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METHODS OF WASTE PROCESSING OF MINING ENTERPRISES

Toshov J.B., Doctor of technical sciences, professor
j.toshov@tdtu.uz, https://orcid.org/0000-0003-4278-1557

Tashkent State Technical University named after I. Karimov, Tashkent, Uzbekistan

Annotation. In this scientific article, the methods of waste processing, which are formed during the development of mineral deposits and quarries in the Republic of Kazakhstan, are considered. Subsoil of Kazakhstan contains a significant amount of minerals. On the basis of explored reserves, powerful oil and gas extraction, uranium and coal industries, mining and processing of ores of ferrous, non-ferrous and precious metals, the presence of various types of non-metallic minerals has been established. The author, revealing the problems, offers a way of waste management and processing of this mining industry. In modern market conditions and taking into account the available technologies, when determining the amount of rocks that can be used with the creation of added value, these secondary resources should be processed.

Secondary mineral resources in the mining industry are rocks and tailings that can be used as raw materials in production or as additional material resources as final materials. The use of secondary resources, as a rule, is economically beneficial for extraction, enrichment and processing of primary subsoil resources. The main source of secondary resources in the mining industry is man-made waste, which is formed during the processing of mineral raw materials and is concentrated in man-made formations. These man-made formations are distinguished by the quantity and quality of mineral raw materials suitable for industrial use at the present time or in the future - technologies for its processing are being developed and the corresponding demand is formed.

Keywords: mining industry, raw materials, industrial waste, recycling, construction, safety.

Introduction. The mining and metallurgical complex includes more than 200 mining and processing enterprises, the sale of their commercial products is currently carried out in European countries, the USA, China, South Korea, Singapore, Malaysia, etc. countries (Figure 1-3).

The volume of production of commercial products of the mineral raw materials complex of Kazakhstan is 44% of total industrial production, of which 39% is accounted for by the oil and gas complex and 5% by the production of mineral raw materials other than oil and gas. The mining sector plays an important role in the economy of Kazakhstan. The state has established a scheme for attracting foreign direct investment in the oil and solid minerals sectors, which are rich in raw materials.

By morphological features, secondary mineral resources in the mining industry are divided into two types:

1) technogenic resources in dumps and waste heaps.

2) technogenic resources formed during the filling of depressions of the earth's surface.

Depending on the composition and technological features and industry affiliation, secondary mineral resources in the mining industry are as follows:

1) technogenic resources of natural rocks and gravelly material rocks;

2) sludge and tailings of enrichment plants;

3) technogenic resources of pyrometallurgical processes of non-ferrous and ferrous metallurgy, folded with sludge and slag;

4) technogenic resources accumulated from ash and slag of thermal power plants;

5) technogenic resources of chemical production.

Based on the areas of potential use, secondary mineral resources in the mining industry are classified into the following types:

1) technogenic resources of construction raw materials;

2) man-made resources containing carbon used in energy;

Figure 1 – Methods for removing stripped rocks

Figure 2 – Mines and quarries of ferrous and rare earth metals

Figure 3 – Filling of depressions in the earth's surface

3) man-made resources by type of metal extracted (copper, nickel, gold, silver, rare earths, etc.);

4) mixed-type man-made resources, i.e. suitable for the extraction of construction raw materials and metals.

Materials and methods of research. The main types of use of secondary resources of the mining industry include: backfilling of cuttings, quarries and mine pits. Assessing the energy efficiency of this type of use of secondary resources, when designing a mining enterprise, it is

necessary to take into account the transportation distance that can be optimized taking into account this direction of use of the waste mass. In addition, it is necessary to analyze resource efficiency in terms of assessing the cost of the mining mass used to backfill mines, quarries and mine pits. In the case of processing secondary resources of the mining industry as raw materials for the production of building materials (ogloporite, ceramic products, cement, porous aggregate for concrete), energy consumption increases and a negative impact on the environment is determined. However, it should be noted that in this case, the level of energy consumption and negative impact on the environment is much lower than when extracting raw materials from new deposits. The processing of mining wastes, metallurgical technologies, by complete extraction or leaching of useful components of ores (rare earth elements, metals and chemical raw materials) increases the energy consumption and the degree of environmental impact.

