TROTUŞ SALT MINE COMPLEX VENTILATION NETWORK MANAGEMENT

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Abstract

The attestation of salt extraction in these areas was located in the Geto-Dacian period at Oituz and Târgu Ocna. The oldest written testimony dates from 1380.

The mining works that serve the Trotuş mine within the Tg. Ocna Salt Mine, are located in the Feţele Târgului salt massif located near the town of Tg. Ocna, on the left side of the Trotuş river.

The exploitation of the salt was carried out until 1870 at the Ocniţa Mine with a bell-shaped chamber and continued in the Moldova Veche and Moldova Nouă mines with trapezoidal chambers. Since 1967, the salt has been exploited with "small rooms and abandoned square pillars". The exploitation is carried out descending, on the horizons.

Currently, the Trotuş Salt Mine has 14 horizons: 2 at the Pilot mine and 12 at the Trotuş mine.

The specialized 3D CANVENT program was used to establish the optimal distribution of air flows. A number of 492 junctions and 697 branches were used to solve the ventilation network related to the Trotuş Salt Mine.

Keywords: software, solving, ventilation, networks, salt mine

УПРАВЛІННЯ КОМПЛЕКСНОЮ ВЕНТИЛЯЦІЙНОЮ МЕРЕЖЕЮ СОЛЯНОЇ ШАХТИ TROTUS

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Анотація

Атестація видобутку солі в цих районах проходила в гето-дакійський період в Ойтузі та Тиргу-Очна. Найдавніші письмові свідчення датуються 1380 роком.

Гірничі роботи, що обслуговують шахту Тротуш у межах Тг. Соляна шахта Окна, розташована в соляному масиві Феценле-Тиргулуй, що знаходиться недалеко від міста Тг. Очна, з лівого боку річки Тротуш.

Експлуатація солі велася до 1870 р. На шахті Окниця з дзвоноподібною камерою і продовжувалась у шахтах Молдова Вече та Молдова Ноуа з трапецієподібними камерами. З 1967 р. Сіль експлуатується в "маленьких кімнатах і занедбаних квадратних стовпах". Експлуатація здійснюється низхідно, по горизонтах.

В даний час соляна шахта Тротуш має 14 горизонтів: 2 на пілотній шахті та 12 на шахті Тротуш.

Для встановлення оптимального розподілу повітряних потоків була використана спеціалізована програма 3D CANVENT. Для вирішення вентиляційної мережі, що стосується соляної шахти Тротуш, було використано 492 перехрестя та 697 гілок.

Ключові слова: програмне забезпечення, рішення, вентиляція, мережі, соляна шахта

1. INTRODUCTION

One of the greatest riches of Romania is salt. This useful mineral substance was discovered in the Neolithic and man first used it as an ingredient in food.

On the Romanian territory there are large salt deposits grouped on both sides of the Carpathian mountains. The Carpathian saliferous regions were densely populated in prehistory, some settlements being founded near the outcrops of rock salt or springs with salt water. In Romania there are over 300 large salt deposits covering an area of about 30.000 km^2.

Among these salt deposits is the one located in the Tg. Ocna depression where the salt deposit approaches the surface, often coming out. Between the Trotuș valley and the Cașin valley are the outcrops from Tuta and Bogdănești, near which there are several Chalcolithic settlements from the Bronze Age.

The attestation of salt extraction in these areas was located in the Geto-Dacian period at Oituz and Târgu Ocna and the oldest written testimony dates from 1380.

2. TROTUŞ SALT MINE VENTILATION NETWORK

The mining works that serve the Trotuş mine within the Tg. Ocna salt mine, are located in the salt massif of Feţele Târgului located near the town of Tg. Ocna, on the left bank of the Trotuş river. The salt massif has the shape of an elongated lens that extends in the N-S direction on a length of 1 -1.2 km, and in the E-V direction on approx. 0.7 km, with a maximum thickness in the central - northern area of the deposit of approx. 0.35 km.

The Trotuş mine was opened in 1970 through the coastal gallery I 101, executed at the level of horizon II.

The gallery was dug in the sterile rock, with a profile of 13.5 m^2 and supported in concrete blocks masonry. At the entrance to the salt massif, the gallery was enlarged to a profile of 32 m^2. For the deep opening of the lower horizons, the gallery was continued with an inclined plane in a spiral, at an identical profile.

