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UPDATE OF THE VENTILATION NETWORK RELATED TO LIVEZENI MINE

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Abstract: *The ventilation networks are associated with the set of underground mining works used for the extraction of useful mineral substances. Over time, the ventilation networks involve a change in the structure due to either the expansion or restriction of the mining works structure. For the establishment of air flows at the level of each active mining work, specialized programs are used at international level. These programs allow the modelling and solving of complex ventilation networks. The most advanced specialized programs are those from the VENTSIM range. The paper presents the updating of the ventilation network related to Livezeni mine, with the help of the VENTSIM program.*
Keywords: *modeling, ventilation, network, VENTSIM program, air flow*

1. Introduction

In the underground exploitation of useful mineral substances, the mining ventilation represents the primary protection of the workers. The phenomena that can take place at the level of active mining works or at the level of the exploited space, are dynamic phenomena that require the real knowledge of the air flow distribution and their evolution in time, as the extraction process evolves [1, 2]. In this sense, solving the ventilation networks with the help of the calculation technique represents a huge step forward that allows the practitioners to anticipate the possible disturbances in the ventilation system [3, 4, 5, 6, 7].

2. Presentation of the ventilation network of Livezeni Mine

E. M. Livezeni has two independent ventilation systems, which have a source of fresh air inlet [8]. The Main Shaft and the Auxiliary Shaft inside E. M. Livezeni, as well as Shaft no. 3 inside Maleia. Their ventilation is provided by two fan stations located as follows:

• PA-2 fan station inside Maleia, with 2 VOD type fans - 2.1.
• PA - East fan station inside Dâlja Mică, having 2 V.A.D. type fans - 2.1.

In the Livezeni mining field, in 2021 the following strata are exploited:

- layer 3 at the horizon level. 300, in block VI;
- layer 13 at the horizon level. 100 block IX and block VII.

The existing coal reserves in the respective blocks are exploited by approved framework methods for Jiu Valley, respectively classic frontal abatements with long front and mechanized support.

3. Presentation of the Ventsim program

Ventsim Visual ™ Standard and Advanced has been developed to meet the requirements for simulation and design of underground environmental conditions, to ensure adequate conditions for miners and equipment.

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First, it was designed as a ventilation tool, which can work independently of other mine planning software, but ensures a high level of compatibility [9]. Ventsim Visual ™ offers a complete set of closely integrated utility tools to analyze airflows, heat input, contaminants and financial aspects of mining ventilation. Ventsim Visual ™ aims to make the simulation of ventilation networks accessible to any mine engineer or ventilation specialist.

Ventsim Visual ™ Advanced provides tools on:

• Simulation and recording of air flows at the level of underground mining works;
• Carrying out simulations regarding the planning of new mining works;
• Short-term help and long-term planning of ventilation requirements;
• Assistance in the selection of types of fans for mining ventilation;
• Assistance in the financial analysis of ventilation options;
• simulation of the appearance of smoke, dust, or gases for the realization of the plan for prevention and liquidation of damages.
• Performing thermodynamic analysis on heat, humidity and cooling in underground mines;
• Considering air compressibility for deep mines;
• Providing tools to analyze several options for sizing airways, both financially and for establishing ventilation capacity;
• Analysis based on the dispersion and concentrations of contaminants in an underground mine;
• Providing tools for verifying aspects related to air recirculation;
• Simulation of dust dispersion in suspension from PDM diesel engines.

Ventsim Visual ™ offers three-dimensional 3D presentation with perspective view. A 3D perspective view is natural and easy to understand, especially for someone familiar with the ventilation network.

The program also allows solid 3D visualization of airways that provide quick assessment to verify that the dimensions or position of the mining works are correct.

4. Solving of Livezeni Mine ventilation network

To solve the ventilation network of Livezeni mine, the existing database was used, the geodetic data specific to the structural changes of the ventilation network, respectively the flowmetric and depressiometric measurements performed in situ [10, 11, 12, 13, 14, 15, 16]. After entering the geodetic coordinates into the database of the Ventsim Visual Advanced program, it automatically calculates the spatial distance between two consecutive nodes and instantly draws the specific branch.

After modeling the ventilation network in 3D Solid system, specific technical data are introduced for each branch, respectively the profile and shape of the mining works and ventilation constructions. The next step was to introduce the aerodynamic parameters specific to each branch.

After completing the steps presented above, the ventilation network is balanced and solved, after which the animation is activated both for the air currents specific to each branch and for the fans related to the main ventilation station. In this phase, the information specific to each branch is available, respectively the modeled and solved network is ready to perform any necessary simulations.

In order to update the ventilation network of the Livezeni mine modeled and solved in the previous stage, the following circuits and branches were eliminated: work front Panel 6; work front Panel 5A.