The operation of the mining industry, without paying due attention to the issues of waste generation, has led to the formation of extensive, often closed zones of technogenic impact, which are environmentally dangerous for the population living in these areas and for the environment as a whole. In this regard, in recent years, the task of isolating and neutralizing technogenic and natural-technogenic objects saturated with harmful substances has become especially acute. In Kazakhstan, more than 1.53 billion tons of useful solids are extracted annually, a third of which (534 million tons) - for metallurgy. However, the amount of this goes to the final product is slightly more than 4-8%, and the rest is a significant area of rocks, tailings and metallurgical slag, which are increasingly accumulating there. The largest share of waste (59.5%) is from non-ferrous and ferrous metallurgy (37.9 and 24.7%, respectively). Coal industry waste in energy reached 1.8 billion tons or 12%, in the phosphorus industry - 2.4% of the total in the republic.

Industrial waste is concentrated on construction sites, does not require funds for geological exploration, as well as transportation to a place of processing. Taking into account the costs of creating and storing dumps, land reclamation and other measures to protect the environment, the additional cost of the resulting product to the national economy is 2-4 times cheaper than using the same raw materials. Analysis of the actual situation in the field of waste disposal shows the following problems: solid waste from non-ferrous metallurgy is still used unsatisfactory. In addition, mining wastes in non-ferrous metallurgy production consist mainly of sedimentary rocks - sandstones, siltstones and clays, sands and clays, sand-gravel stones and clayey rocks. Volcanic limestones and rocks diabases and basalts are rare. Therefore, as in ferrous metallurgy enterprises, they, like the construction industry, the chemical industry, etc. in some cases, can be used with great success as industrial raw materials for the processing of poor ores with technical progress in the relevant industries. It is also necessary to organize the extraction of valuable components from waste rocks that were not taken into account by geological services in due time.

As for the waste from enrichment production, about 2.5 billion tons of flotation tailings and sludges have accumulated in the tailings ponds of non-ferrous metallurgy enrichment plants of Kazakhstan. One of the most promising areas of their use should be considered as bedding. This is because, by constructing the space extracted during underground mining, good results are achieved in terms of full and high-quality extraction of minerals from the subsoil, elimination of negative effects of mining operations on the surface of the earth. In addition, in this system, it is necessary to conduct joint development of deposits with the possibility of safe development of fire-hazardous and flooded areas, as well as open-pit and underground mining. Currently, about 362.8 million tons of waste with no potential value are stored at non-ferrous metallurgy enterprises. The use of industrial waste looks promising, as it has valuable components in the production of building materials. Such an area may be the most important in creating technological schemes and processes with minimal and no waste. The range of raw materials for the production of building materials should be mass, cheap and suitable for wide production. A significant part of the enrichment waste has such properties.

The most important task in solving this problem is the feasibility of using gases from metallurgical production, the construction of new purification and ventilation facilities and their disposal.

Analysis of the state of the problem shows that there are significant unrealized opportunities for effective use of almost all types of accumulated and generated waste.

The low level of their use and utilization by the population is explained by a number of economic reasons. First, the departmental interests of individual mining operations are metallurgical enterprises, the previous planning practice and the allocation of capital investments, equipment and materials. Secondly, there are many unresolved technical and economic problems, the lack of reliable and complete information on the qualitative and even quantitative characteristics of the accumulated waste. The development of dumps and tailings dumps, as well as the creation of such dumps, ensuring the preservation of potentially useful rocks and unconditioned ores, ensuring minimal damage to the environment and the effectiveness of their further development, there are no sufficiently substantiated technical solutions.

Despite numerous laboratory technologies, research on the extraction of useful components containing metals from waste and the feasibility of using the silicate or carbonate fraction for their extraction is impossible without a feasibility study of economic indicators due to the lack of building materials and other products. Elaboration of issues of technical and economic assessment and determination of waste requires the effectiveness of their comprehensive use as a mineral raw material, as well as environmental pollution. There is a need to use the same waste in different ways and technologies, as well as to choose the most effective directions for the selected waste.

At the present stage of development, the economic crisis in the republics, the lack of investments (capital investments) for the reconstruction of enterprises or the creation of new production of technogenic products, as well as the decline in raw material production, are added to this. The variety of identified reasons indicates the need for a comprehensive systematic approach to solving the problem, which has led to the emergence of a more complete account of the interconnectedness of individual parts of the development of technogenic mineral resources.

The main natural wealth of the subsoil is mineral raw materials, that is, a set of minerals, the extraction (extraction) and processing of which is the main goal of subsoil use. On the other hand, subsoil development has a detrimental effect on all components of the environment and its overall quality [3].

