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title: **Current problems of mine dewatering in Upper Silesian Coal Basin (Poland)**

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Since 1990 there have been substantial changes in the organization of Polish coal mining sector. All coal mines in the Lower Silesian Coal Basin, and almost a half of the mines in the Upper Silesian Coal Basin (USCB) have been closed down. This had a major impact on the range of drainage zone due to mining activity. Concentration of mining works (Dubiński ed., 1999), constant increase in the average depth of mine exploitation (Bukowska ed. 2009) and changes in the range and intensity of the drainage enforce the changes in the system of mine water reception and surface disposal. Therefore mining activity impacts both the resources and the perspectives of groundwater and surface water management. This impact for surface water means the need of disposal of huge amounts of water of various quality into, whereas for groundwater means mainly depletion of the amounts and the quality of the resources. On the other hand there is more and more water of various chemistry filling the mine voids. This water may in turn be a source of water hazard for the adjacent mines, as well as for the fresh water resources and even for the land surface. On the other hand, this water may be a chance for a new recoverable energy sources or may be used for industrial needs (Bukowski, 2009).

There is significant vertical and lateral variability in the floodable void volume as well as in the quality of mine water in the mines of USCB (Różkowski ed., 2004; Kropka, 2009; Janson et al., 2008). On the other hand there are substantial changes in the structure of mining enterprises, which enforces the changes in mine water management and the disposal ino surface water. Quite often the changes are also enforced by the changes in EU legislation and the subsequent changes in Polish law.

For 1991, which was the year of the start of major structural changes, the total daily inflow to whole USCB mines was about 843 000 m^3. The sum of the load of chloride and sulfate ions was 8 000 tones (Rogoż et al., 1992). According to classification of mine water by Central Mining Institute (vide: Rogoż, 2004), the majority of this inflow was the fresh water, with total dissolved solids (TDS) less than 1g/dm^3 (36%) and the mere salty water, with TDS from 3 to 70 g/dm^3 (33%). So called “industrial water” (TDS from 1 to 3 g/dm^3) had a lower share (25%) and salty water (TDS >70 g/dm^3) had a minor share (6%).

For 2008 the total daily inflow to whole USCB mines was about 649 000 m^3 (23% decrease). The sum of the load of chloride and sulfate ions in 2008 was 5 000 tones (37% decrease) while average concentration of chlorides and sulfates decreased from 9,7 g/dm^3 in 1991 r. to 7,3 g/dm^3 in 2008 (Augustyniak & Bukowski 2009). The majority of the mine water was merely salty (53%). The water has been pumped by mining systems and disposed into surface water – mainly small rivers and creeks, tributaries of two main Polish rivers: Wisła and Odra.

Until 1990 in Polish coal mines the one- or multi-level stationary pumping system dominated. It was important for the selective pumping and rational management of mine water. There have been four quality groups of mine water (Rogoż 2004), with regard to the possibility of its use as drinking water or for the industrial needs. However, as regards water hazard, stationary system is vulnerable for each unexpected change (increase) in mine water inflow and requires lots of maintenance and operational efforts. The cost of operation of such system is usually a significant part of mine maintenance, of course depending on specific conditions like inflow rate, and dispersion of water collection points.

Therefore, since many mines have been closed down, the pumping systems have been simplified and a shift from stationary pumping system into submersible pump system occurred. Currently there are 9 areas with submersible pump dewatering systems in USCB created on the base of the shafts of 9 coal mines that have been closed down. Submersible pump dewatering system is usually in operation in the mines which major part is already flooded, up to the level that is safe with regard to adjacent mine, taking into consideration the water flow and the resistance of safety measures. As regards the operation costs the submersible pump dewatering system is cheap. However, from a perspective of an adjacent active mine, such system is vulnerable for the water hazard resulting from large volumes of water stored in the mine voids (Bukowski 2009). In such system the water inflowing into the mine are usually contaminated and mixed and the outflow from the system in the first stage is limited due to storage in the mine voids (Banks, Gzyl, 2007). The quality is usually suitable rather for industrial use than for drinking water purposes and the possibility of selective collection of water having different quality is usually very limited.

Lately, there is a trend to close down the mines through their inclusion into adjacent active mines; the mine voids of the part that is closed down are either flooded or included into dewatering system of an active mine. The practice to close down a mine through joining the adjacent mines is driven by the social acceptance. People somehow tend more to accept the closure, when at first two mines are joined together and then a part of one big mine is undergoing closure. However, for technical and economical reasons such practice brings a burden for the active mine, as it has to take over the dewatering of the closed mine, including investment costs, the efforts to protect the deposit and the costs of closure process, as well as refund for any damages caused by a closed mine during its operation.

In the perspective of implementation of EU Water Framework Directive (WFD) and related regulations in Polish water management and environmental laws, the organization of mine dewatering and the related environmental costs may in future be the key factors for the economy of mining industry (Ney ed. 2006). In order to reach the WFD aims it is often necessary to reconsider substantially the mine water management system. Some measures like the controlled redirection of mine water to specific parts of the mines would have to be applied. This is going to enforce huge amounts of costs for investment, maintenance as well as for the safety both down the mines, as well as on the surface. Mine dewatering systems would now need in many cases a new complicated network of pipelines, pumping stations and water galleries.

In general, the situation of current mining industry is going to change soon with the implementation of WFD. It is expected that the mine water management would become more and more important and that the significant increase in investment for surface water protection is going to be enforced.

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