For the modeling of the ventilation network of the Livezeni mine, the following circuits and branches were introduced: Blind Shaft no. 6; Circuit PO6 oriz. 100; Horizon 100 main gallery; Connection circuit Horizontal collector plane. 300-100; Extension Collector plan 300-100; Conjugated galleries oriz. 100; Hauser suite access plan. Fig. 1 shows the spatial scheme in 3D Solid system related to Livezeni mine.

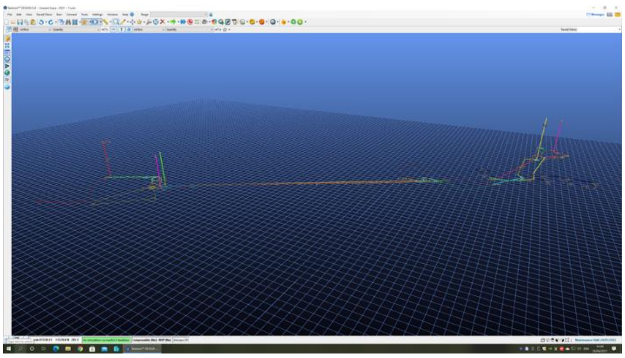

Fig. 1. The ventilation network of Livezeni mine in 3D Solid system

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To solve the ventilation network of Livezeni mine, a number of 218 nodes and 280 branches were introduced. In figures 2 - 9 details are provided within the ventilation network related to Livezeni mine, representing the area of the active felling Panel no. 4N, central area Auxiliary Shaft 3, Skip Shaft area Auxiliary Shaft 3 – Ventilation Shaft 2, area layer 13 horizon 100, area of the main galleries horizon 300, Detail of Blind Shaft area no. 6, 300-100, Auxiliary Shaft - Skip Shaft connection circuit area, respectively Degeratu Suitor Circuit area.

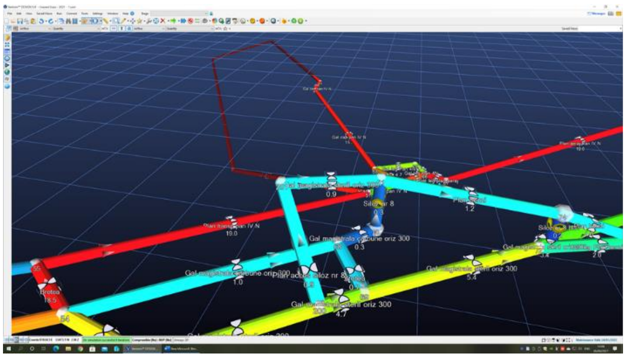
Fig. 2. Detail Panel no. 4N

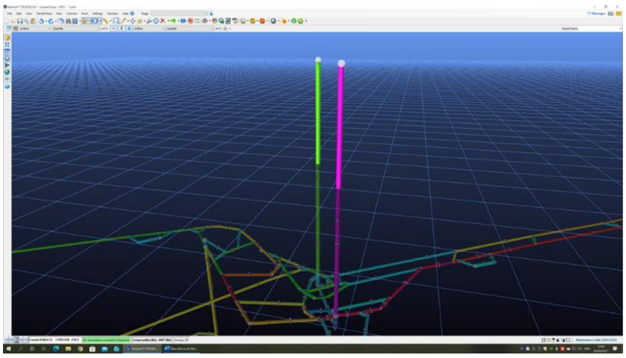
Fig. 3. Detail of the central area Auxiliary Shaft, Skip Shaft

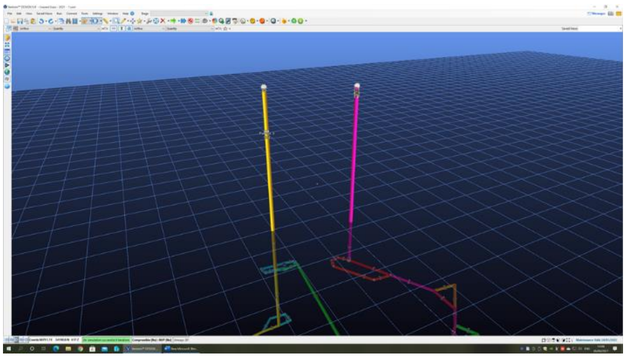
Fig. 4. Detail of Auxiliary Shaft 3 area Ventilation Shaft 2

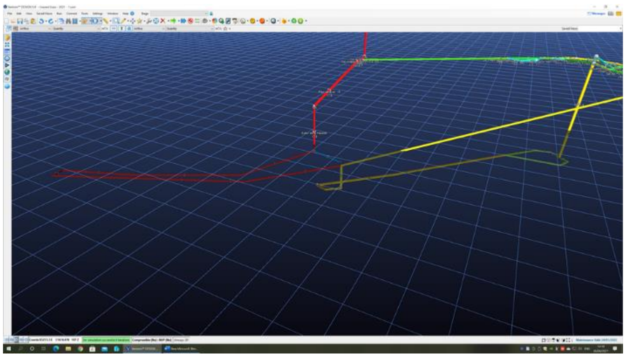
Fig. 5. Detail area layer 13 horizon 100

