POSSIBILITIES TO REDUCE THE NEGATIVE ENVIRONMENTAL IMPACT OF MINING ACTIVITES IN THE RHODOPE MINING BASIN

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ABSTRACT. Mining and processing of natural recources have brought about high levels of pollution, deterioration of the quality of the environment, and depletion of resources. Nowadays, it is imperative to find alternatives for the rational and environmentally friendly use of natural resources. This paper discusses the different mining activities in the Rhodope mining basin that can be sources of environment pollution and the possible measures to prevent their impact.

Keywords: natural recources, mining activities, environmental protection, the Rhodope mining basin

ВЪЗМОЖНОСТИ ЗА НАМАЛЯВАНЕ ВРЕДНОТО ВЪЗДЕЙСТВИЕ ВЪРХУ ОКОЛНАТА СРЕДА НА ОБЕКТИ ОТ МИННО-ДОБИВНИТЕ ДЕЙНОСТИ ОТ РОДОПСКИЯ МИНЕН БАСЕЙН

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РЕЗЮМЕ. Добивът и преработването на природните ресурсите са довели до високи равнища на замърсяване, влошаване качеството на околната среда и изчерпване на ресурсите. В днешно време се налага търсене на възможности за рационално използване на природните ресурси, при опазване на околната среда. В настоящата статия се разглеждат различните източници на замърсяване на околната среда от минно-добивната дейност в Родопския минен басейн и възможните мерки за предотвратяване на въздействието им.

Ключови думи: природни ресурси, минно-добивни дейности, опазване на околната среда, Родопски минен басейн

Introduction

The Rhodope Mining Basin is a lead - zinc ore field covering a wide area of the Eastern Rhodopes and the vicinity of the towns of Topolovgrad and Elhovo. Since the 1950s, large lead-zinc deposits have been exploited here. There are several ore areas in the Rhodope Mining Basin, the most significant of which are around the towns of Madan and Madzharovo. The Madan ore region is presented by almost six parallel steep ore-bearing failures that are oriented northwest. Many vein and metasomatic deposits are located along these lines - for example, Ribnitsa - Shahonitsa - Belevitsa, Varba - Krushov dol - Stratiev kamak, Karaalievski dol - Petrovitsa - Erma reka, Sharenka - Borieva reka - Gyudyurska, and Spoluka - Strashimir. The lead-zinc fields near the town of Nedelino also belong to the Madan ore region. The Madzharovo ore region is located along either side of the Arda River south of the town of Harmanli and includes more than 45 ore veins, four of which have a very important industrial importance. The remaining ore areas that are of significance for the mining branch are the Ustrem region (between Topolovgrad and Elhovo), the Davidkovo region, the Persenk - Laki deposits, and others.

The Rhodope basin is an important mining center with a number of active mines and flotation factories.

The mining and metallurgical industries create significant environmental problems with their large-scale development.

The consequences of land disruption and environmental pollution are now at the center of the attention of the global public (Atanasov, 2007).

Industry has a direct impact on all environmental components - air, water, soils. Mostly landscape pollution is associated with releases of harmful substances into air and waters, previous accumulations of harmful substances in the soil, unresolved problems with waste, etc. In mining industry, the risk of contamination is also observed in tailing ponds (acidic and containing heavy metals sewage and sediments). Acidic ore depositions are a long-term problem, as well as the potential danger of accidents and failures .

The extraction and processing of natural resources have led to high levels of pollution, deterioration of the environment and depletion of resources.

Nowadays, it is necessary to search for opportunities for rational utilization of natural resources while preserving the purity of the atmosphere, water and soil.

The rational use of natural resources and the protection of the environment are questions that interest not only scientists, but also governments of many countries and public figures and organizations (Atanasov, 2007).

This paper examines the different sources of environmental pollution from mining activities in the Rhodope Mining Basin.

Pollution of waters from mining activities

One of the most serious environmental problems is the generation of acidic drainage water leaking from different deposits, ore and waste dumps. Because of their high acidity (extremely low pH), these waters lead to the disappearance of the entire flora and fauna in the water intakes where they are discharged.

