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NEW TOOLS THAT CAN BE USED IN VENTILATION NETWORKS

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

National Institute for Research and Development in Mine Safety and Protection to Explosion – INSEMEX, 332047 Petroşani, Romania; doru.cioclea@insemex.ro; constantin.lupu@insemex.ro; ion.gherghe@insemex.ro; florin.radoi@insemex.ro; corneliu.boanta@insemex.ro

ABSTRACT. Explosion type phenomena which may occur at the level of a ventilation network generate changes of the network's structure determined mainly by the destruction of ventilation constructions. The flame front generates a high quantity of burning gases having an extremely high temperature, which leads to their rapid expansion. The phenomenon of the explosion causes serious disturbances in the ventilation system. May occur reversal of the direction of air flow, unventilated or poorly ventilated areas or destabilizing the functioning of active fan. These are a few reasons for that restore ventilation becomes priority. Within FFCS Coal RTD Programme was developed AVENTO project - Tools for Advanced Ventilation Methane Emissions and Control, which had one objective restore ventilation network, affected by explosion.

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Introduction

When an explosion occurs, there is formed on one hand a dynamic wave developing an overpressure ranging between 1-8 bar in case of methane participation and between 1-11 bar when coal dust also participates, and on the other hand the flame front generating temperatures of over 2500°C /2;4;7;8/.

Due to high pressure generated by explosion in underground mine workings, there occur high forces which action upon all obstacles encountered on the propagation direction of the dynamic wave.

These forces exceed by far the resistance breaking o compression, shearing strength tensile strength, resistance to buckling or torsion specific to materials encountered on the dynamic wave propagation direction /1;10/.

The least resistant obstacles encountered by the dynamic wave are ventilation constructions – regulator doors, insulation doors, insulation dams.

Due to these situations, the following effects can occur:

- maintaining the air flowing direction with the decrease of air flow on some branches;
- increase if air flow on some branches;
- reversal of air flowing on some branches;
- intensification of existent spontaneous combustion phenomena:
- occurrence of new spontaneous combustions;
- increase of carbon oxide concentrations (up to 2-3% vol.);
- decrease of oxygen content (up to 3-7 % vol.).

Ventilation re- establishment

Following the occurrence of an explosion in the complex ventilation network, if the active fan is not operationally affected, results a change of the ventilation network structure and as a consequence a change of the active fan's operational parameters. Due to these aspects, occurs a new air flow repartition on the branches of the ventilation network /3;6;9;11;12/.

For ensuring safety conditions after the event, the re-establishment of the ventilation network is required.

The re-establishment of the ventilation network is performed on the basis of critical pathways. In order to identify the critical pathways there have to be firstly established ventilation constructions in relation with their related emergency level.

Emergency levels are established in connection with the risk generated by their destruction upon the active mine workings, from the point of view of uncontrolled explosive gas releases in active mines and from the point of view of a new explosion's occurrence in conditions of an efficient ignition source existence.

Emergency levels are established as follows:

• **Emergency levels 1** – of this category are part ventilation constructions aiming to close the goaf.

• **Emergency level 2** – of this category are part ventilation constructions aiming to adjust air flow in active coal faces.

• **Emergency level 3** – of this category are part critical ventilation constructions. They are represented by the ventilation constructions which produce instability in the ventilation network and as a consequence large variations of operation parameters of the operating fan. Therefore, by restoring these constructions, the operational parameters of the active fan considerably tend to the fans nominal parameters.

• **Emergency level 4** – of this category are part ventilation constructions aiming to adjust the air flow at the level of the ventilation network.

• Critical pathways are represented by ventilation circuits on which are located ventilation constructions comprised in the emergency levels.

The restoration of the ventilation network is performed step-by-step. Within each phase are determined the operational parameters and is solved the ventilation network in the new given conditions.

Re-establishment of the ventilation based on critical pathways corresponding to an emergency level 1: in order to perform this, there are identified ventilation constructions comprised in this category. There are established the operational parameters of the active fan in the new conditions and there is solved the ventilation network for the new given conditions.

Re-establishment of the ventilation based on critical pathways corresponding to an emergency level 2: in order to perform this, there are identified ventilation constructions comprised in this category. There are established the operational parameters of the active fan in the new conditions and there is solved the ventilation network for the new given conditions.

Re-establishment of the ventilation based on critical pathways corresponding to an emergency level 3: in order to perform this, there are identified ventilation constructions comprised in this category. There are established the operational parameters of the active fan in the new conditions and there is solved the ventilation network for the new given conditions.