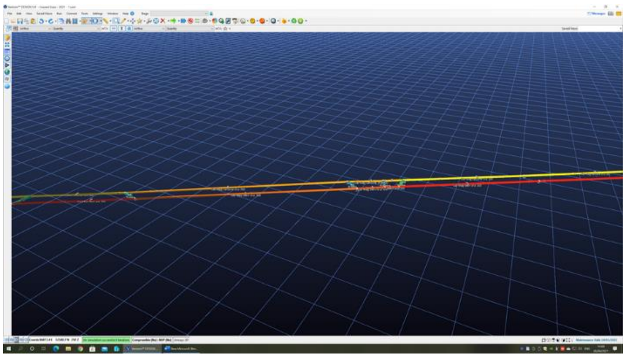
Fig. 6. Detail the area of the main galleries horizon 300

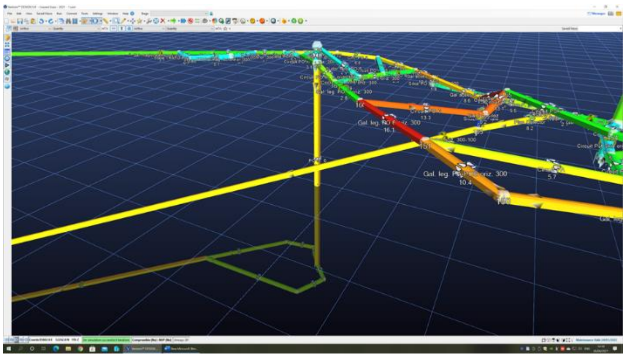
Fig. 7. Detail area Blind Shaft no. 6, 300- 100

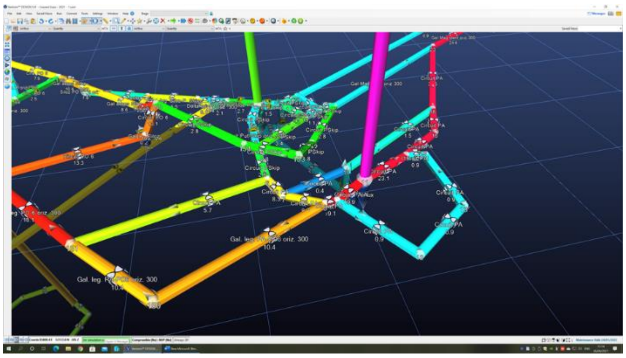
Fig. 8. Detail of the area Circuit connection Auxiliary Shaft – Skip Shaft

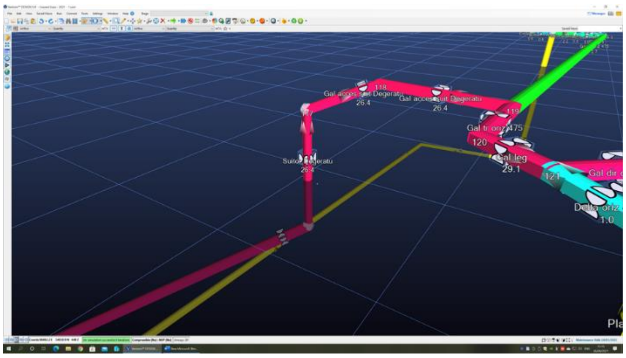
Fig. 9. Detail of the area Circuit connection Auxiliary Shaft - Skip Shaft

The results obtained after modeling and solving the ventilation network related to Livezeni mine are presented in fig. 1 for the spatial scheme of ventilation in 3D Solid system, in fig 10 for the geodetic coordinates respectively in fig. 11 for the technical data specific to the ventilation network.

