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Environmental problems in the Kazakhstan coal industry and their solutions

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Abstract. This article discusses development of the coal industry in Kazakhstan after the 1990s and environmental problems caused by the coal industry. Along with industrial development, an increase in coal production, the level of environmental pollution is increasing. The authors say that transition to the market economy increased the economic potential of the republic, including coal companies, and caused an environmental crisis. The problem can be solved by maximizing the economically viable use of all types of waste and resources of the developed coal fields. These activities will solve geo-ecological problems, improve the environment through the greening of economic activities focusing on the needs of future generations. The methodological basis of the research is scientific objectivity which made it possible to analyze the subject taking into account economic changes in the industry.

1. Introduction

The coal industry in Kazakhstan and other republics of the former Soviet Union developed in hard conditions [1–4]. In 1991, the total coal production was 130.4 million tons, or 20.7 % of the total coal production in the territory of the former USSR. The industry had 26 mines, 7 deposits. Factories washed 27 % of all coal mined, including 98 % of coking coal. Coal was shipped to all republics of the former Union and Eastern European countries. The fundamental changes in the sociopolitical situation, acquisition of sovereignty, development of commodity-money relations, a decline in coal production required a search for new approaches in the coal industry. After the privatization of coal-mining enterprises, there has been a gradual recovery from the crisis. At present, the difficult period of coal production restructuring has been completed, positive results have been achieved, coal production volumes have increased.

2. Discussion

Transformations ensured the transition of the coal industry to market relations. Today, the coal industry produces 78 % of energy; there are opportunities to meet fuel needs of the household sector. There are 33 coal mining companies (5 foreign and 28 national ones). For ten years, they have invested more than 3 billion US dollars in the subsoil use of coal. In comparison with 1996, the volume of investment increased 10 times; in 2006, it amounted to 428.7 million dollars. Currently, coal production is 95–96



million tons per year. The expected volume of production will be 97 million tons. Taking into account the urgent need to ensure newly commissioned generating capacities with solid fuel, the Concept of development of the coal industry until 2020 has been developed. It involves an increase in coal production up to 145.6 million tons by 2020, or by 49.3 million tons, including coking coal – up to 24.3 million tons or by 11.4 million tons, thermal coal – up to 121.3 million tons or by 37.9 million tons, which meets the needs of domestic and foreign markets in coking and energy coals.

2.1 Problem statement

Coal-mining enterprises have a significant impact on the environment, as coal and surrounding rocks extracted and their processing products pollute it with dust, soot and gases. Methane and carbon dioxide create negative phenomena. Water from mines contains a large amount of salts and various solid impurities that pollute water intakes. Location of the rock in dumps cause land degradation. In order to reduce harmful effects on the environment, coal enterprises carry out very labor-intensive environmental protection works. The aging of mine equipment, hard mining and geological conditions due to the transition to deeper horizons decrease technical and economic performance and deteriorate the ecological situation caused by an increase in the anthropogenic impact on the environment. The coal industry is a basic component of the fuel and energy industry and the raw material base of metallurgy; it is one of the leading industries in the economy of Kazakhstan. As of 2016, Kazakhstan ranked eighth by coal reserves (25.6 billion tons, or 2.2 % of the world reserves, the BP Statistical Review of World Energy, June 2017) and tenth by the coal production volume (102.4 million tons, or 1.4 % of the world production volume).

In 2016, according to the British Petroleum company, Kazakhstan consumed 56.5 % of coal, 20.9 % of oil, 19.1 % of natural gas, and 3.3% of hydropower. The coal industry is one of the most important resource sectors of the economy of Kazakhstan. There are more than 300 coal deposits with geological reserves of 170.2 billion tons. More than 9/10 of all coal reserves are concentrated in the central and northern parts of the country. The largest basins are Ekibastuz (12.5 billion tons), Karaganda (9.3 billion tons) and Turgai (5.8 billion tons). 70% of coal reserves are mined in three giant fields (Bogatyr, Severny and Vostochny mines) in the Ekibastuz basin (Pavlodar region) and in four fields in Karaganda region (Borlinskoye, Shubarkol, Kushokinskoye and Saryadyr). The remaining coal reserves are mostly mined in the Karaganda basin (for the needs of local metallurgical enterprises). The coal industry is one of the largest sectors of the national economy which provides for the production of 74 % of electricity, full loading of coke-chemical production, satisfies needs of the population. Coal is widely used in heavy and mining industries, other industries related to mining. The share of metallurgy and other industries in the overall structure of coal consumption is comparable to the indicator characteristic of the household sector (approximately 20 % of the total consumption) [5].

