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ENVIRONMENTAL AND SAFETY PROBLEMS OF OSTRAVA-KARVINÁ DISTRICT

Summary. Basing on the Ostrava-Karvina District example the article shows a whole number of environmental problems caused by the character of mining industry. One of the most dangerous is a non-controlled leakage of mine gases which explosiveness and cumulation can lead to a danger of crashes and extraordinary events.

PROBLEMY ŚRODOWISKA I BEZPIECZEŃSTWA REJONU OSTRAVA-KARVINA

Streszczenie. W artykule przedstawiono szereg istotnych problemów ochrony środowiska w rejonie Ostrava-Karvina, związanych ze skutkami zaniechanej eksploatacji górniczej na obszarach zlikwidowanych kopalń. Szczególnym problemem jest zagrożenie niekontrolowanymi wypływami gazów niebezpiecznych oraz ich gromadzenie się w strefach i obiektach na powierzchni.

1. Introduction

The contradiction between the raw materials resources utilization and environment protection is generally known. Character of mining industry leads to the rise of a whole number of environmental problems. The land occupation, subsidence and destruction of surface, dustiness, rise of wastes from mining and treatment of mineral raw materials, noise level and others belong to them. Nor the finishing of mining activity can prevent from these problems rise – e.g. the surface subsidence continues a whole number of years after underground mining finishing. In last years, in the Ostrava-Karviná District (OKR) a further problem connected with finishing of underground mining occurred which is of an important

safety character. This is a question of non-controlled leakage of mine gases, especially methane, due to finishing of mining, artificial ventilation and degassing of underground mines. The explosiveness of mine gases and their cumulating in residential and industrial objects led to rise or danger of crashes and extraordinary events. The non-controlled leakage of mine gases in localities with finished mining activity becomes so the most important safety, res. environmental problem of the Ostrava-Karviná District.

2. Exit of mine gases on the surface

In the existing Ostrava-Karviná District the coal mining in small range started more than 200 years ago, at first on surface outcrops of the seams, later the exploitation was led in the underground. A whole number of prospecting as well as mining mine workings was sunk, in the initial time periods with short service life. Not all these mine workings were liquidated properly, however, as a rule, they were in reach of ventilation systems of productive mines.

In the year 1991, the mining activity phasing out and mines liquidation start in the OKR. This process was connected with the finishing of ventilation of the mines liquidated, flooding of mine spaces and backfilling of shafts. Herewith, the taking off of mine gases to places of controlled harmless outlet is decreased or finished. The mine gases start to exit in an uncontrolled way, and namely *in points* (e.g. the exit through the mine workings in the underground mouthing on surface) or *in areas* (through tectonic zones, from worked out seams in places of gas-permeable covering formation). The result was a number of crashes and extraordinary events connected also with the mortal consequences. It concerned the explosion of methane in canteen and in family house, filling of subways and tram platform in the Ostrava city center with gas, filling the under-surface objects, garages, cellars etc. with gas, area exit of methane in the space of built-up area, industrial object, playground.

3. Solution of problem of the mine gases exit

The beginnings of the solution of the problems concerning the mine gases exit on the surface are related to the year 1994, so several years after commencement of mining activity phasing out and liquidation of underground coal mines in the OKR. The extraordinary events

connected with the uncontrolled methane leakage represented the immediate impulse for it, and namely both in OKR and in abroad.

The existing experience leads to the proposals concerning the realization of measures in the sphere of active and passive prevention.

Passive prevention should consist in distribution of the region into separately solved areas, and namely with the help of individual degassing bore holes or whole degassing systems. An important part is also the searching for and securing of old mine workings as point sources of the mine gases exits.

Active prevention should concern especially the construction of active degassing systems which create the underpressure in the underground artificially and take off the mine gases on the surface.

The commercially new approach to solution of the problem of mine gases leakage on the surface is the stowing of underground spaces, and namely single mine workings or whole mines. In this case this would be a question of the way of the underground mines liquidation.

The background is the consideration that the problems connected with the releasing and leakage of mine gases arose especially due to impairment of rock massif homogeneity and initiation of pressure manifestations in the rocks containing the coal seams, and namely due to mining activity. On this basis there came to rise of communication ways with the possibility of local concentrations of mine gases and their exit on the surface.

