22
0045	45	21,38	47	25	28	–	23
004	40	7,9	51	14	35	–	23

Invention relates to building materials and can be used as inorganic binder with a mineral additive in production of Portland ash cement from acid ash from thermal power plants [7, 8].

Thus, the processing and disposal of mining and metallurgical waste into construction materials is aimed at solving technological, environmental, social and economic problems in regions with developed mining and metallurgical industries. The development of technologies for the production of building materials based on technogenic waste, contributing to the development of the industrial and innovative potential of the state, careful attitude towards natural resources and the environment, should be considered as the most important scientific and practical task, the solution of which is directly related to environmental safety when disposing of billions of tons of waste in industrial regions [9, 10].

Expected effect (*technological, economic, social and environmental):*

Technological effect. As part of the implementation of the state program for industrial and innovative development of the Republic of Kazakhstan in the field of environmental protection, various methods of processing industrial waste through the introduction of waste-free technology are being considered.

The economic effect is the production of additional building materials and products.

Social effect: creation of new jobs in the vicinity of existing mining and metallurgical complexes due to the work of newly created solid waste recycling facilities; improvement of working conditions, since solid waste is located on the surface of the Earth.

Environmental effect – improvement of the environmental situation; reduction of new land areas allocated for dumps; reduction or elimination of costs associated with eliminating the environmental consequences of waste storage.

Conclusions

Thus, it can be argued that utilization of technogenic waste from mining and metallurgical industries into construction materials is aimed at solving environmental and social problems in regions with developed mining and metallurgical industries. Rational organization of waste recycling process in combination with efficient modern equipment makes it possible to obtain products from secondary raw materials at a cost 2-2,5 times lower than for similar products from primary raw materials, with comparable product quality.

Acknowledgments

Research was carried out with the financial support of Ministry of Science and Higher Education of the Republic of Kazakhstan (Grant No AR14871694 «Development of technology for processing ash and slag waste from a thermal power plant to produce popular building materials»).

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