COMPLEX VENTILATION NETWORKS' SOLVING

Doru CIOCLEA, Constantin LUPU*,*
*Ion GHERGHE**, Florin RĂDOI**, Corneliu BOANTĂ**,*

Abstract
A primary protection should be provided for getting the optimum working conditions in the underground, i.e. a good ventilation.
Consequently, it is necessary to develop a suitable ventilation network for being able to provide a good air flow splitting at each mine working. For ex., the ventilation networks of mines from Jiu Valley are quite complex and includes shafts, ventilation raises, with the related main ventilation networks, mine workings spread all through many levels which at their turn include opening and preparatory mine workings. The total length of the mine workings belongings each mines is of several dozen kilometres.
In this spirit, this paper shows the manner used to develop the ventilation network with the help of the iterative method Hardy-Cross and with the help of the Canadian expert software - CANVENT.
Keywords: *expert software, ventilation, ventilation network*

1. Introduction

Mine ventilation is an extremely sensitive and complex domain that includes several disciplines used to accomplish and preserve safe conditions in underground [1; 3]. In this spirit, a good ventilation network developed with the help of a software, is a huge step forward that allows the experts to see in real time the changes occurred in this network and, more important, to anticipate the possible disturbances in the ventilation system.

2. General notions

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 [6; 7]. The purpose of this ventilation is to:

- provide the concentration in oxygen necessary for the personnel currently working in 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 distribution of air flows along each branch of the ventilation network. Subsequently it is necessary to settle the ventilation network of each mine.

** PhD. Eng., INCD INSEMEX Petroşani*
*** Eng., INCD INSEMEX Petroşani*

3. Description of mine ventilation networks

In Jiu Valley hard coal basin exist seven active mine units. A few of them will be presented in the following.

The ventilation network of Vulcan mine was quite complex [2]. At present it is diminished because of some accidents (such as explosions) and due to the depletion of the useful mineral deposits. Therefore, the ventilation network includes four ventilation shafts: Chorin Shaft, Puţul cu Schip, Prokop Shaft and X Shaft - Valea Arsului. It also includes three ventilation raises with the related ventilation stations (B'Allomas Raise, Karollus Raise and Ionaşcu Raise) and underground mine workings located on four levels (level 315; level 360; level 420; level 480). These mine workings comprise main cross sectional galleries, directional galleries, diagonal galleries, plain cross sectional galleries, inclines, working faces, connection raises.

The whole ventilation network includes 251 junctions (knots) and 300 branches [2].

The ventilation network of Uricani mine is quite complex [3]. Therefore, the ventilation network includes three ventilation shafts: Schip Shaft, 4 Shaft, 8 Shaft and 15 ventilation incline. It also includes two ventilation shafts with the related ventilation stations (East Shaft and West Shaft) and underground mine workings located on four levels (level 580; level 500; level 400; level 300). These mine workings comprise main cross sectional galleries, directional galleries, diagonal galleries, plain cross sectional galleries, inclines, working faces, connection raises.

The whole ventilation network includes 291 junctions (knots) and 300 branches.

The ventilation network of Paroşeni mine is quite complex [3]. Therefore, the ventilation network includes four ventilation shafts: Schip Shaft, Auxiliary Shaft no. 1, Auxiliary Shaft no. 2 and Air Shaft. It also includes one blind ventilation shaft with the related ventilation station and underground mine workings located on five levels (level 575; level 425; level 360; level 300 and level 250). These mine workings comprise main cross sectional galleries, directional galleries, diagonal galleries, plain cross sectional galleries, inclines, working faces, connection raises.

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

The ventilation network of Lonea mine is quite complex [4;5]. Therefore, the ventilation network includes four ventilation shafts: New Skip Shaft, Old skip Shaft, Auxiliary Shaft and Valea Arsului Shaft. It also includes two blind shaft, two main ventilation stations (Valea Arsului and Level 840) and underground mine workings located on seven levels (level 615; 500; 460; 400; 350; 300 and 250 and level 200). These mine workings comprise main cross sectional galleries, directional galleries, diagonal galleries, plain cross sectional galleries, inclines, working faces, connection raises.

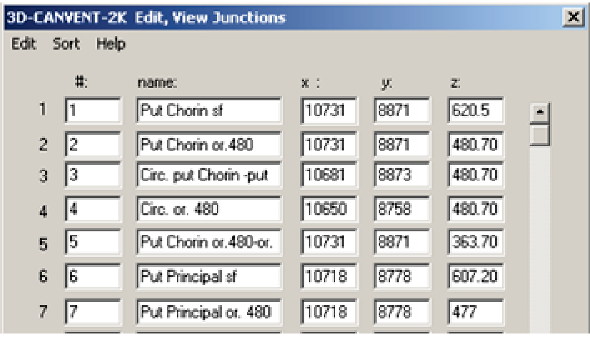
The whole ventilation network includes 339 junctions (knots) and 424 branches.