From purely theoretical point of view these safety and ecological risks could be eliminated or significantly limited by putting the rock massif into the original non-impaired state. Practically, it is possible to try to achieve this state partially by stowing of underground spaces which would lead to breaking of communication ways and liquidation of free spaces in the underground. The substance of this problem technical solution is known from the past when, in the underground of productive mines, there came to stowing of free spaces by hydraulic non-washable fills produced on the basis of electrical power plant and thermal power plant ashes and flotation waste rocks, especially with the aim of limitation of spontaneous fires and short circuits in ventilation draughts, for benching technology in mining of thick seams and moderation of deformations and surface subsidence.

An objection of economic demands can be applied to this process and mining practice confirmed it, in a substance – increase of mining activity costs and decrease of working productivity led to leaving this part of mining technology. Under this situation, however, the uncontrolled exit of mine gases did not occur because an effective system of ventilation existed on productive mines.

In the contrary, as the support of stowing, besides the risk of methane exit on the surface the basic innovation consisting in utilization of industrial wastes for production of mining construction materials (stowing mixtures) can be mentioned when the processor of industrial wastes is paid for their take off from the originators of these wastes and contributes, at the same time, to limitation of these wastes depositing on surface stockyards. The creation of surface stockyards not only defaces the landscape but represents the potential risk of ecological catastrophe, e.g. in case of floods. The Ostrava region is loaded by industrial wastes from mining activity, metallurgical as well as chemical industry, so the processing at least of a part of these wastes seems to be very of great contribution from the ecological point of view.

The stowing of underground spaces as the prevention of mine gases exit on the surface differs from stowing of underground mines in some aspects:

- the relation on old mine workings, in a substance, eliminates the stowing on productive mine, herewith the objection of increasing the mining costs and drop of working productivity of productive mines falls
- the stowing of underground spaces will have the form of liquidation of mines with the mining finished, so it will be necessary to cover the continuous costs of the mines being liquidated (i.e. costs connected with ensuring the necessary operation of equipment in a mine and on the surface of the locality being liquidated and with ensuring the activities connected with the management of a mine liquidation)
- in case that in given locality the technical liquidation of a mine has already started the underground can be filled in with the help of surface bore holes mouthing into old mine workings and free spaces, and namely into newly drilled bore holes or old bore holes, so into such ones which already have not met the requirements and purpose for which they have been realized.

From given possibilities, the last case is ideal from the economic point of view, so the **utilization of old bore holes (probes) for depositing of industrial wastes processed** because the business subject realizing the take off and processing of industrial wastes and depositing of arised mixtures in the underground:

- expends negligible fixed costs connected with the technology of depositing
- it is paid by originator of industrial wastes for their take off
- it saves the locality owner (mining companies or state) costs for liquidation of consequences of mine gases exit on the surface and other ecological or safety risks, so the

business subject should have a reasonable benefit from this economy – e.g. in the form of subsidy determined for this activity.

There are not many practical examples of underground mine liquidation by stowing in the Czech mining industry, however, they can be mentioned.

The first case concerns the liquidation of the ore mine Křižanovice where, however, the reason for stowing was not the mine gases exit but the problem surface stability. All mine workings mouthing on the surface, large-space mine workings after mining and mine workings jeopardizing the surface at their caving were secured by their filling in with solidifying gob with given degree of its strength. The gob was created by concrete mixture which was transported from the surface through the bore holes lagged of the diameter 245 mm. The bore holes were located in the highest part of mine working or underground surface. Into all mining chambers the access from single sub-level drifts was ensured and, in this way, the stowing quality was checked. The access roads into the chambers were gradually closed by filtration dams. In the time period from March 1992 till November 1993 three spaces worked out, natural cavity, the third sub-level and tectonic displacement over the second sub-level were filled in. Single gob bore holes were filled in with concrete until the surface after stowing completion. Totally, 12 339m^3 of concrete mixture were used. The mine liquidation was connected with disassembly of head frame, winding engine and compressor house/room. The demolition of head frame, engine house/room and store of explosives was carried out, subsequently the terrain formations, technical and biological reclamation were carried out. The utilization of concrete mixture was possible from the economic point of view due to small range of the mine underground because the deposit was worked out only up the depth of 50 meters under surface before the mining was stopped and the mine liquidation was commenced.