A 131.2 m deep concrete ventilation shaft, with a section of 7.5 m^2, is used to make the ventilation. It connects to the 204 ventilation arise, which is deepened with the exploitation of new horizons.

Subsequently, in order to increase the transport capacity, for the opening of horizon VII, a new coastal gallery, Unirea, was executed, which was continued with an inclined plan following the exploitation level and on which the salt is transported to the preparation plant with the help of conveyor belts.

The salt was mined, until 1870, in a bell-shaped chamber and continued in trapezoidal chambers at Old Moldova and New Moldova mines. Since 1967, the salt has been exploited with "small rooms and abandoned square pillars". The exploitation is carried out descending, on horizons.

La începutul exploatării camerele aveau 16 m lăţime şi 8 m înălţime, iar pilierii aveau latura de 14 m. În prezent camerele au 13,5 m lăţime şi 8 m înălţimea bolţii, iar pilierii au latura de 16,5 m. Între orizonturi se lasă un planşeu de 8 m grosime. Pilierii sunt perfect suprapuşi (coaxiali).

At the beginning of the operation, the rooms were 16 m wide and 8 m high, and the pillars were 14 m wide. Currently the rooms are 13.5 m wide and 8 m high, and the pillars are 16.5 m wide. An 8 m thick floor is left between the horizons. The pillars are perfectly superimposed.

The general ventilation of the Tg. Ocna Salt Mine is carried out in a suction system, by means of two main ventilation stations, motor-fan unit, located on the surface.

One installation is equipped with a double suction centrifugal fan type V562-00 DA and the second main station is equipped with two axial fans type VOKD-1.5.

The ventilation network related to the Trotuș Salt Mine includes three old mines: the Ocnița Mine, the Moldova Veche Mine and the Moldova Nouă Mine. It also consists of the Pilot Mine with two horizons, namely Horizon I and Horizon II. The central area of the operation comprises 12 horizons from Horizon I to Horizon XII. The active horizons are Horizon IX - Sanatorium, Horizon XI and Horizon XII. (xxx, 2020).

3. VENTILATION NETWORK MODELING

In order to ensure the safety and health conditions at work when exploiting the salt underground, it is necessary to ensure the distribution of the necessary flows at the level of each branch (Le Roux, 1990).

In order to ensure optimal flows at the level of each branch, specialized programs are used. In this sense, the 3D CANVENT (CANMET, 2000) program is used to solve the complex ventilation network of the Trotuș salt mine.

3D – CANVENT can simulate ventilation systems in operation, which include parameters such as: air flows and their distribution in the system, frictional pressure losses, fan performance, air energy requirements and operating costs for each mining job taken separately as well as for the entire network. These simulations are performed for the development of ventilation models based on the physical input data resulting from the design of mining projects and the designed ventilation parameters used to determine the estimated resistance of the mining works in the network.

Mainly for modeling and solving an ventilation network (Boantă, C. Rădoi, F., 2017; Cioclea, D., 2007; Cioclea, D., 2011; Gherghe, I., 2004; Cioclea, D., 2008; Cioclea, D., 2009, Gherghe, I., 2008), it is necessary to complete the following steps:

- Obtaining topographic plans in the basic plan and topographic plans at horizon level;
- Obtaining the spatial ventilation scheme;
- Identification of nodes and branches on topographic plans and on the spatial ventilation scheme;
- Identifying the geodetic coordinates specific to each node;
- Ventilation network modeling:
  - Entering the coordinates in the database of the 3D-CANVENT program;
  - Initialization of branches based on node coordinates;
- Carrying out measurement campaigns at the level of each branch regarding:
  - determination of aerodynamic parameters;
  - determination of electrical parameters;
  - determining the state parameters.
- Calculation of the determined parameters;
- Recalculation of parameters in a form compatible with the database of the 3D-CANVENT program;
- Entering the value of the parameters in the database of the 3D-CANVENT program;
- Balancing the ventilation network;
- Solving the ventilation network;
- Obtaining data.

In order to know the real values of the aerodynamic parameters specific to the mining works from the composition of the ventilation network afferent to the salt mine, flowmetric and depressiometric measurements are performed (Cioclea, D., 2006; Cioclea, D., 2013; Gherghe, I., 2006; Jurca, L. , 2008; Gherghe, I., Jurca, L., 2006)

In order to measure the pressure losses in order to determine the aerodynamic resistance for each mining work, the "Hose Method" was used.