The formation of acidic ore water is a natural process that goes through all the stages of function of a specific mine working. The oxidation of sulphide minerals, mainly pyrite (FeS2), chalcopyrite (CuFeS2), sphalerite (ZnS), galena (PbS), arsenopyrite (FeAsS), cinnabarite (HgS), etc., leads to generating waters that are acidic and with a high level of sulphates, Fe, Mn, Al, Cu, Zn, Pb, and other toxic elements. All of these heavy metals are soluble, mobile, and can be transported over long distances away from the source of the pollution (Panayotova et al., 2013).

The sources of wastewater are the functioning or the already abandoned open pits and underground mines, the landfill waste, transport roads, etc.

The adverse environmental impact of water discharged from mining activities includes: acidification of water; metal pollution; increasing the concentration of the dissolved salts in water bodies where mine waters are discharged; silting.

The negative impact of acidic ore water is the strongest, since the pH of the water bodies where such water is discharged reduces. Hence, their corrosive effect increases. Acidified waters are not able to support the life of aquatic organisms. Heavy metals (Pb, Cd, Hg, Cu, Zn, Ni), even in very low concentrations, are toxic, especially for the aquatic fauna.

In cases when the mine waters are not acidic, they have high mineralization, high concentrations of suspended solids, and often bacterial contamination. The water in these cases usually contains calcium (Ca), magnesium (Mg), sodium (Na), potassium (K) cations, and basic anions are sulphate (SO_4^{2-}), chlorine (Cl^{1-}), fluoride (F^-) , nitrate(NO_3^-), hydrogen carbonate (HCO_3^-), and carbonate (CO_3^{2-}) (Panayotova et al., 2013).

All mining activities require a huge amount of water: dust suppression after blasting, ore processing and transportation, and landfilling of waste and sediments.

Opportunities to reduce water pollution from mining activities

With current technologies, it is almost impossible to stop the generation and prevent the leakage of acidic ore water since fast chemical processes occur. It is necessary to put in more effective means for the treatment of acidic ore water, for discharging and landfilling of sludge. The best opportunity to prevent from acidic ore water is to reduce their generation by contacting sulfide-containing ores with air and water.

For mining waste with high pyrite content, it is necessary to reduce the oxygen flow. The passive prevention is by means of covering the waste with a water layer or a dry mass. For the dry cover layer, waste material is used that is obtained before reaching sulfide ores or materials from abandoned tailings. The water coating is a lagoon that may contain material from the tailing ponds. In both cases, the purpose of the coating is to prevent or reduce the weathering of sulfide minerals to insignificant levels by preventing the flow of oxygen to the pyrite and other sulfide minerals.

The storage of sulfide-containing materials under water reduces the microbial population with oxidizing capabilities and allows the development of sulfate-reducing bacteria. These bacteria contribute to the reverse process - the reduction of sulphate ions to sulphide ions, which help the precipitation of mobile metals in the form of metallic sulphides. The formed sludge is drained through channels or underground drains.

To optimize the effect of the coating, sulfide-containing materials need to be placed below the level of the underground water and the depth of atmospheric oxygen penetration reaches the underground water level to the utmost. One of the most important requirements in designing the coating system is its long-term integrity.

Often, in order to reduce the possibility of generating acidic ore water in waste banks, sulfide-containing waste rock materials are mixed with unslacked lime (CaO), ash, and slag from blast furnaces rich in Al_2O_3, SiO_2, CaO, and MgO.

When mining water is placed into consecutively connected tanks for precipitation, the amount of insoluble suspended solids in the water to be discharged is reduced.

To collect the drainage water from waste banks, it is necessary to construct a drainage ring. The addition of a suitable coagulant helps to precipitate the coarsely dispersed pollutants directly into the drainage ring (Panayotova et al., 2013).

Reclamation of damaged area

Mining industry has a negative impact on the environment, and the restoration of damaged areas is much slower. One of the serious tasks of landscape construction in regions with developed mining industry is the reclamation of damaged areas. Its purpose is to enable "technical lands" to be reused in agriculture and forestry.

According to the normative documents that regulate the preservation and restoration of the environment in the open pit mining process in the whole country, since 1980 it has been obligatory to carry out reclamation works.

The process of reclamation of the damaged areas is regulated by Ordinance №26 of 2/10/1996 on the reclamation of damaged areas, improvement of low-productive lands, removal and utilization of the humus layer (Prom., SG, issue 89 of 22/10/1996, amended and supplemented, issue 30 of 22/03/2002). It covers a complex of engineering, meliorative, agricultural, forestry and other activities, the implementation of which leads to the restoration of damaged areas and to the improvement of the landscape, the harmonious combination of the natural components - relief, climate, soil and vegetation.