4. Providing the solution for the ventilation network of the mine

For providing the best solution available for such a complex ventilation network, we have used the Hardy-Cross method for successive approximation. This method represents the grounds of an expert software CANVENT designed in Canada (8). 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.

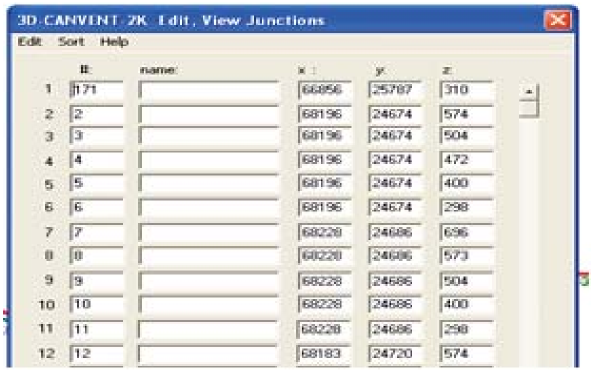
This process made necessary to run several stages:

- Marking the junctions of the ventilation network on the spatial diagram;
- Determining the geodesic coordinates of the identified junctions;
- Inputting the geodesic coordinates of junctions and the existing branches into the database of the software (see fig.1, fig. 2, fig. 3, fig. 4);
- 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;



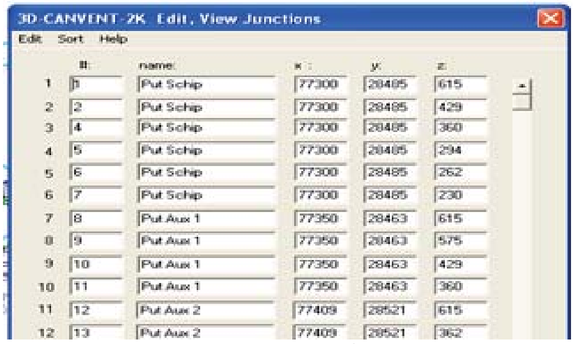
	#:	name:	x :	y:	z:
1	1	Put Chorin sf	10731	8871	620.5
2	2	Put Chorin or.480	10731	8871	480.70
3	3	Circ. put Chorin -put	10681	8873	480.70
4	4	Circ. or. 480	10650	8758	480.70
5	5	Put Chorin or.480-or.	10731	8871	363.70
6	6	Put Principal sf	10718	8778	607.20
7	7	Put Principal or. 480	10718	8778	477

Fig. 1 *Geodesic coordinate from Vulcan Mine*



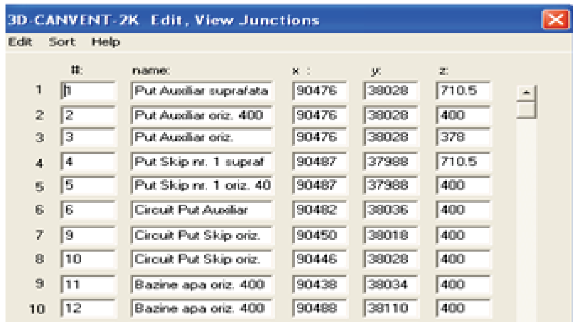
	#:	name:	x :	y:	z:
1	171		66856	25787	310
2	2		68196	24674	574
3	3		68196	24674	504
4	4		68196	24674	472
5	5		68196	24674	400
6	6		68196	24674	298
7	7		68228	24686	696
8	8		68228	24686	573
9	9		68228	24686	504
10	10		68228	24686	400
11	11		68228	24686	298
12	12		68183	24720	574

Fig. 2 *Geodesic coordinates from Uricani Mine*



	#:	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
9	10	Put Aux 1	77350	28463	429
10	11	Put Aux 1	77350	28463	360
11	12	Put Aux 2	77409	28521	615
12	13	Put Aux 2	77409	28521	362

