NEW TECHNOLOGY IMPLEMENTED IN THE SETTLING OF COMPLEX VENTILATION NETWORKS

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For providing the best possible occupational health and safety conditions for the staff working in potential explosive and/or toxic atmospheres, there are used special ventilation installations.

For the case of underground operations, this aspect is quite complex because the ventilation network covers tens of kilometers. Also, the mining network is in a continuous change and consequently, the distribution of air flows along each branch is quite difficult to be made.

The settlement of ventilation networks with the help of classical methods needs a lot of time and is difficult to be implemented; nevertheless the use of new methods, for ex. of new expert software, represents an accessible option.

In order to settle the ventilation network related to Paroşeni mine, there has been used a Canadian expert software called CANVENT; as a result, there was settled both the basic network and there were simulated certain possible technical conditions that involved major changes regarding the distribution of air flows.

This paper presents both the specific elements regarding the settlement of the ventilation network and the above said simulations

General notes

The mine network necessary for the mining of useful mineral substances displays a high complexity, different shapes and cross-sectional areas and can reach tens of kilometres in length.

For getting the best possible working conditions in underground, it is necessary to provide the primary protection, i.e. suitable ventilation [3] . The purpose of this ventilation is to:

- provide the concentration in oxygen necessary for the personnel currently working underground;
- dilute the explosive and/or toxic gases existing in the mine network;
- diminish the heat emitted inside mine workings, both due to human activities and to thermal gradient.

A good ventilation of each mine working involves the best possible repartition of air flows along each branch of the ventilation network [4]. In this spirit it is necessary to settle the ventilation network of each mine. An example of complex ventilation network is the one belonging to Paroşeni mine.

Analysis of the ventilation network belonging to Paroşeni mine and measurements carried out in situ

The general ventilation of Paroşeni mine is of the upward type, under the influence of the depression s created by the main ventilation station no. 18 VOD 30.

At Paroşeni, coal is extracted through four workings:

- face working panel 4, bed 3, block VI level 300;
- face working panel 24, bed 3, block V level 250;
- working with short face (pillar), bed 3, block V level 250;
- working with short face, panel 3 bed 3, block V level 250.

According to the annual project for general ventilation for the second, third and forth trimesters that takes into consideration the structure of the ventilation network, the dispersion of the working faces in operation, as well the operation of the main ventilation station no. 18 VOD 30, there have been devised three main ventilation circuits:

- the ventilation circuit of the level 250;
- the ventilation circuit of the level 300;
- the ventilation circuit of the level 360.

In order to find out the real values of the aerodynamic parameters specific to the mine workings that are part of the mine ventilation network, there have been carried out measurements of the air flows and of the depressions.

The whole ventilation network includes 171 junctions (knots) and 216 branches [2].

Settling the ventilation network of Paroşeni mine

For providing the best solution available for such a complex ventilation network, we have used

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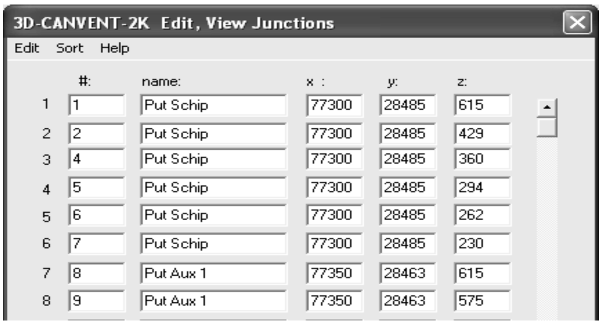
the Hardy-Cross method for successive approximation. This method represents the grounds of expert software CANVENT designed in Canada [1]. 3D – CANVENT is a Window type application and it has been designed to support the planning, design and analyze the mine ventilation systems. 3D – CANVENT represents a mixture between a friendly use of graphic representations and the capability to design 3D networks that makes possible to visualize the ventilation network in a 2D system (X–Y, X–Z, Y–Z) and/or 3D system (X–Y–Z).

This software helped us to provide the solution for the ventilation network as well an optimization of the air flow distribution within the ventilation branches.

Settling the ventilation network of Paroşeni mine made necessary to run several stages:

• Marking the junctions of the ventilation network on the spatial diagram;

• Determining the geodesic coordinates of the identified junctions and inputting the geodesic coordinates of junctions and the existing branches into the database of the software (see Fig. 1).