The largest liquidation of the underground coal mine by stowing up to now was carried out by the firm GEMEC s.r.o. in case of the Jan Šverma Mine in East Bohemia. The hard power coal was mined here in depths up to 800 meters under surface, the production was ended in the year 1992. After the mining ended approximately 65 km of long mine workings with total free volume of 650 000m^3 were left in the mine. In the year 1993, the firm GEMEC s.r.o. taken over the Jan Šverma Mine for liquidation which was carried out by a new method - by filling in of free mine spaces by self-solidifying, incompressible and non-washable gob mixture. This mixture was created on the basis of ash matters and flotation rock wastes. The mine workings were filled in in separated sections in a such way so that the remaining part would serve further for transport of outfit disassembled, ventilation and control activity.

The goal of stowing was to achieve the reduction in the surface subsidence, prevention from creation of explosive mixtures of mine gases, prevention from mine waters contamination and pollution of water flow in their discharging.

In situation of flue ash shortage for production of stowing mixture, after the year 1995 the industrial wastes from metallurgical industry and steel making started to be used. The stowing mixtures were transported into the underground by piping in such a way so that the liquidation would run from the lowest mine level and from the most distanced mine working towards the main shaft. In the time period of the years 1993 - 2003 for liquidation of mine workings roughly 554 000 tons of flue ash, flotation waste rocks and other secondary raw materials were used. In the time being, the liquidation of the Jan Šverma Mine proceeded up to the 2nd level, whereas the leaving of the 1st level on the level of -96 m under the shaft mouth is considered, and namely for creation of inspection route for visitors who want to make acquaintance with the miners' work.

The results of an underground coal mine liquidation with the help of hydraulic stowing can be generalized as follows:

- the risk of mine waters contamination due to long-term contact with waste rocks and surface equipment including support was eliminated. The mine workings filling in up to the shafts mouth will eliminate also the contamination of rain waters.
- the accumulation of mine gases in free underground spaces with the possibility of rise of explosive or non-breathable mixture was eliminated
- the risk of mine gases exit on the surface was removed, especially through the old, non-registered mine workings what is necessary for the area where the mining with various intensity lasted several hundreds years
- the caving of free underground spaces was limited, herewith the stability of rock massif including surface was increased.

Not less important is also the breaking of distrust against the new method of liquidation and creation of legislative presuppositions for realization of this activity.

4. Conclusion

The examples mentioned above witness about technical, technological and, to an significant extent, also the legislative managing of risk elimination of mine gases exit on the

surface. After realization then, the economic aspect of underground spaces stowing remains decisive. In each case, however, the stowing of underground spaces of underground mines eliminates the safety and environmental risks connected with mining capacities with the mining ended.

In smaller scale, the filling in of underground cavities can be a suitable way of mine gases exit elimination from sub-base of construction objects in places where the exit of mine gases into the soil or construction objects is verified. More complicated is the effort concerning the breaking of communication paths in the underground with utilization of new or old bore holes, and namely with the respect of ignorance of concrete situation and concerning the size of underground spaces and permeability of rock environment for liquids and gases. Also the local effect of these measures is limiting.

On the other hand, it is necessary to take into account that the industrial wastes processing into the form of gob materials and their depositing in the underground solves not only the safety and ecological problems connected with free spaces of underground mines but also environmental problems connected with depositing of industrial wastes on the surface.

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Omówienie

W artykule przedstawiono szereg istotnych problemów ochrony środowiska w rejonie Ostrava-Karvina, związanych ze skutkami zaniechanej eksploatacji górniczej na obszarach

zlikwidowanych kopalń. Szczególnym problemem jest zagrożenie niekontrolowanymi wypływami gazów niebezpiecznych oraz ich gromadzenie się w strefach i obiektach na powierzchni. Autorzy przedstawili różne warianty możliwości działań technicznych i organizacyjnych, mających na celu ograniczenie ryzyka środowiskowego.