Fig. 3 *Geodesic coordinates from Paroseni Mine*



	#:	name:	x :	y:	z:
1	1	Put Auxiliar suprafata	90476	38028	710.5
2	2	Put Auxiliar oriz. 400	90476	38028	400
3	3	Put Auxiliar oriz.	90476	38028	378
4	4	Put Skip nr. 1 supraf	90487	37988	710.5
5	5	Put Skip nr. 1 oriz. 40	90487	37988	400
6	6	Circuit Put Auxiliar	90482	38036	400
7	9	Circuit Put Skip oriz.	90450	38018	400
8	10	Circuit Put Skip oriz.	90446	38028	400
9	11	Bazine apa oriz. 400	90438	38034	400
10	12	Bazine apa oriz. 400	90488	38110	400

Fig. 4 *Geodesic coordinates from Lonea Mine*

- Inputting the values of parameters specific to the ventilation network into the expert software CANVENT (fig. 5, fig. 6, fig. 7, fig. 8);
- The 2D or 3D drawing of the ventilation network;
- Balancing the ventilation network;

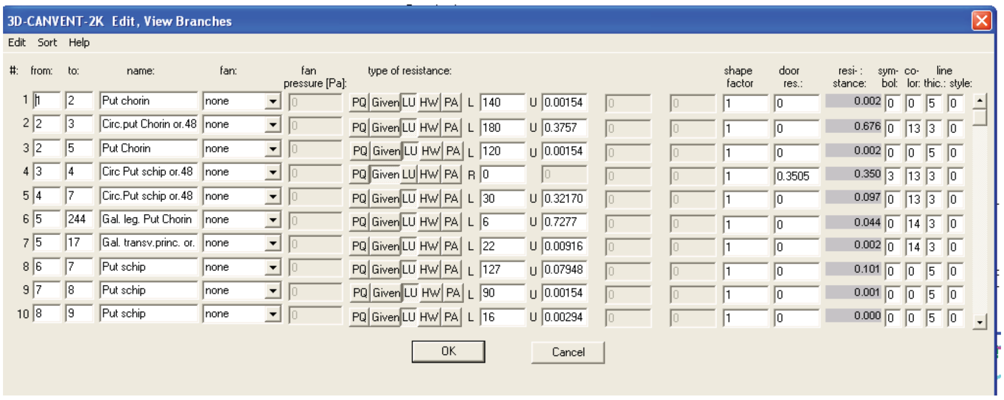


Fig. 5 *Specific parameters from Vulcan Mine*

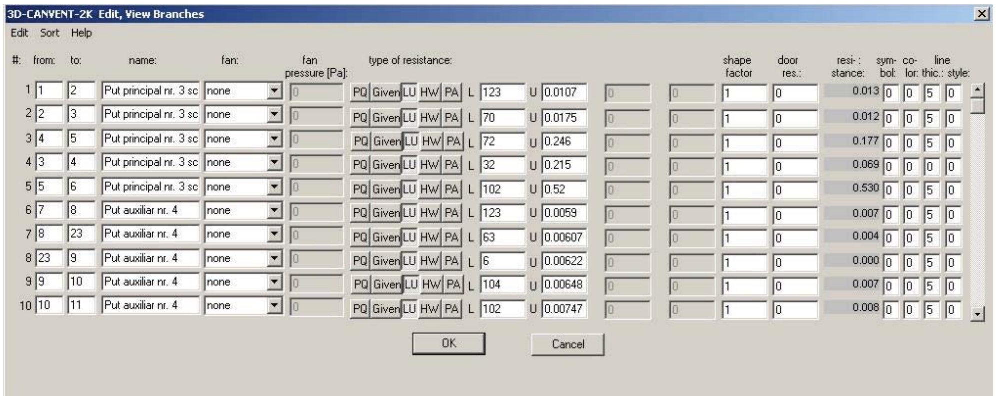


Fig. 6 *Specific parameters from Uricani Mine*

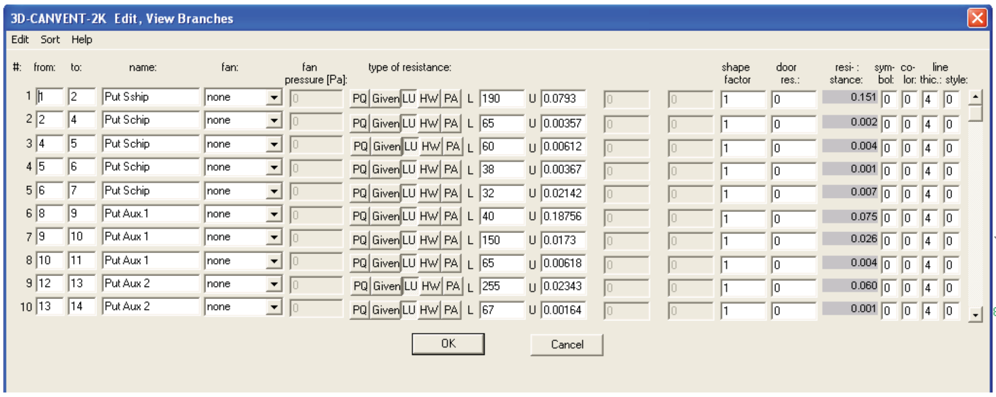


Fig. 7 *Specific parameters from Paroseni Mine*

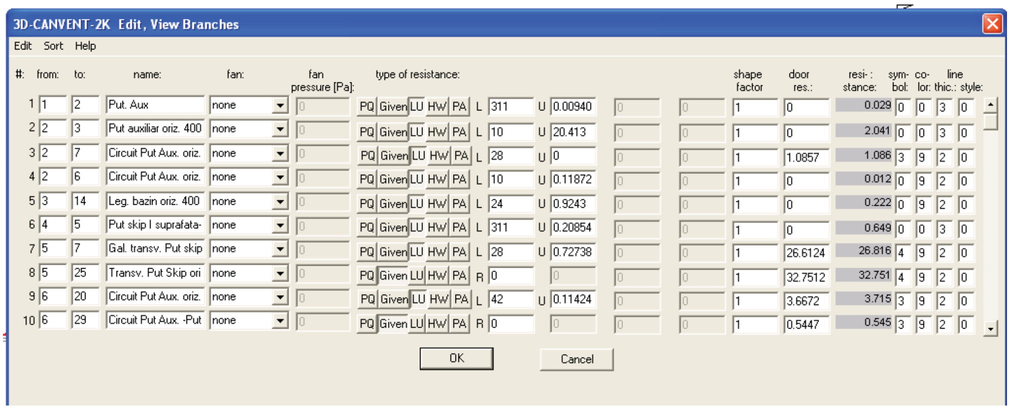


Fig. 8 *Specific parameters from Lonea Mine*

- 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.9, fig.10, fig.11, fig.12);
- Getting the results.

This final stage provides the data on electronic support or paper regarding the graphic settlement of the ventilation network.

The method shown above allows to give solutions to any ventilation network, irrespective of their level of complexity.