3D-CANVENT-2K Edit, View Junctions

Edit Sort Help

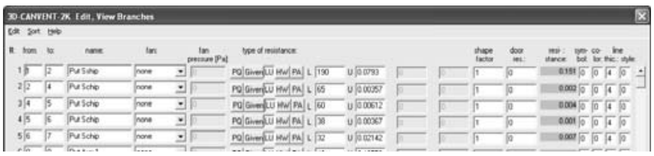
	#:	name:	x :	y:	z:
1	1	Put Schip	77300	28485	615
2	2	Put Schip	77300	28485	429
3	4	Put Schip	77300	28485	360
4	5	Put Schip	77300	28485	294
5	6	Put Schip	77300	28485	262
6	7	Put Schip	77300	28485	230
7	8	Put Aux 1	77350	28463	615
8	9	Put Aux 1	77350	28463	575

Fig.1. Table with knots

• The carrying out of measurements in situ; these measurements include:

- measurements of the aerodynamic parameters of mine workings;
- measurements of the geometrical parameters of mine workings;
- measurements of the physical parameters of the air;

• Calculation of aerodynamic strength specific to each branch and the inputting the values of parameters specific to the ventilation network into database (see Fig. 2);



3D-CANVENT-2K Edit, View Branches

Edit Sort Help

#:	from:	to:	name:	fan:	fan pressure [Pa]	type of resistance:	L	U	shape factor	door res.:	resi-stance:	sym-bol:	co-lor:	line thic.:	style:
1	1	2	Put Schip	none	0	PQ Given LU HW PA	190	0.0793	1	0	0.151	0	0	4	0
2	2	4	Put Schip	none	0	PQ Given LU HW PA	65	0.00357	1	0	0.002	0	0	4	0
3	4	5	Put Schip	none	0	PQ Given LU HW PA	60	0.00612	1	0	0.004	0	0	4	0
4	5	6	Put Schip	none	0	PQ Given LU HW PA	38	0.00367	1	0	0.001	0	0	4	0
5	6	7	Put Schip	none	0	PQ Given LU HW PA	32	0.02142	1	0	0.007	0	0	4	0

Fig.2. Table with branches

• The 2D or 3D drawing of the ventilation network;

• Settling the ventilation network. Both the direction and the optimum distribution of the air flows along each branch are being identified in this stage (Fig. 3).

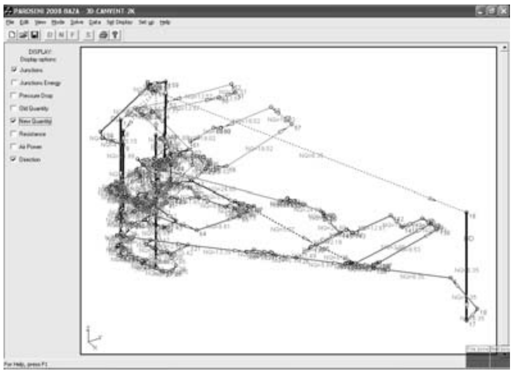


Fig. 3.

Modeling / simulations in the general ventilation network of Paroseni mine made with the help of 3D CANVENT software

With the view to evaluating the future changes that may come up in the mine general ventilation network in relation to the distribution of the air flows [2], both from the point of view of their size and direction, the locations of the structures for the control and drive of air flows, as well the types of mine ventilation structures, there have been settled, in full agreement with the department for occupational health and safety at Paroseni mine, the following simulations:

Simulation no. 1 – Settling the ventilation network with the change of the route used to discharge the poisonous air on the new inclined plane Panel 4/3/VI level 300, implicitly of the related ventilation structures.

Simulation no. 2 – Settling the ventilation with the opening of a group comprising 3 air doors at the level 250, at the base of the ventilation rise 250 – 360.

Simulation no. 3 – Settling the ventilation with the opening of a group comprising 3 air doors at the basis of the behind shaft 360 – 575.

Simulation no. 4 – Settling the ventilation with the opening of a group comprising 3 air doors at the connecting gallery no. 4, between the west longitudinal way level 250 and the conjugated ventilation longitudinal way level 250.

There follows the presentation of results gained after performing two of the above-said simulations (i.e. simulation no. 1 and simulation no. 4).

Simulation no. 1 – Settling the ventilation network with the change of the route used to discharge the poisonous air on the new inclined plane Panel 4/3/VI level 300, implicitly of the related ventilation structures

There have resulted the following aspects after the simulation no. 1 (Fig. 4):

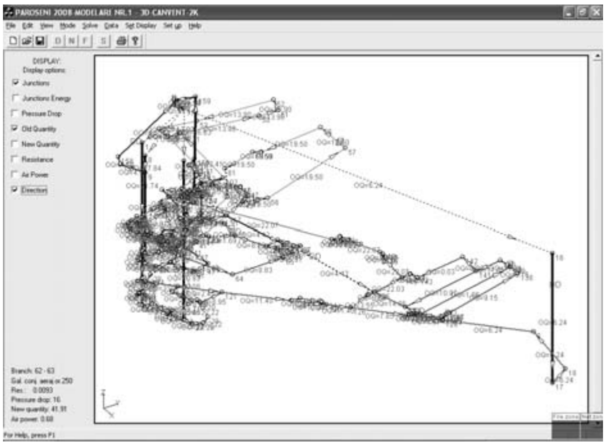


Fig. 4.