Re-establishment of the ventilation based on critical pathways corresponding to an emergency level 4: in order to perform this, there are identified ventilation constructions comprised in this category. There are established the operational parameters of the active fan in the new conditions and there is solved the ventilation network for the new given conditions.

Software for re-establishing the ventilation

For re-establishment based on critical pathways corresponding to the emergency levels of a ventilation network affected by an explosion, within the project were developed two software, in JAVA language, as follows:

• VENTEX software developed for simulating an explosion at ventilation network level

• VENTREF software for simulating the step-by-step process for restoring a ventilation network affected by an explosion

The two software used for simulating some processes may work with any external software specialized for solving ventilation networks. Within this project, VENTEX and VENTREF operate using CANVENT external software. At the same time, VENTEX is integrated in the specialized software VENTREF.

In principle, VENTEX is based on the explosion's propagation algorithm.

The purpose of the algorithm is that, starting from the initiation place of an explosion of established pressure, to be identified mine workings covered by the destructive blast of the explosion and the destroyed ventilation constructions.

VENTEX is integrated in VENTREF, VENTREF uses CANVENT external software for simulating the step-by-step re-establishment of the ventilation network affected by an explosion type phenomenon.

VENTREF and also VENTEX can simulate the explosion phenomenon and the restoration of the ventilation network for each junction or branch specific for the ventilation network, respectively for every pressure comprised between 0.1 and 10 bar.

For exemplification, there are presented the results obtained using VENTREF application for an average intensity explosion - 6 atm.

Firstly, the junctions and branches which result from the analysis peformed for determining emergency levels specific for the ventilation network of Uricani mine unit /5/ are the following:

Emergency level 1 =27 ventilation constructions:
Emergency level 2 =5 ventilation constructions:
Emergency level 3 = 10 ventilation constructions:
Emergency level 4 = 41 ventilation constructions which represent the remaining ones.

Details specific for an average intensity explosion simulation at the level of Uricani mine unit ventilation network are presented in Figures 1.

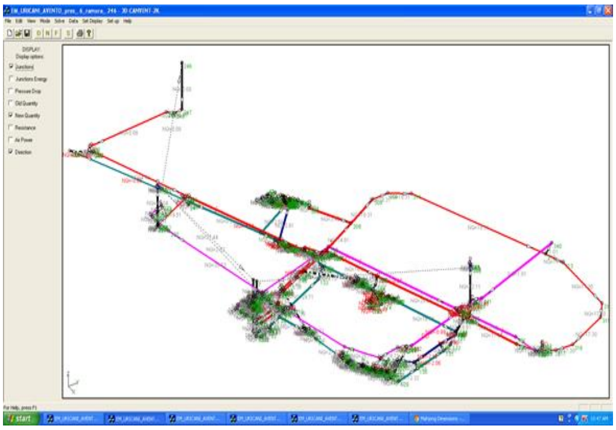

Fig. 1. Uricani ventilation network - VENTEX simulation – 6 bar

Figure 2 show the simulation on the restoration of Uricani mine unit ventilation network based on critical pathways, emergency level 1.

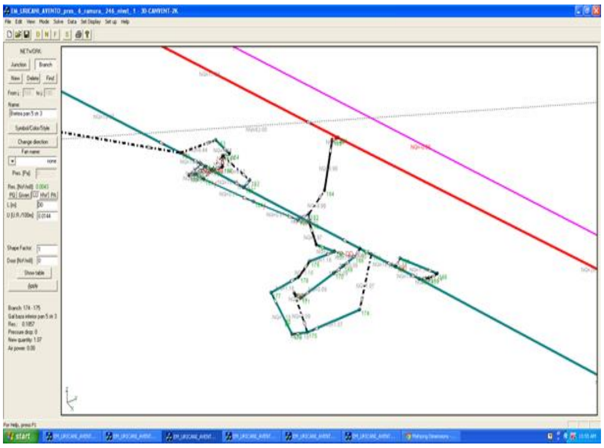

Fig. 2. Detail Bl. IV S - VENTREF simulation – Emergency level 1

Characteristic curves and operational parameters related to active fans from within main ventilation stations Ventilation Shaft E are presented in Figure 3.