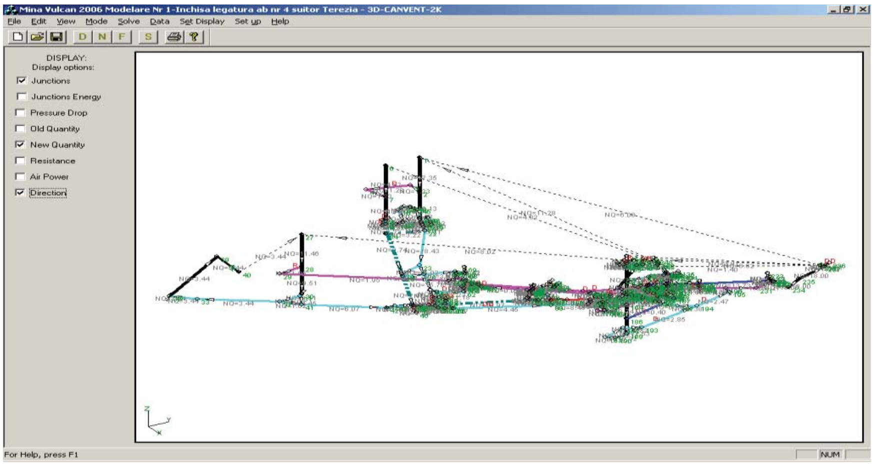


Fig. 9 *Ventilation network of Vulcan Mine*

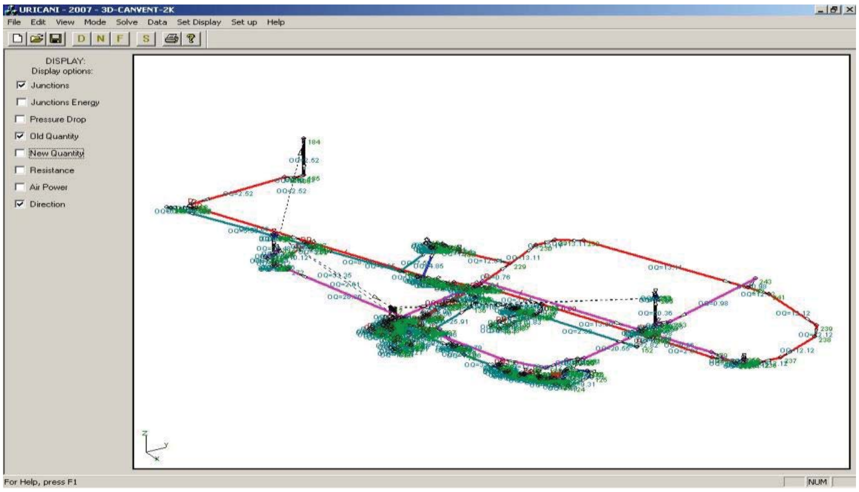


Fig. 10 *Ventilation network of Uricani Mine*

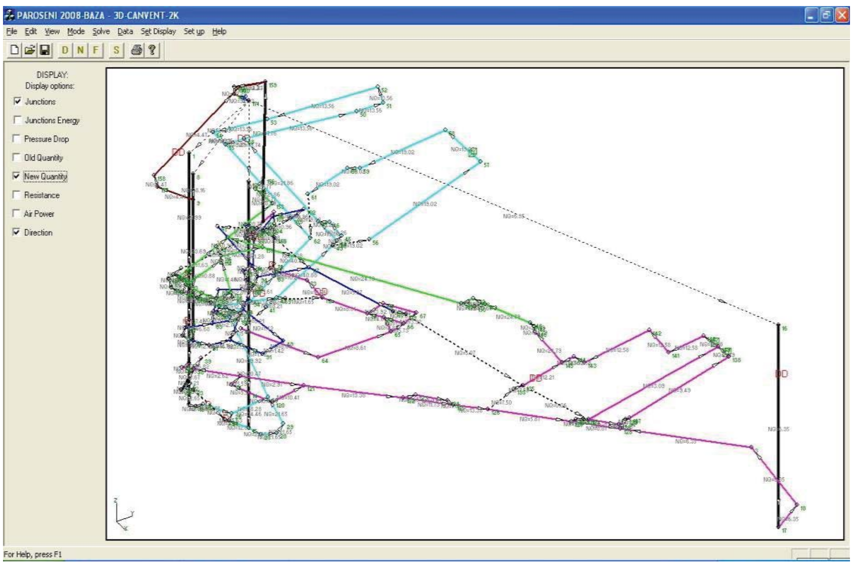


Fig. 11 *Ventilation network of Paroseni Mine*

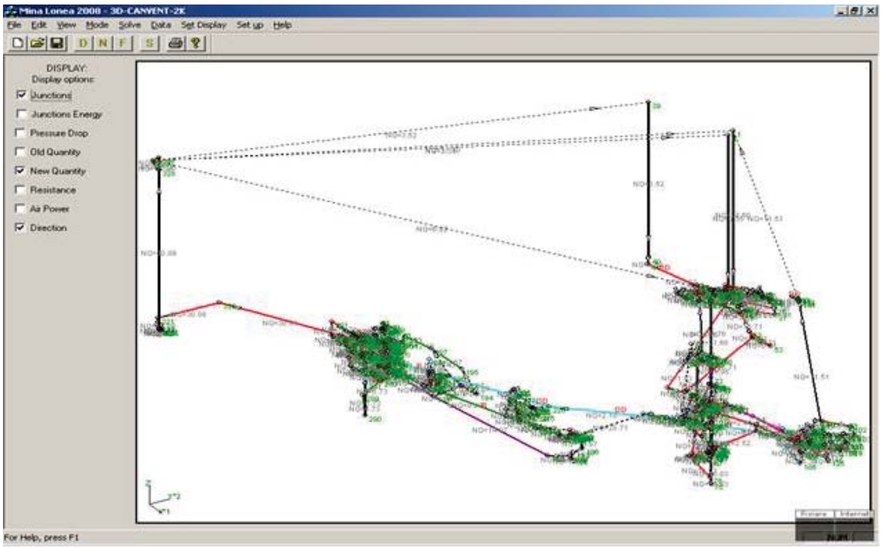


Fig. 12 *Ventilation network of Lonea Mine*

5. Conclusions

- Giving solutions for the ventilation networks with the help of an expert sofware is a huge step forward that allows optimal ventilation and a visualisation of the changes made on the network in real time.
- The ventilation network given as example belongs to Vulcan Mine, Uricani Mine, Paroseni Mine and Lonea Mine and include shafts and one ventilation incline, ventilation shafts, many levels and several underground workings (cross-sectional galleries, directional galleries, diagonal galleries, inclines, connection raises and working faces).
- The best solutions available for the ventilation networks have been obtained with the help of the Canadian software called CANVENT. It includes the run of 10 main steps.
- Settling ventilation network with the help ofan expert software allows the best possible solutions irrespective of their complexity.

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