2.2 Environmental problems of the coal industry in the Republic of Kazakhstan

The economic success of the industry is due to the commercial interest of coal companies which often violate environmental requirements. At present, among the real dangers, environmental issues are crucial due to technological impacts on the environment, including man-made transformations of the subsoil in the mining process. In the last quarter of the twentieth and the beginning of the twenty-first centuries, humanity faced serious environmental problems in mining operations. They are caused by man-made and natural processes. Large-scale and intensive activities lead to the accumulation of environmental problems, decrease economic capacities of the natural environment. At present, it is impossible to indicate a single source of energy whose use would not cause the degradation of the natural environment (NE).

In the republic, the main amount of harmful substances emitted into the atmosphere by extracting industries falls on the oil-extracting, coal and gas industries. Nearly 80 % of total emissions are sulfur dioxide, carbon oxides, nitrogen oxides and hydrocarbons. In addition, mining enterprises are the largest water consumers; they consume 30% of fresh water used in the country and up to 75 % of water used by industries. The coal industry has the largest discharge of polluted wastewater. Coal mining is

accompanied by issuing and placing of 150 m³ of host rocks and 100–120 m³ of waste. With the extraction of one million tons of coal, up to 7.5 hectares of land in mines and up to 20 hectares in quarries are disturbed. When mining fields, the earth's surface subsides, the amount of subsidence varies from 12 to 20 m which causes losses of agricultural land. The development of coal deposits causes damage to all elements of the biosphere.

The solution of environmental problems, reduction of the load on the environment should be accompanied by creation of an underground system, a closed water system excluding the discharge of untreated water into external water bodies; systems for processing solid waste, reduction of alienation of land for their storage; creation of raw coal enrichment systems, dust suppression systems, a complex-mechanized technology for development of environmentally sensitive parts of the array, including near aquifers [6].

Analysis of environmental protection measures in individual mining regions shows that most technical solutions and measures are aimed at neutralizing and eliminating effects of production activities, rather than eliminating their sources. Reduction of the negative impact on the environment is carried out through partial restoration of the disturbed natural state which is achieved through land reclamation, clarification and purification of wastewater, dust and gas recovery by heat and power plants.

Environmental activities associated with achievement of established standards require significant costs. Water and air purification technologies, water treatment and gas trapping facilities are imperfect and ineffective [7]. Since there are no integrated treatment technologies, only a few dozen harmful substances are caught by treatment plants, and other are emitted into the air. These measures are ineffective, since they do not eliminate causes of negative phenomena which deteriorates the ecological situation in the coal mining regions. Without a significant amount of expenditures, it is impossible to eliminate harmful effects of coal mining.

The greening of a coal enterprise depends on technological processes of coal extraction, rational use and protection of the subsoil, complex use of waste to produce marketable products, elimination or reduction of environmental pollution, land violations, water circulation cycles and closed fuel and energy structures. Requirements are a system of restrictions (environmental and economic), technological directions and possible technical solutions for coal mining, rational use of natural resources and protection of the natural environment. During the extraction of minerals, a large number of mine, quarry and drainage waters polluting water bodies are released onto the surface. Phenols, aromatics and other pollutants in mine waters fall into the underground aquifer of groundwater and pollute it causing serious environmental and economic damage [8]. Currently, there is no universal technology for treating mine and other wastewater from soluble organic substances. Depending on the physical and chemical composition and technological properties of mine waters, various methods can be used to purify them.