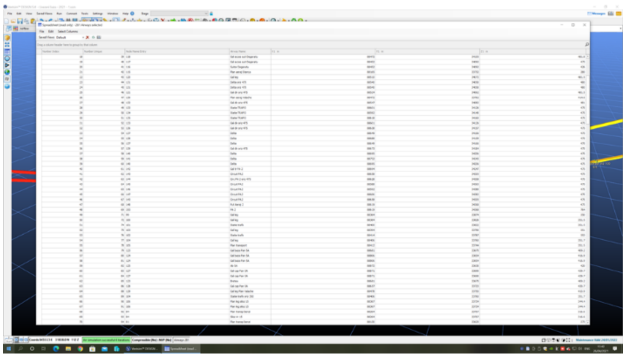

Fig. 10. Geodetic coordinates – detail

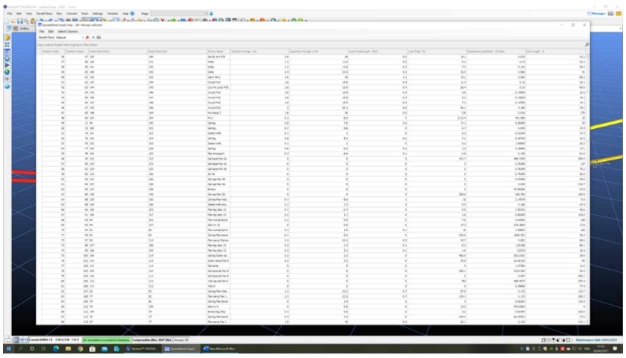

Fig. 11. Technical data specific to the ventilation network - detail

Following the solving of the ventilation network, the following results were obtained:

• Under the action of the main ventilation Stations East Ventilation Shaft and Ventilation Shaft no. 2, a fresh air flow of 57.6 m^3/s or 3456 m^3/min is introduced in underground, distributed as follows:

- horizon 300: 29.4 m^3/s or 1764 m^3/min;
- horizon 100: 17.9 m^3/s or 1074 m^3/min;
- horizon 350: 7.6 m^3/s or 456 m^3/min;
- horizon 475: 2.7 m^3/s or 162 m^3/min;

TOTAL ENTRY: 57.6 m^3/s or 3456 m^3/min.

• The air flow at the level of panel 4N was 15.5 m^3/s or 930 m^3/min;
• The air flow at the level of the Iscroni main gallery was 3.7 m^3/s or 222 m^3/min;
• The air flow at the level of Blind Shaft 6 was 9.5 m^3/s or 570 m^3/min;
• Air flow at the level of the main gallery 100 was 9.5 m^3/s or 570 m^3/min;
• The air flow at the level of the 300-100 collector plane was 8.4 m^3/s or 504 m^3/min;
• The air flow at the level of the ventilation plan no. 15 was 17.9 m^3/s or 1074 m^3/min;
• The air flow at the level of the sterile main gallery was 13.4 m^3/s or 804 m^3/min;
• The air flow at the level of the Stanca ventilation inclined plan was 26.4 m^3/s or 1584 m^3/ min;
• The air flow at the level of the Valache ventilation plan was 6.8 m^3/s or 408 m^3/min;
• Under the action of the depression created by the main ventilation stations, a flawed air flow, at mine level, of 57.6 m^3/s or 3456 m^3/min is evacuated from the underground, distributed as follows:

- Main ventilation station East Ventilation Shaft: 21.6 m^3/s or 1296 m^3/min;
- Main ventilation station Ventilation Shaft No. 2: 36 m^3/s or 2160 m^3/min;

• The air flow achieved at the level of the main fans was 74.8 m^3/s or 4488 m^3/min, distributed as follows:

- Main ventilation station Ventilation Shaft East: 32 m^3/s or 1920 m^3/min;
- Main ventilation station Ventilation Shaft No. 2: 42.8 m^3/s or 2568 m^3/min;

• The flow of short-circuited air with the surface at the level of the main ventilation stations Ventilation Shaft East was 10.3 m^3/s or 618 m^3/min, and at the level of the main ventilation system Ventilation Shaft Nr. 2 was 6.8 m^3/s or 408 m^3/min.

5. Conclusions

• The VENTSIM Visual Advanced program was used to modeling and solving Livezeni mine ventilation network.

• When elaborating the solid 3D scheme related to the mine, the topographic plans for each horizon were used, based on which the nodes and branches of the networks were established, resulting in a number of 218 nodes and 280 branches.

• Ventsim Visual ™ Standard and Advanced has been developed to meet the requirements for simulation and design of underground environmental conditions, to ensure adequate conditions for miners and equipment. First, it was designed as a ventilation tool.

• The elements necessary for the development of the program, which constitute input data, result from the activity of monitoring the ventilation, respectively flowmetric and depressiometric measurements performed underground.

• In order to update the ventilation network of the Livezeni mine, two circuits were eliminated and eight circuits or mining works were introduced.

• Based on the processing of the results obtained from the measurements performed, the ventilation network of the Livezeni mine was modeled and solved. The modeling took into account the size distribution and the direction of air flow.

• Under the action of the depression created by the main ventilation stations, a vicious air flow at the level of the mine of 57.6 m^3/s or 3456 m^3/min was evacuated from the underground;

• The air flow achieved at the level of the main fans was 74.8 m^3/s or 4488 m^3/min.

• The flow of short-circuited air with the surface at the level of the main ventilation stations was 17.1 m^3/s or 1026 m^3/min.

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