The value of the pressure loss, of the measured and corrected air flow, serves to establish the aerodynamic resistance specific to the respective section or branch (Băltărețu, R., Teodorescu, C., 1971; Cioclea, D., Lupu, C., Gherghe, I. , 2013; Matei, I., Moraru, R., 2000; Patterson, AM, 1992), which is determined by the relation:

$$R_T = \frac{\Delta H}{Q^2} \ (Ns^2/m^8)$$

where:

R T - aerodynamic resistance specific to the working section (Ns^2 / m^8);

ΔH - pressure loss on the respective section, Pa;

Q^2 - squared air flow, corrected, m^3 / s.

The modeling and simulation program allows the option of visualizing the network in two-dimensional system, fig. 1; 2 and 3 and three-dimensional fig. 4, the coordinates of each node being taken from the topographic maps afferent to each horizon.

In order to solve the aeration network related to the Trotuș Salt Mine, a number of 492 nodes were introduced, respectively a number of 697 branches.

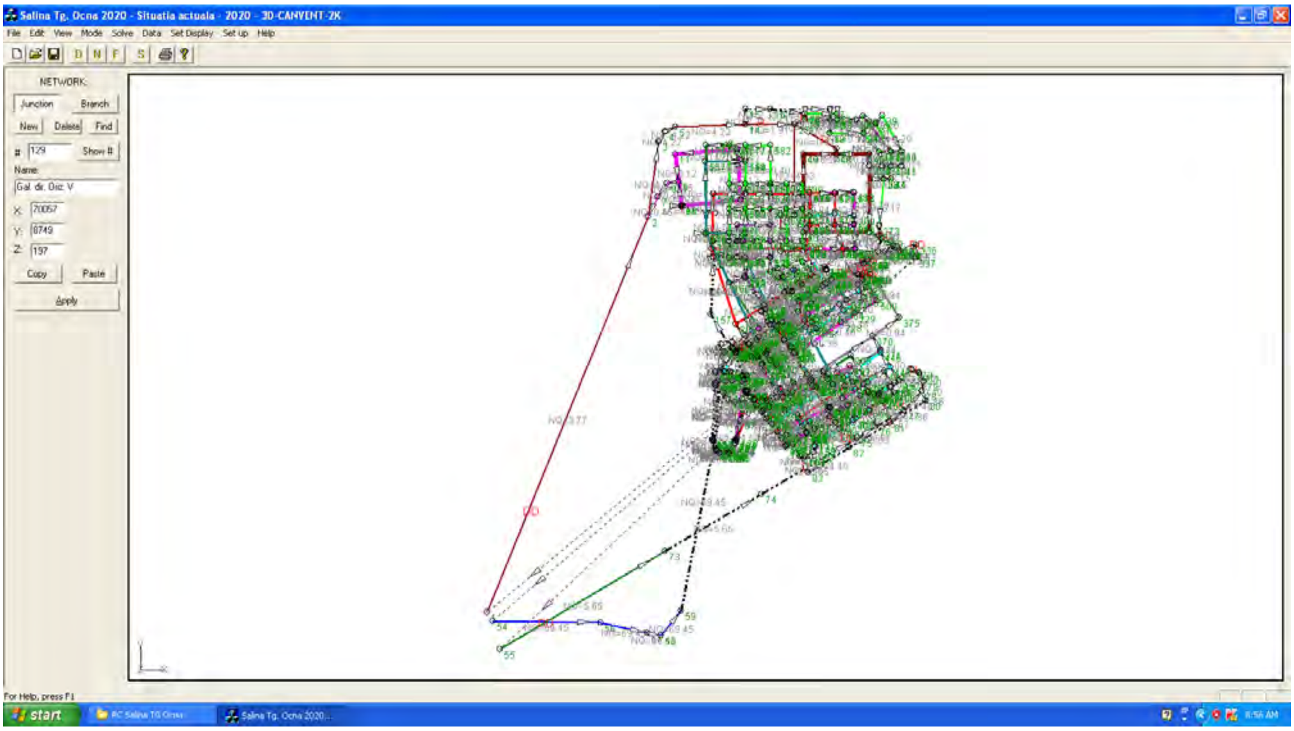

Fig. 1 - The ventilation network of the Trotuș Salt Mine, 2D representation - x-o-y.

