MINISTRY OF EDUCATION
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THE DOCTORATE AREA OF MINE, PETROLEUM AND GASES

THESIS
-SUMMARY-

MANAGEMENT OF VULCAN MINE COMPLEX VENTILATION NETWORK AND ESTABLISHING THE DYNAMICS OF GASES

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SUMMARY

Mining is a very heavy industry and in constant shrinking. Every day, miners take incredible risks to extract valuable ores and minerals from the earth's crust.

To ensure the underground activity, under safe conditions, adequate ventilation is required, which will ensure permanently the supply of fresh air to the work sites. Combining general ventilation with kilometres of secondary ventilation pipes, mining ventilation is a special area where errors can occur.

Complex ventilation networks include mining works paths developing both horizontally and vertically and can reach cumulative lengths of tens of kilometres. At the level of the complex ventilation networks it is necessary the optimal distribution of the air flows in order to ensure the safety and health conditions underground. During the excavation of the underground mining works, both the ones executed in the tailings and those made in the coal, the phenomenon of oxidation of the organic materials on one hand and the release of significant quantities of gases of toxic, suffocating or explosive character appear.

The goal of the doctoral thesis is to improve the management of the ventilation networks in the conditions of the occurrence of unwanted events and to establish the dynamics of the gases at the stopes level as well as the general ventilation networks.

The doctoral thesis is structured in nine chapters, eight technical chapters for presenting, processing and obtaining data and a chapter for personal conclusions and contributions. The scientific volume comprises 162 pages, 112 figures, 3 tables and 4 annexes.

The scientific approach will be addressed in three main areas:

- analysis and determination of the physical laws as well as of the aerodynamic parameters that influence the air flow process on the mine workings pathway;

- solving a complex ventilation network (Vulcan Mine) using 3D CANVENT 2000;

- identification of the dispersion degree of the toxic, explosive and asphyxiating gases under the conditions of achieving a stable mechanized ventilation with the help of the specialized program VentSIM Visual Advanced.

In the present scientific approach, the following aspects have been presented in chapters:

Chapter I. Establishing the laws that define the airflow in various environments.

Within this chapter are presented the flow flaws through the active mining works. Also, the specific parameters regarding the airflow through rocks and in particular, the airflow through saturated rocks are presented.

Chapter II. Presentation of the special programs currently used to solve the ventilation networks.

Within this chapter are presented briefly two programs used internationally, for the purpose of modeling, solving and optimizing complex ventilation networks. The first program is 3D Canvent designed in Canada and which performs the ventilation network solving in 3D microfilament system. The second, Ventsim Virtual Advanced program designed in Australia that realizes the 3D Solid system ventilation network with the possibility of rotating the entire ventilation network at any angle, for the spatial visualization of the distribution of mine workings within the complex ventilation network.

Chapter III. Management of the Vulcan mine ventilation network using the 3D program - Canvent - the initial update phase.

Within this chapter, a systematic presentation of the specific ventilation system of Vulcan Mine is made through the distribution of air flows at the level of the main ventilation circuits. It is also presented the level of achievement of modeling, solving and optimization of the ventilation network, related to the Vulcan Mine. In this sense, the two important stages are presented, namely the engineering part, which leads to solving the complex ventilation network.

Chapter IV. The management of the ventilation network for the Vulcan Mine using the Ventsim Visual Advanced program

Within this chapter the modeling, resolution and optimization of the ventilation network for the Vulcan Mine are carried out using the Ventsim Visual Advanced program. For this, the 3D Canvent database was used.

Chapter V. Underground atmosphere

This chapter deals generally with the composition of the underground atmosphere, respectively at the level of detail of the explosive, toxic and asphyxiating gases present in the underground atmosphere such as methane gas, carbon monoxide and carbon dioxide.

Chapter VI. Modification of the underground atmosphere.

This chapter deals mainly with the regime of methane releases, and in particular the regime of methane releases from the frontal stopes, respectively from the stopes with undermining in order to establish the changes of the underground atmosphere after the virtual production of an event. In this sense, the gas concentrations are determined, respectively the air flow after the event in relation to the gas concentrations before the event.

Chapter VII. Establishing the dynamics of the gas dispersion under the conditions of changing the structure of the ventilation network.

Within this chapter, at the level of the ventilation network for the Vulcan Mine, the dynamics of the gas dispersion is established both under normal conditions and under virtual simulation conditions regarding the reduced modification, respectively at the upper level of the structure of the ventilation network. Within these simulations, the dispersion of methane, carbon

dioxide and carbon monoxide are determined, both under normal conditions and under conditions of modification of the structure of the ventilation network, reduced or at higher level.

