COAL MINE SUSPENSION AND ABANDONMENT

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Mining operations are often suspended or abandoned due to depletion of colliery reserves or unfavorable economic and market conditions. “Abandonment” is defined as an act of complete cease from maintaining coal mines, developing and producing coal reserves without possibility of return [5]. “Suspension” is termed as the act of stopping or delaying mining operations for a usually short period of time. In accordance with Art., 26 of the Federal Law “On Subsoil” [2], the suspension and abandonment of mines and other facilities related to coal mining operations shall be made at the expense of mining companies-subsoil users with due regard to environmental protection of natural resources located on or below the Earth’s surface.

In case of undue control, these suspension and abandonment works could cause severe damage to the territory and have a negative impact on individual lives and operational and commercial activities of neighboring enterprises. Sometimes, it is even required to relocate the residents of towns (settlements).

There are three basic methods to suspend coal mines [6]:

- “wet” that implies complete flooding of a working with water;
- “dry” that implies preservation of mine drainage;
- “combined” that implies the constant level of water in suspended mine.

The manner of method application is an individual choice which is basically defined by geological and hydrogeological characteristics of the territory.

The “dry” method involves either preservation of water drainage for the operation period of neighboring mines which are connected with the mine being suspended by water communication system or provision of constant water drainage in order to prevent flooding of mine workings. During this period, the costs of mine maintenance are rather significant.

The “combined” method assumes the constant control of water level in order to eliminate a possibility of water irruption into the mine workings of neighboring enterprises and unexpected flooding of farm lands and other territories of social nature.

The “wet” method implies the shutdown of water drainage and water flooding of mine workings. The dynamic level of mining water should achieve the value close to the initial static ground water level. In this case, waterlogging and minor flooding occur in lowlands and depressions both at mine field, and in adjacent areas ($R \geq 1\text{-}1{,}5$km). It is worth noting that this method is considered the cheapest one. It is a common place when selecting the “combined” method of mine suspension, the enterprise firstly complies with the prescribed requirements and monitors the implementation of safe procedures in suspended mine working. However, if the pump is broken, the enterprise is not always ready to buy a new one, which results in automatic transfer from “combined” to “wet” method of mine suspension. The costs of “combined” method are significantly higher than that required for commissioning a new mine working, however, due to unfavorable market conditions and irrelevance of the coal rank, discontinuation of this coal sales is considered to be necessity.

Among the above-mentioned suspension methods, the “wet” one is proved the most environmentally unfriendly. In accordance with the data and results of long-term research carried out by All-Russian Research Institute of Mining Geomechanics and

Survey [1], the following types of risks have been identified in seismic-geodynamic polygons:

Hydrogeological: – disturbance of steady regime and dynamics of groundwater level fluctuations, which leads to flooding, land degradation, and subsequent swamping;

Geochemical: – contamination of water resulting in "infection" of soil, drink water resources and other ecological consequences; at the first stages of mine abandonment, the sharp increase in suspended materials concentration is often observed (100 or even more times higher); at the second stage, there is increase in the concentration of Fe (up to 80 MAC – maximum allowable concertation – based on Sanitary-Hygienic Standard [4] and heavy metals (up to 300 MAC); at the subsequent stages, in 60 percent of the cases hydrogen sulfide pollution is observed; for example, based on the data provided by Kuzbass Health, Safety and Environmental Monitoring Center, the level of hydrogen sulfide pollution was 12000 times higher than MAC in Severnaya mine working and the mine n.a. Dimitrov and 9000 times higher in the mine working n.a. Kalinin;

Seismic: – seismic activation that is usually manifested in technogeneous earthquakes caused by the increased pressure of surplus water masses on building components of geo-environment (the magnitude up to 3.5 MSK scale);

Geomechanical: – activation of land movement and caving on the surface in the zones of seam outcrop where pumps are installed; this constitutes the risks of building and facilities basement damaged as these phenomena are of impulsive and hard-to-predict character; during the period of mass closure of colliery enterprises in Kuzbass region in 1997-2005, 4820 cave-prone areas with 911 residential houses were identified in mine takes of the coal mines which were being abandoned within the frame of the coal-mining restructuring program. Precisely, during the period of mine flooding 430 caves on the surface of these mining sites were identified, with the total volume being 200 000 m^3.

Gas-dynamic: – accumulation of harmful gases ($CO_2$and CH_4) in basements, underground communication, residential building, soil layer and atmosphere of residential areas; as methane has no color and odor, it is difficult for a person to detect its presence without special detectors; penetrating into basements, due to a weak spark ignition methane can develop into a detonation; A number of fatal cases have been detected in Rostov region.

Endogenic: – coal ignition and combustion during its oxidation in in the zones of seam outcrop where pumps are installed; these zones are characterized by seam aeration.

Due to serious environmental threat, the total effect of all mentioned risks on the environment and local residents deserves increased attention and should be carefully tackled. Besides, ignorance of this problem could result in significant economic losses of neighboring coal-mining enterprises. Being connecting vessels, the mining workings constitute an integrated geological system. Consequently, the increase in surface water level in one mine can increase the water level in the next one, which represents so-called "chain reaction" of departure of mining enterprises from the market.

The significant damage to public health and human welfare, and the environment was done during 1992-2000 when a great number of coal mines were abandoned in a short period without due regulation and supervision of normative requirements implementation. The accident in "Sapando-Kapital'naya" mine [3], Rostov region is a vivid example of such a negligence that can cost the lives of dozens of innocent people and hundreds of human fates. At the beginning, "Koshkinskiy" water drainage was used in the nearby suspended mines "Stepanovskaya", "N.a. Lenin", etc. However, this drainage system became damaged. Due to lack of money required for water drainage repair, water started accumulating in underground lake. It was the responsibility of the party in fault to

liquidate this lake, however, the company decided to neglect this fact despite the significant risks and hazards. Finally, water of underground lake (V≈ 28 mln.m^3) broke through above "Sapando-Kapital'naya" mine.

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ENVIRONMENTAL PROBLEMS IN TRANSPORTATION OF HYDROCARBONS

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One of the most important environmental problems of the XXI century is emergencies arising during transportation of hydrocarbons. Thus, according to Greenpeace, the loss of the oil feedstock in the production and transportation in Russia is about 1%, and according to "Centre of Ecology of the fuel-energy complex" – 3.5-4.5% [5]. During transportation of hydrocarbons there are many difficulties that seriously affect the ecological state of the environment components.

Oil and gas transportation from the field to the consumer using a pipeline is the most common way of transporting oil: 99% of the "black gold" is delivered to destinations in this way. In this regard, one of the global problems is the oil spill during transport by pipeline. This is due to the fact that the life of the pipe steel and insulating coatings of 55% of oil has already expired and the possibility of manufacturing defects is quite large [3]. Only in our country there occur 50-60 accidents annually. The result of this situation is the large number of accidents involving oil spills, which lead to serious consequences for the environment. Remediation of contaminated areas is an expensive process, so it is much more profitable to invest all possible resources in the prevention of accidents [1].

To reduce the risk of accidents it is necessary to raise reliability requirements for oil pipelines. Today the technology and the production of anti-corrosive coating of pipelines are constantly improved; the use of flexible piping reinforced with plastic and having an unlimited operation life is being mastered. The most progressive companies are putting special systems for monitoring pipelines. To do this, a variety of technologies and strategies, from bypassing by people to controlling the objects from satellites, is applied. Nowadays a system of tracking the main characteristics of hydrodynamic processes (pressure, temperature and flow behavior of the fluid) is widespread. The data obtained are