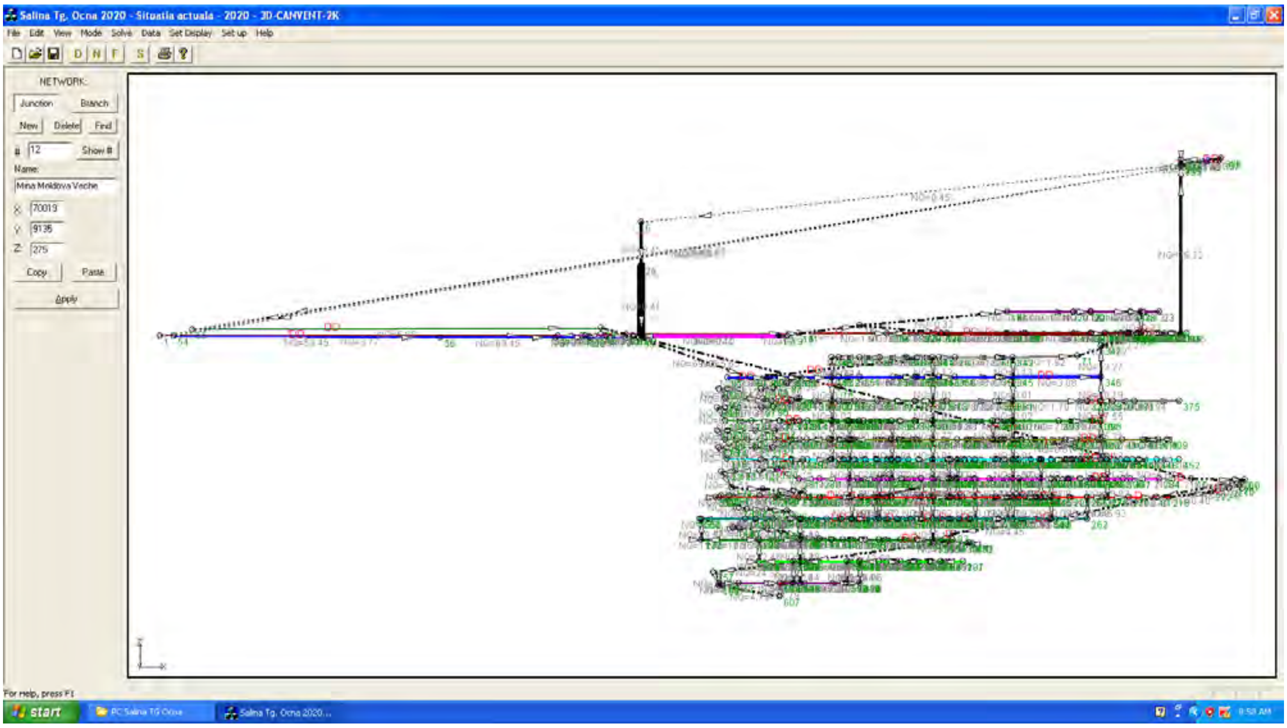

Fig. 2 - The ventilation network of the Trotuș Salt Mine, 2D representation - x-o-z.