Chapter VIII. The upgrade of the Vulcan Mine's ventilation network.

This chapter covers the upgrading of the complex ventilation network of the Vulcan Mine, with the help of the Ventsim Visual Advanced program, namely the simulation of the dispersion of gases, methane and carbon dioxide under real conditions at the level of the ventilation network.

In chapter XI "Final conclusions, own contributions" we presented the thesis conclusions and personal contributions.

Here are some of my personal contributions:

- I carried out an exhaustive analysis regarding the laws of air flow through the active mining works;

- I also approached the complex field of air flow through the exploited space;

- at the same time, I presented in detail technical aspects related to air circulation through exploited space;

- regarding the circulation of air through saturated rocks, we presented the main specific parameters;

- I also presented the IT program in detail. specialized 3D Canvent, used for modeling the resolution and optimization of complex ventilation networks;

- at the same time, I presented in detail the IT program. specialized, advanced Ventsim Visual Advanced, which we used both for modeling, solving and optimizing the ventilation network, as well as for the simulations performed on it;

- To solve the complex ventilation network using the 3D Canvent program, we have taken the following steps:

• obtaining topographic technical maps;

• identification of the nodes and the branches of the network on the graphic side;

• carrying out measurement campaigns;

• entering the data obtained in the program database;

• solving the ventilation network;

• obtaining the results in graphical and tabular form.

- in order to solve the ventilation networks of the Vulcan Mine, we presented in detail the ventilation system, respectively the distribution of the air flows on its specific circuits;

- In the next phase, we went through all the steps regarding the modeling, solving and obtaining the Vulcan Mine ventilation network;

- for the in-depth analysis of the ventilation network, related to the Vulcan Mine regarding in particular the gas dispersion at the level of the active mine workings, we proceeded to solve the ventilation network with the help of the specialized program Ventsim Visual Advanced;

- to solve the ventilation network using the Ventsim Visual Advanced program, we have used the database specific to the 3D Canvent program;

- regarding the underground atmosphere as a comparative basis of the gas dispersion analysis, we briefly presented the composition of the underground atmosphere;

- I also presented in detail the main gases of explosive, toxic and suffocating nature encountered in the underground atmosphere, namely methane gas, carbon monoxide and carbon dioxide;

- in order to establish the changes that may occur at the level of the underground atmosphere, we have presented the regime of meta releases;

- also, specifically we analysed the regime of methane releases at the level of the frontal stopes;

- at the same time, we presented and analysed the regime of methane gas releases at the level of undermines stopes;

- in order to establish the changes of the underground atmosphere, we analysed the change of the post-event gas concentrations, in relation to the gas concentration before the event;

- in order to establish the dynamics of the gas dispersion under the conditions of the modification of the structure of the ventilation network, generated by the development of an event, we proceeded to solve the ventilation network related to the Vulcan Mine under normal conditions;

- also, based on solving the Vulcan Mine's ventilation network under normal conditions, we performed the gas dispersion simulation;

- in order to establish the dynamics of the gas dispersion under the conditions of the modification of the structure of the ventilation network, we realized in the first phase the network solving. After that we established the gas dispersion in the event of the virtual occurrence of an event, at the reduced level within the ventilation network;

- at the same time, we simulated the dynamics of gas dispersion, in case of virtual occurrence of an event at the top level within the ventilation network;

- for the virtual simulations regarding the dispersion of gases under actual conditions, we proceeded in the first phase to describe the main ventilation circuits;

- I also performed the modeling, solving and optimization of the ventilation network, related to the updated Vulcan Mine;

- At the same time, it was established the dispersion of the gases at the level of the upgraded ventilation network, related to the Vulcan Mine.

For the development of the field approached by the present scientific paper, the following research directions are proposed:

- generalizing the methods of modeling, solving optimization and simulation of the ventilation networks;

- Simulation of the dynamics of gas dispersion under normal operating conditions and introduction of this method in the regulation Health and Safety at Work;

- Insert the computer simulations, realized with the Vensim Visual Advanced program regarding the establishment of safe areas for personnel evacuation, in case of occurrence of events, in the prevention and protection plan;

- virtual simulation on modeled, resolved, optimized and updated networks of gas dispersion dynamics, in relation to the critical areas, respectively the different degrees of event intensity

Any scientific endeavour is perfectible and may involve improvements, refinements and additions.

The results of the scientific approach can be applied specifically to the ventilation network of the VULCAN mine, but the technique and means used can be applied to any ventilation network, regardless of its complexity.