The reclamation of damaged areas in the open development of mineral resources can only be successfully carried out in a complex way and provided that are shared enough resources and material equipment from mines for this important activity. The present and future of mining and industrial regions depends largely on the adequate accomplishment of this technological process.

The restoration of damaged natural landscapes is determined by the sanitary, hygienic, moral and aesthetic requirements of modern society and by the public interests in the future of mankind (Atanassov, 2007).

Contamination of water by mineral processing

The main stages in mineral processing are the crushing and grinding of ores, classification, flotation, compression, and filtration. The most significant is the water consumption in the flotation and transport of the concentrate and the waste, as well as a result of evaporation and infiltration in the tailings ponds.

In mineral processing, different types of waste in the liquid and solid phase are generated.

The solid wastes from the flotation are mainly rock materials and small amounts of non-extracted minerals. The liquid phase consists of water, dissolved and suspended substances and compounds, and unused during the flotation reagents. The liquid phase is usually taken to tailings ponds in which the suspended particles precipitate. Certain natural physicochemical processes also lead to the formation of slightly soluble compounds. The clarified liquid can be returned to the mills or to be discharged in natural water sources, provided that it meets the water quality standards. Depending on the processed ore, the used reagents, and the processes, different liquid and solid wastes are generated. The suspensions from grinding and from gravity enrichment are also disposed in tailing ponds.

The added flotation reagents are precipitated, neutralized and adsorbed on the surface of the mineral particles, but in some cases some of them remain dissolved in the wastewater, requiring the application of measures to prevent the pollution of the environment.

The type and concentrations of pollutants in wastewater from flotation depend on the type of enriched material (copper ores, copper-molybdenum ores, iron ores, lead-zinc ores, nickel ores, sulfide ores, oxide ores, mixed type, etc. or industrial minerals, coal). In general, wastewater contains: heavy metal ions (lead, zinc, copper, cadmium, manganese, molybdenum, iron, nickel), increased concentrations of other metals (aluminum, calcium, sodium), increased concentrations of sulphates, arsenic, selenium, sulfides, chlorides, phosphates, cyanides. The main inorganic pollutants in wastewater from the flotation of lead-zinc ores, processed in the Rhodope region are Pb, Zn, Hg, Cd, Cu, Cr, Mn, Fe, CN.

Often the waters are contaminated with organic reagents: collectors (butyric and some aromatic amines, sulfhydryl collectors - with basic xanthogenates, dithiophosphates (aerofloites), dithiocarbamates, products from the distillation of oil and tar); regulators - mercaptans (thioalcohols and thiophenols); Foaming agents – compounds, containing carboxyl (-COOH), carbonyl (= C = O), amine ($-NH_2$), sulfo group ($-OSO_2OH$ or $-SO_2OH$) Waters are usually neutral, but some cases of releasing low acid (pH 4.0 - 4.5) or slightly alkaline (pH 8.0 - 8.5) water are also observed (Panayotova et al., 2013).

Measures to reduce water pollution from mineral processing

One or more of the following mechanisms for the efficient use of water are chosen:

• In the processing plant:
- Installation of thickeners to obtain a high density concentrate;
- Installation of filter presses;
- Primary water transport of the concentrate, with subsequent water recovery.

•In tailing ponds:
- Filtration of the waste suspension feeding from the ore-dressing plant to the tailing pond;
- Additional feeding of flocculants and / or alkalizing agents (calcimine) to accelerate flocculation and precipitation;
- Improvement of the tailing pond to achieve a higher water recovery rate, as evaporation and infiltration losses are the greatest;
- The bottom and walls of the tailing pond must be covered with a waterproof material such as gravel, clay or processed ore after leaching;
- A fine waterproof material must be accumulated on the bottom and the walls of the tailing pond to prevent or reduce the infiltration of contaminated water into underground or surface water;
- Installation of drainage in the tailing pond for the reduction of filtration losses (Panayotova et al., 2013).

Conclusion

Finally, it should be pointed out that the above measures do not cover the full list of conservation measures that can be proposed for the protection of the environment damaged by the result of mining and processing activities. The main concern is not just to know but to apply those in practice. It is necessary to move towards economically justifiable solutions and environmentally friendly technologies.

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