2.3 Possible solutions to environmental problems in the coal industry of the republic

To solve environmental problems, drastic measures are required. It is necessary to develop low-waste production based on the integrated use of mineral and energy resources of mines and other enterprises of the coal industry. Extraction and enrichment of coal are integral parts of heat and electricity production. Therefore, a coal enterprise should be part of an energy enterprise. The final product is electrical and thermal energy. It is important to improve energy efficiency and environmental protection in the coal-energy enterprise in all the links of the technological chain: extraction and processing – energy production – energy consumption. Secondly, technological processes of the coal-energy enterprise will make it possible to use natural resources, create and apply waste-free and energy-saving technologies taking into account advantages of a through-production cycle. The organic combination “TPP – coal enterprise” will make it possible to reduce losses in the power supply network, utilize recovered energy of coal mining waste (methane, low temperature mine water, air flow, flue gases, recycled water, etc.) with a maximum efficiency.

In addition, it is necessary to use waste coal as a fuel. Since solid waste from coal combustion is much more in power plants than in coal-fired boiler houses, it is necessary to use it for laying the mined-out space in the mine which will make it possible to eliminate inevitable rehabilitation works. According to [9], technologies should be developed for processing and placing rocks in the mines without storage them on the surface. To reduce the volume of pumped and treated mine and quarry waters, appropriate technologies should be developed to reduce permeability of rocks, separation of the process and drainage water flows, prevention of surface waters from entering, dumping of highly mineralized waters in geological structures, etc. Implementation of these tasks can be achieved with through the integrated use of coal industry waste provided that waste should be considered as a product rather than a goal. Waste products should differ in technological stages of their formation; states of aggregation; valuable components; degrees of damage to the natural environment; costs [10].

Kazakhstan is developing a nationwide waste management program. The program is aimed at reducing waste, including coal products, processing accumulated industrial waste and land reclamation. Despite discussions about feasibility of valuation of natural resources, most countries recognize that natural resources are owned by the society, and the state is entitled to withdraw. The Statistics Division of the UN Secretariat summarized statistical data on natural resources in a number of countries and developed international recommendations of the environmental-economic accounting system (EEAS). The EEAS concept helps assess the relationship between the nature and the economy in the reproduction process taking into account the consumption of natural resources and the return of production wastes to the natural environment, preservation and improvement of the quality of the environment.

The study on water purification methods [11] shows that a sorption method can be applied using both natural and synthetic sorbents to purify natural and industrial wastewater from metals. This method can purify water from any contaminants. The process is easy to manage. At the same time, sorbents should be cheap. In combination with a sufficient depth of purification, they can be used to solve environmental protection issues.

Industrial activated carbons are very expensive, their number does not meet the demand. In the Republic of Kazakhstan, carbon sorbents are imported from the Russian Federation. The Chemical and Metallurgical Institute n.a. J. Abishev (Karaganda) developed a technology for producing carbon sorbents from low-sulfur, low-phosphorus Shubarkol stone long-flame coal characterized by low ash content (5–15 %) [12]. The sorbent fraction of 0-5 mm can be used instead of activated carbon in the process of wastewater treatment. Active carbon sorbents are produced from brown coal. Coal sorbents are worse than brown coal sorbents. The sorbent produced by the technology of the Chemical and Metallurgical Institute is unique, since it is not worse and cheaper than brown sorbents. The high content of volatile components in Shubarkol coal (about 45%) predetermines formation of a porous structure. The developed technology can be used to produce relatively cheap adsorbents.

3. Conclusion

The lack of a mandatory preliminary expert assessment of environmental consequences of the use of scientific and technological developments, effective economic levers that encourage economic managers to use natural resources rationally, departmental disunity in environmental protection, imperfect legal sanctions, localism and negligence of officials complicate the environmental situation. Moreover, the lack of awareness of about the state of the environment, relevant knowledge and practical experience in this area, passive behavior of coal enterprises and citizens, the lack of ecological culture, belief in inexhaustibility of natural resources make the situation even worse. All these economic, legal, managerial and ideological factors are a base of the braking mechanism that impedes the optimization of environmental management. Unfortunately, a complex system of environmental and economic indicators has not yet been developed. Ways to optimize permissible limits of economic and environmental parameters taking into account mining effects have not been determined. Therefore, the most important problem for effective development of the coal industry is implementation of a program for comprehensive assessment of the environmental impact of coal enterprises. It should encourage them to develop an environmental management system.

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