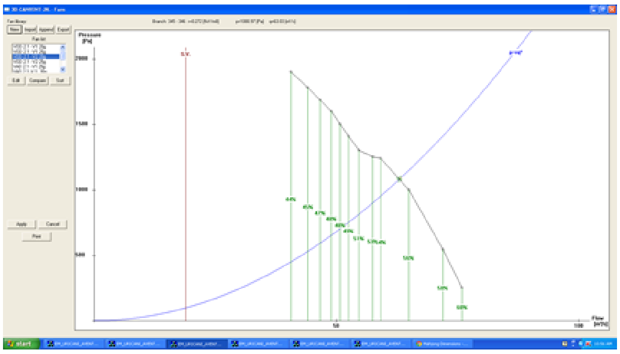

Fig. 3. Characteristic curve main ventilation station V.S. E – Emergency level 1

Figure 4 present the simulation on the restoration of Uricani mine unit ventilation network based on critical pathways, in relation with an emergency level 2.

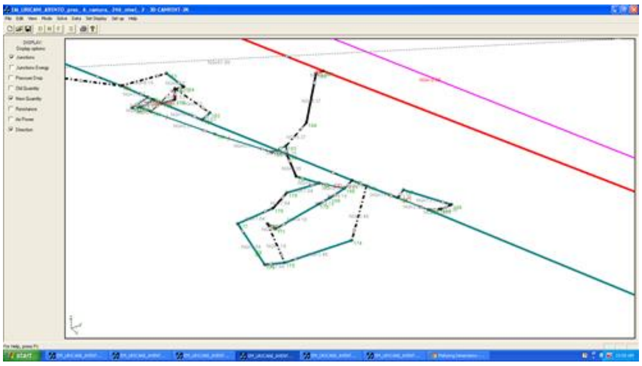

Fig. 4. Detail Bl. IV S - VENTREF simulation – Emergency level 2

Characteristic curves and operational parameters related to active fans from within main ventilation stations Ventilation Shaft E are presented in Figure 5.

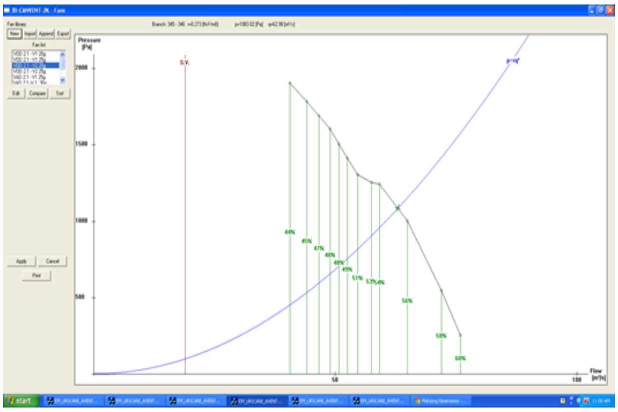

Fig. 5. Characteristic curve main ventilation station V.S. E – Emergency level 2

Figure 6 present the simulation on the restoration of Uricani mine unit ventilation network based on critical pathways, in relation with an emergency level 3.

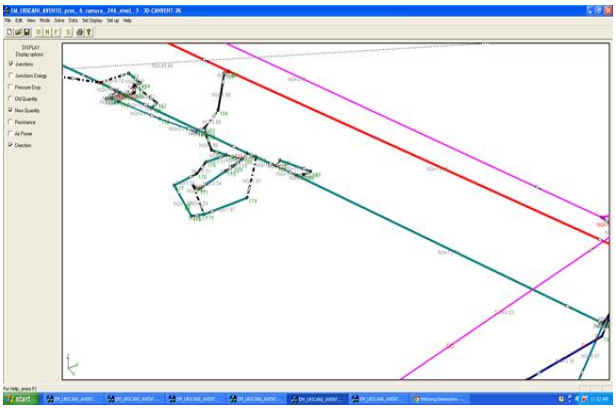

Fig. 6. Detail Bl. IV S - VENTREF simulation – Emergency level 3

Characteristic curves and operational parameters related to active fans from within main ventilation stations Ventilation Shaft E are presented in Figure 7.

