

ABSTRACT

Application of model tests to the analysis of methane hazard in the mining production process

The subject of the dissertation concerns one of the most important issues related to production engineering, which is the improvement of the safety and efficiency of the mining production process. It presents an original approach to this issue, including the use of model tests using the finite volume method and tests in real conditions to analyze the state of methane hazard occurring in the mining production process. The measure of this state are determined, thanks to the developed methodology, spatial distributions of methane concentrations in the area of conducted exploitation. The main element of the developed methodology is the structural model of the studied region and the phenomena occurring in it, developed using the finite volume method, classified as computational fluid dynamics (CFD). For its development, verification and validation, research were carried out in real conditions, the purpose of which was to determine the ventilation parameters of the air stream in the examined area and the geometry of this area and the strength parameters of the rocks forming the goafs. Based on the mentioned studies, a model of the mining area was developed, taking into account the ventilation phenomena occurring in it and goafs as a porous permeable medium, which has a significant impact on the methane hazard in this area during exploitation.

The acceptance of the underground mining production process for the study resulted from the fact that it is one of the most dangerous production processes, which results primarily from the very complex and difficult environmental conditions in which it is carried out and the role and importance of coal as an energy resource, used for the production of coke and used in various other industries. Events resulting from the methane hazard significantly disturb the continuity of this process, posing a great threat to the crew and mine equipment, and the natural environment. Therefore, it becomes reasonable to conduct research in order to reduce this risk, and thus improve safety and efficiency of the entire mining production process.

The research, conducted in accordance with the developed methodology, made it possible to achieve the main scientific goal of the dissertation, which was to determine dangerous, from the point of view of methane hazard, zones in mining excavations in the area of conducted exploitation. Their determination is of key importance for the activities undertaken by specialist mining services in order to ensure the safety of this process. They indicate potential places where dangerous concentrations of this gas may occur, which may result in its ignition or explosion. The dissertation also presents the results of multi-variant analyzes of potential ventilation states that may occur during operation and their impact on the state of methane hazard. Knowledge acquired from the implementation of the scientific part of the dissertation made it possible to develop guidelines for the practical application of the results obtained in order to improve safety and efficiency of this process, which also made it possible to achieve the utilitarian goal of the dissertation.

The developed structural model, research methodology and the obtained results give great opportunities for their practical application to improve the safety of the underground mining production process. The universality of these studies also allows them to be widely used to

study other ventilation phenomena occurring in this process, in order to improve safety and working conditions during its implementation.

Therefore, taking into account the huge role and importance of hard coal in Poland and the difficult and not entirely predictable conditions in which this production is carried out, it can be concluded that the topic taken up is current and important from both a scientific and utilitarian points of view and fits into the area of production engineering in the scientific discipline of mechanical engineering.