– There has been a significant change in the distribution of the air flows inside the ventilation network of Paroşeni mine, especially within the mining area related to the block VI; subsequently, the flow rate diminished from12.61 m^3/s to 1.29 m^3/s at the face no. 4/3/VI;
– As a result of settling the ventilation network (after the location of 5 ventilation structures), there resulted a distribution of the air flows almost similar to the distribution of air flows at the basic model, except the flow rate gained at the face panel 4/3/VI where it diminished from 12.6 m^3/s to 10.97 m^3/s;
– A diminution of the annual costs related to air conveyance along the blind shaft (branch 156-159) with 3.82% from 387,019 lei to 372,219 lei;
– An increase of the annual costs related to air conveyance along the air way W that connects to the blind shaft level 360 (branch 100-155) with 7.73%, from 3,168 lei to 3,413 lei,
– A diminution of the annual costs related to air conveyance along the air way that connects to the blind shaft level 425 (branch 154-156) with 24.91%, from 562 lei to 422 lei;
– There has been registered a diminution with 3.53%, from 95,519 lei to 92,150 lei for the ventilation canal of the main ventilation station no. 18 VOD 3.0 (branch 159-160);
– There has been registered a diminution of the annual costs related to air conveyance with 0.35%, from 1,118,298 lei to 1,114,401 lei for the whole main ventilation station no. 18 VOD 3.0.

Simulation no. 4 – Settling the ventilation with the opening of a group comprising 3 air doors at the connecting gallery no. 4, between the west longitudinal way level 250 and the conjugated ventilation longitudinal way level 250

Simulations no. 4 relied on the simulation no. 1 and it comprised a removal of the air doors located on the connecting gallery no. 4 between the longitudinal way W level 250 and the conjugated ventilation longitudinal way level 250, branch 48-55 (Fig. 5).

There have resulted the following aspects after the simulation no. 4:

– The distribution of the air flows in the ventilation network of Paroşeni mine didn't change significantly for the ventilation circuit panel 1/3/V level 250; there were moderate changes for the face panel 4/3/VI, where the air flow rate diminished from 12.61 m^3/s to 10.89 m^3/s and for the face panel 2/3/V where the flow rate diminished from 19.02 m^3/s to 17.2 m^3/s. The distribution of air flows changed significantly for the ventilation circuits panel 1/3/III level 250, where the air flow rate diminished from 13.57 m^3/s to 4.47 m^3/s;

– A diminution of the annual costs related to air conveyance along the blind shaft (branch 156-159) with 2.72% from 387,019 lei to 376,492 lei;

– An increase of the annual costs related to air conveyance along the air way W that connects to the blind shaft level 360 (branch 100-155) with 10.48%, from 3,168 lei to 3,500 lei;

– A diminution of the annual costs related to air conveyance along the air way that connects to the blind shaft level 425 (branch 154-156) with 26.3%, from 562 lei to 414 lei;

– There has been registered a diminution with 2.51%, from 95,519 lei to 93,120 lei for the ventilation canal of the main ventilation station no. 18 VOD 3.0 (branch 159-160);

– There has been registered a diminution of the annual costs related to air conveyance with 0,25%, from 1,118,298 lei to 1,115,557 lei for the whole main ventilation station no. 18 VOD 3.0.

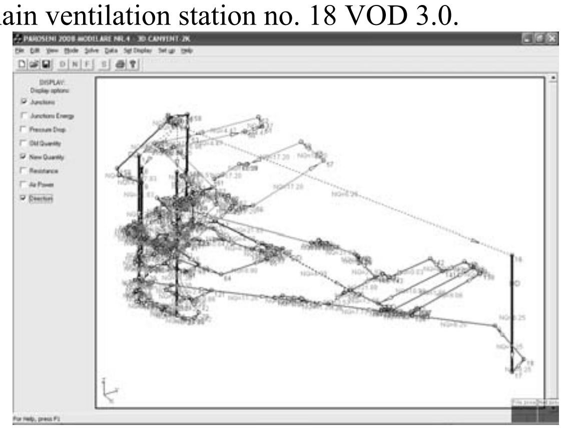


Fig. 5.

Conclusions

• For modeling the ventilation network of Paroşeni mine, there has been used the iterative method of successive approximations; the whole software for settling the ventilation networks (3D - CANVENT) relies on this method.

• The elements necessary to run the software (i.e. the inputs) are gained after monitoring the ventilation process.

• Based on the current ventilation network, there have been determined the simulations of possible situations.

• The simulations have underlined both the important part played by the group of air doors and their influence over the distribution of air flows at each branch.

• Each simulations intended to acquire the necessary flow rates in accordance with the Annual ventilation project, measured at faces of the main ventilation circuits and at the main ventilation station. It has to be stipulated the type of control and/or regulating structures, as well their locations in order to be able to reach the desired distribution.

• For each simulation, there has been determined the operating mode of the two fans at the main ventilation station no. 18 VOD 3.0; these simulations have also allowed to evaluate the ventilation capabilities of the mine for each situation apart.

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