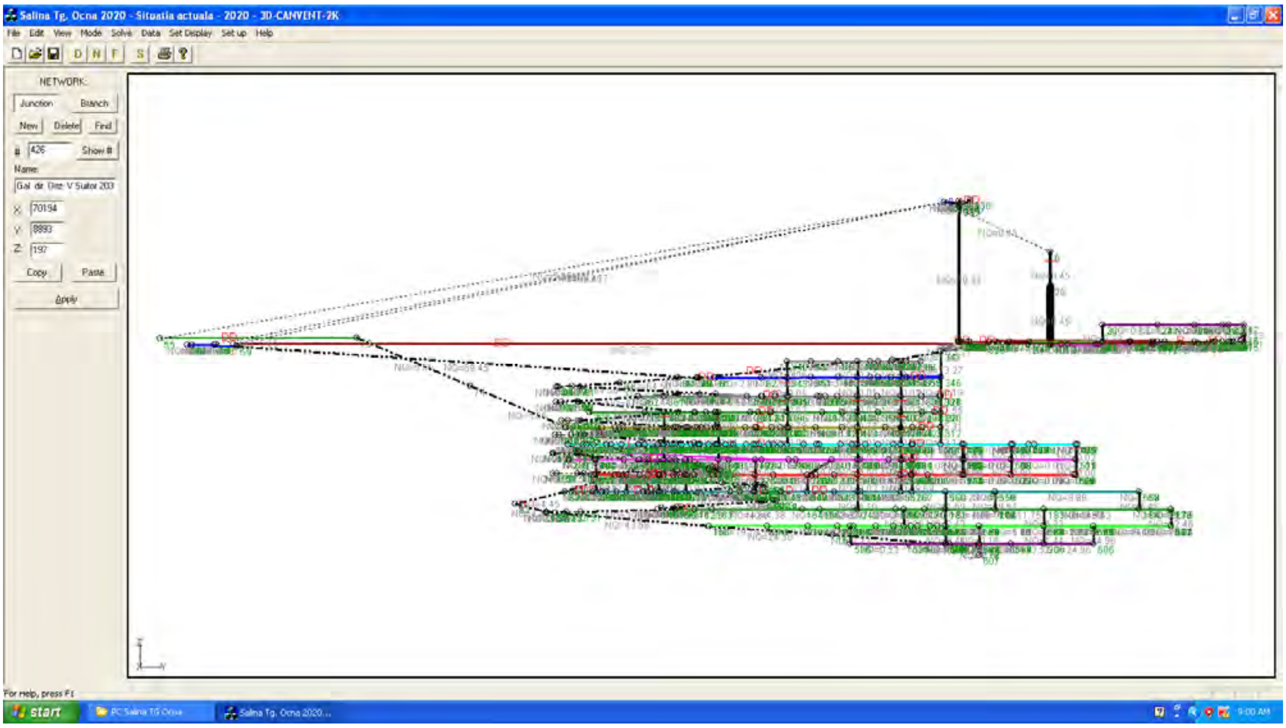

Fig. 3 - The ventilation network of Trotuș Salt Mine, 2D representation - y-o-z.