Changes in the transportation of mineral raw materials, their processing, underground development of mining enterprises, etc. have a significant negative impact on the environment. The most important aspect of the problem of interaction of mining and quarrying is the choice of solutions during the design, construction and operation of mining enterprises, the development of mine tailings, reclamation, mining, placement of external dumps, etc. at the present stage of production with the environment, i.e. the impact of conditions [3].

For the most complete use of mineral resources, the following conditions must be met:

- in the field of mineral raw materials production - optimization of planned costs for the development of complex raw material regions;
- use and processing of raw materials, the use of raw materials;
- review and use of recycling and production enterprises;
- new technological solutions using physicochemical geotechnical methods;
- reduction of losses due to the use of advanced technologies in the field of mineral raw materials consumption. The most common changes in the natural environment are the use of secondary raw materials and waste, the replacement of obsolete raw materials with artificial materials, etc. [3].

-water pumping and processing of objects due to changes in the landscape and underground structures of urbanized areas of mining and mining and solid mineral extraction areas as a result of the extraction of liquid and solid minerals;

-irrigation of the land, during production, for example, during the planning of the territory with changes in the natural environment, in order to increase the bearing capacity of the aquifers and soil, to raise the level of groundwater and build reservoirs, irrigation of the land;

-pollution of the subsoil due to the discharge of liquid waste into the wastewater as a result of the redistribution of surface waters and a change in the hydrodynamic regime

-ensuring the stress-deformed state of the mountain massif and the state of natural geological, hydrogeological, geomechanical, thermal, geochemical, radiation and biological equilibrium (Table 1).

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Table 1 – Types of waste from the mining and metallurgical industry

Phase characterization of waste	Mining and metallurgical industry						
	Production			Enrichment		Metallurgical transformations	
	Open	Underground	Geotechnological	Gravity magnetic, electric	Flotation	Hydrometallurgy	Thermometallurgy
Solid	Exposed rocks	Loose rocks	–	Waste	Waste	Precipitation	Waste
Liquid	-	Mining waters	Solution	Wash water, sludge	Sludge, pulp	Brine	Cooling water
Dust Gas	Dust	Methane, mine air	–	–	Air ext-raction	Steam	Gases, dust

The "irrecyclability" of waste is a relative concept depending on the time, the technology used and the needs of the market. This is the accumulated part of non-recyclable waste, which is a real waste. As practice shows, more than 70% of all waste generated by industry, including mining waste, cannot be recycled within the framework of the enterprises that produce them [25]. The technologies of production and processing of subsoil users do not allow to reduce the generation of waste and at the same time maintain the achieved level of profitability of production, which means that for mining and enrichment industries this is used. Reducing the level of waste generation and increasing the recycling rate of generated waste is possible when implementing technological innovations, taking into account the environmental factor. An important element for the region in this structure is the relationship between potential mineral resources and waste. Since the prospect of resource recycling can attract investments and create new jobs, at the same time the accumulation of waste prevents the alternative use of land in the territories and poses an environmental threat to the population. The main factors influencing the structure of the mining mass extracted for subsoil use are: the composition and quality of the extracted minerals, the mining and geological conditions of the work, the market situation, the availability of effective technologies for the processing of minerals and waste disposal, environmental restrictions and incentives.

Conclusion. Currently, a huge amount of technogenic waste has accumulated during the extraction and processing of minerals, the use of which in the national economy can have a significant economic impact and is important for solving environmental problems. Among them, stripping and capacious rocks; tailings and sludge of enrichment plants; slags, dust and gases of metallurgical plants; ash and slag residues from coal combustion stand out. It can be concluded that only a certain part of them is a valuable raw material that can be processed at the current level of development of equipment and technology. Therefore, among mining wastes, it is necessary to single out the first-order objects that can be called technogenic deposits by analogy with natural deposits. They are an accumulation of waste from the extraction and processing of mineral raw materials with reserves ranging from tens of thousands to hundreds of millions of

tons, the use of which allows obtaining additional volumes of commodity products with a large economic impact. Some authors propose dividing mining and technological waste into two groups: balance waste - these are production and consumption wastes, the use of which is economically viable at the current level of development of processing equipment and technology; off-balance waste - production and consumption wastes, the use of which is economically impossible, but which may participate in the production process in the future.

In order to fully characterize the waste, it is necessary to know not only qualitative parameters, but also a quantitative assessment that can be achieved by conducting geological exploration in dumps and tailings. The result of all geological and technological studies conducted from the economic assessment of the obtained material is to determine the efficiency of waste use on an industrial scale.

An important factor in increasing profitability when developing technogenic deposits is the integrated use of mineral raw materials through the extraction of base and associated metals, as well as the extraction of important materials for use in industry and construction.

