Abstract

The PhD dissertation focuses on the coal dust explosion hazard, which is one of the most dangerous natural hazards occurring in underground mine workings. Despite well-understood issues related to coal dust explosion, such as the mechanism of formation, propagation, and ways to prevent and suppress it, there are occasional collective accidents in underground mine workings involving coal dust. Places considered particularly hazardous are listed in the Regulation of the Minister of Energy of 23.11.2016. The ordinance considers ten places of possible initiation of coal dust explosion, one of which is the longwall areas, in particular the coal mining areas and the intersections with the roadway. The highest intensity of settling of hazardous coal dust occurs there, so these areas require special attention from the mine dust services. All efforts must be made to ensure that coal dust explosions do not occur in the future, and it is with a sense of cautious optimism that we advocate for additional measures to reduce the risk of a coal dust explosion igniting and propagating.

One solution for assessing both the potential for the initiation of a coal dust explosion phenomenon and estimating the possible consequences of its occurrence is to carry out a coal dust explosion risk assessment in the longwall area. The Regulation of the Minister of Energy of 23.11.2016. § 443 indicates that: *'in places where explosive atmospheres may occur, a periodic risk assessment and hazard identification shall be carried out, and this assessment shall be carried out by the manager of the mine site operation at a frequency specified in the documentation securing the workplace against explosion'*. However, the legislator does not specify how such an assessment should be carried out, nor does it specify the methodology that can be used. The decision to choose the method or procedure for assessing the risk of a coal dust explosion remains with the manager of the mine site operation. This PhD thesis develops a method and tools to assess the risk of a coal dust explosion in a longwall area with a high concentration of extraction. To verify the method, four longwalls were selected from among 23 analysed areas, in which coal dust explosion risk assessments were carried out.

The longwalls were selected to represent diverse conditions regarding natural hazards, the amount of coal extracted per day, the mining method, etc. The main

parameter in selecting the longwalls was mining concentration, which was assumed at the level of at least 5,000 t/day. The risk assessment results showed that, with the varying mining and geological conditions and the different anti-explosion prevention used, the level of risk ranged from low to high. The risk assessment shows that the major problem for the mine dust services is the maintenance of 200 m longwall safety zones. In this study, a risk assessment was performed for collective accidents occurring in the Polish coal mining industry to validate the method (three case studies resulting in six scenarios). The results show that for all the accidents studied, the safety zone was in very poor condition – the content of non-combustible particles in the deposited mine dust was much lower than required by the regulations. The study established nine scenarios defining the conditions in the workings. Four were based on studies in this respect and five scenarios were developed for hypothetical, real-life conditions prevailing in the area of longwalls exploited in the Polish coal mining industry. The validation process of the proposed methodology was based on analysed coal dust accidents in underground coal mines.

The PhD dissertation also presents solutions to reduce the risk of coal dust explosion ignition and transmission, which will certainly improve mine safety in this aspect.