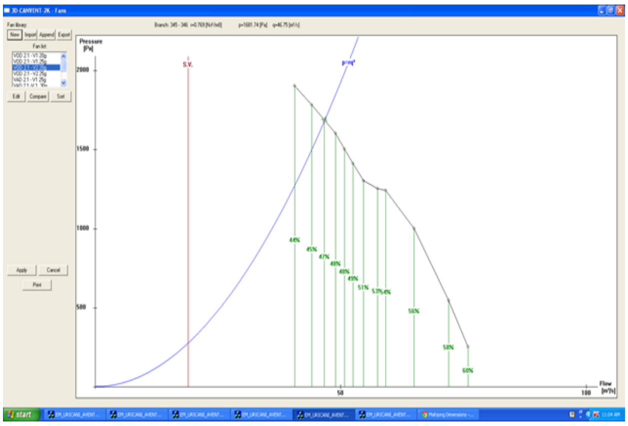

Fig. 7. Characteristic curve main ventilation station V.S. E – Emergency level 3

Figure 8 present the simulation on the restoration of Uricani mine unit ventilation network based on critical pathways, in relation with an emergency level 4.

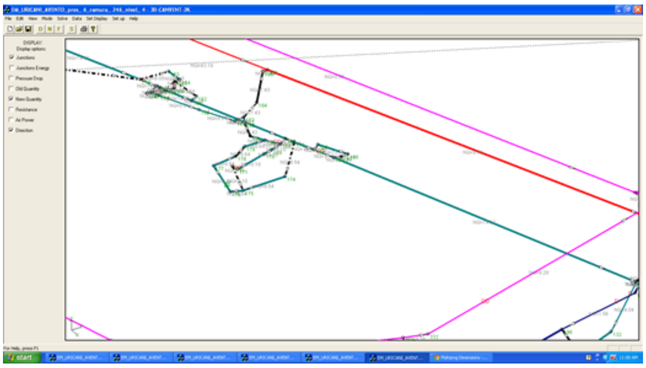

Fig. 8. Detail Bl. IV S - VENTREF simulation – Emergency level 4

Characteristic curves and operational parameters related to active fans from within main ventilation stations Ventilation Shaft E are presented in Figure 9.

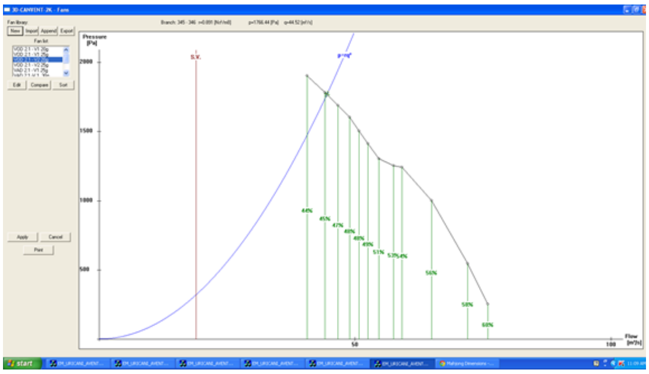

Fig. 9. Characteristic curve main ventilation station V.S. E – Emergency level 4

From the information presented, there may be noticed that simulations conducted using VENTREF lead to obtaining the step-by-step and in safety conditions restoration of Uricani mine unit ventilation network based on critical pathways in relation with emergency levels. Also, values of operational parameters related to active fans from within main ventilation stations after the last restoration phase are almost identical to the ones specific for the normal conditions before the explosion.

Conclusions

1. In case of explosion, there is formed on one hand a dynamic wave developing an overpressure ranging between 1-8 bar in case of methane participation and between 1-11 bar when coal dust also participates, and on the other hand the flame front generating temperatures of over 2500 °C.
2. These forces exceed by far the resistance breaking o compression, shearing strength tensile strength, resistance to buckling or torsion specific to materials encountered on the dynamic wave propagation direction.
3. Following the occurrence of an explosion in the complex ventilation network, if the active fan is not operationally affected, results a change of the ventilation network structure and as a consequence a change of the active fan's operational parameters. Due to these aspects, occurs a new air flow repartition on the branches of the ventilation network.
4. The reestablishment of the ventilation network is performed on the basis of critical pathways. In order to identify the critical pathways there have to be firstly established ventilation constructions in relation with their related emergency level.
5. For re-establishment based on critical pathways corresponding to the emergency levels of a ventilation network affected by an explosion, within the project were developed two software, in JAVA language, as follows: VENTEX and VENTREF.
6. In the work are presented the results obtained using VENTREF application for re-establishment ventilation network after average intensity explosion - 6 atm. for the Uricani mine unit.
7. The values of operational parameters related to active fans from within main ventilation stations after the last restoration phase are almost identical to the ones specific for the normal conditions before the explosion.

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Статията е препоръчана за публикуване от Редакционен съвет.