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ТАУ-КЕН КӘСІПОРЫНДАРЫНЫҢ ҚАЛДЫҚТАРЫН ҚАЙТА ӨҢДЕУ ӘДІСТЕРІ

Тошов Д.Б., техника ғылымдарының докторы, профессор

И.Каримов атындағы Ташкент мемлекеттік техникалық университеті, Ташкент, Өзбекстан

Андатпа. Бұл ғылыми мақалада Қазақстан Республикасындағы тау-кен қазба байлықтарын игеру нәтижесінде пайда болған қалдықтарды қайта өңдеу әдістемелері зерттелген. Қазақстанның жер қойнауы пайдалы қазбалардың едәуір санын сақтайды. Барланған қорлар негізінде қуатты мұнай-газ өндіру, уран және көмір өнеркәсібі, қара, түсті және асыл металдар кендерін, металл емес пайдалы қазбалардың әртүрлі түрлерін өндіру және өңдеу бойынша құрылды. Автор осы мәселелерді анықтай келе, осы тау-кен саласы қалдықтарын игеру, қайта өңдеу жолдарын ұсынады. Қалыптасқан нарықтық жағдай кезінде және қолда бар технологияларды ескере отырып, қосымша құн қалыптастыра отырып пайдалануға болатын тау жыныстарының көлемі анықталған жағдайда, осы қайталама ресурстар қайта өңделуге тиіс.

Тау-кен өнеркәсібіндегі қайталама минералды ресурстар бұл өндірісте шикізат ретінде немесе соңғы материал ретінде қосымша материалдық ресурстар ретінде қолдануға болатын тау жыныстары мен байыту қалдықтары. Қайталама ресурстарды пайдалану, әдетте, жер қойнауының бастапқы ресурстарын өндіруге, байытуға және дайындауға экономикалық тұрғыдан қолайлы. Тау-кен өнеркәсібіндегі қайталама ресурстардың негізгі көздері минералды-шикізат ресурстарын қайта өңдеу кезінде пайда болатын және техногендік түзілімдерде шоғырланған техногендік қалдықтар болып табылады. Бұл техногендік түзілімдер қазіргі уақытта немесе болашақта өнеркәсіптік пайдалануға жарамды құрамындағы минералды шикізаттың саны мен сапасымен ерекшеленеді - өңдеу технологиялары дамып, тиісті сұраныс қалыптасады.

Тірек сөздер: тау-кен өндірісі, шикізат, өнеркәсіптік қалдықтар, қайта өңдеу, құрылыс, қауіпсіздік.

МЕТОДЫ ПЕРЕРАБОТКИ ОТХОДОВ ГОРНОДОБЫВАЮЩИХ ПРЕДПРИЯТИЙ

Тошов Д.Б., доктор технических наук, профессор

Ташкентский государственный технический университет имени И.Каримова, Ташкент, Узбекистан

Аннотация. В данной научной статье рассматриваются методы переработки отходов, образующихся при разработке месторождений полезных ископаемых и открытых карьеров в Республике Казахстан. Недра Казахстана содержат значительное количество полезных ископаемых. На основе разведанных запасов, сформированны мощной нефтегазодобывающей, урановой и угольной промышленности, добычи и переработки руд черных, цветных и драгоценных металлов установлено наличие различных видов неметаллических полезных ископаемых. Авторы, выявляя проблемы, предлагают пути утилизации и переработки отходов этой горнодобывающей отрасли. В современных рыночных условиях и с учетом имеющихся технологий, при определении объема горных пород, которые могут быть использованы с созданием добавленной стоимости, эти вторичные ресурсы должны быть переработаны.

Вторичные минеральные ресурсы в горнодобывающей промышленности – это горные породы и хвосты, которые могут быть использованы в качестве сырья в производстве или в качестве дополнительных материальных ресурсов в качестве конечных материалов. Использование вторичных ресурсов, как правило, экономически выгодно для добычи, обогащения и переработки первичных ресурсов недр. Основным источником вторичных ресурсов в горнодобывающей промышленности являются техногенные отходы, образующиеся при переработке минерального сырья и концентрирующиеся в техногенных образованиях. Эти техногенные образования отличаются количеством и качеством минерального сырья, пригодного в настоящее время или в перспективе для промышленного использования – разрабатываются технологии его переработки и формируется соответствующий спрос.

Ключевые слова: горнодобывающая промышленность, сырьевые ресурсы, промышленные отходы, переработка, строительство, безопасность.

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