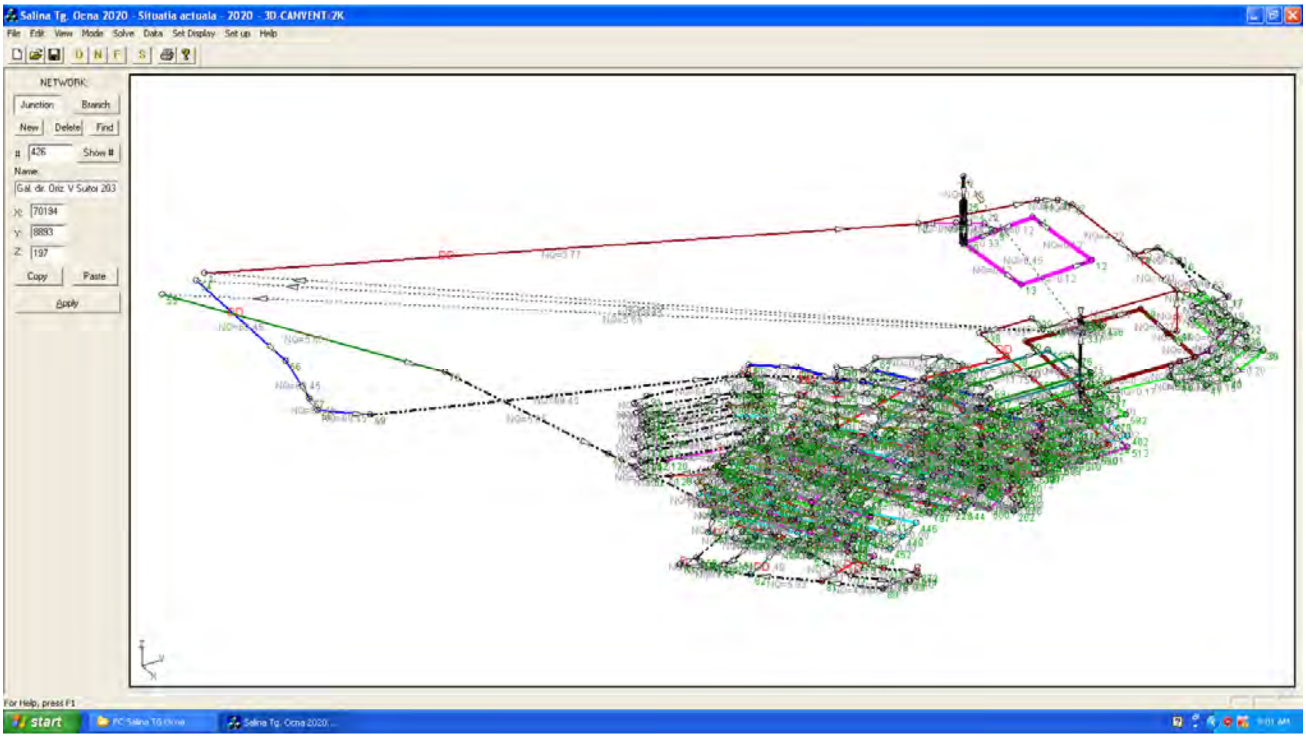

Fig. 4 - The ventilation network of Trotuș Salt Mine, 3D representation - x-y-z.

4. RESULTS OBTAINED

The results obtained after modeling (Gherghe, I., Rădoi, F., 2020) are presented in table no. 1 for nodes, table no. 2 for branches, table no. 3 for fans. In fig. no. 5 shows the characteristic curve related to the centrifugal fan V 562 D.A., resulting from the solution of the ventilation network.

3D-CANVENT-2K

File: Salina Tg. Ocna 2020 - Situatia actuala - 2020 - Junction Results

Junc.#:	Description:	Energy [NM/KG]:	Junc.#:	Description:	Energy [NM/KG]:
72	Gal. leg Oriz XII	-77.99	375	Gal. dir. Oriz. III	-34.11
73	Galeria de coasta Unirea	-56.36	376	Gal. dir. Oriz. III	-34.11
74	Plan inclinat 513	-60.50	377	Gal. dir. Oriz. III	-34.11
75	Plan inclinat 513	-64.61	378	Gal. dir. Oriz. III	-34.11
76	Plan inclinat 513	-65.42	379	Gal. dir. Oriz. III	-34.11
77	Plan inclinat 513	-66.66	380	Gal. dir. Oriz. III	-34.11
78	Plan inclinat 513	-67.23	381	Gal. dir. Oriz. III	-35.20
79	Plan inclinat 513	-67.23	383	Gal. dir. Oriz. IV Suitor 206	-45.61
80	Plan inclinat 520	-67.25	385	Gal. dir. Oriz. IV Suitor 207	-45.61
81	Plan inclinat 520	-67.31	386	Gal. dir. Oriz. IV	-45.61
82	Plan inclinat 520	-67.42	387	Gal. dir. Oriz. IV	-45.61
83	Plan inclinat 520	-67.48	390	Gal. dir. Oriz. IV Suitor 208	-45.61
84	Plan transport 504	-22.59	393	Gal. dir. Oriz. IV	-45.61
85	Plan transport 504	-23.07	395	Gal. dir. Oriz. IV	-45.61
86	Plan transport 504	-23.52	396	Gal. dir. Oriz. IV Suitor 201	-45.61
87	Plan transport 504	-24.89	397	Gal. dir. Oriz. IV	-45.61
88	Plan transport 504	-26.01	398	Gal. dir. Oriz. IV	-45.61
89	Plan transport 504	-26.44	399	Gal. dir. Oriz. IV	-45.61
90	Plan transport 505	-27.06	400	Gal. dir. Oriz. IV	-45.61
91	Plan transport 505	-27.59	401	Gal. dir. Oriz. IV Suitor 202	-45.61
92	Plan transport 505	-30.76	402	Gal. dir. Oriz. IV Suitor 203	-46.70
93	Plan transport 505	-31.17	407	Gal. dir. Oriz. V	-45.74
94	Plan transport 505	-31.95	408	Gal. dir. Oriz. V. Suitor 219	-45.74
95	Plan transport 506	-32.41	409	Gal. dir. Oriz. V	-45.74
96	Plan transport 506	-34.61	410	Gal. dir. Oriz. V, Suitor 228	-45.74
97	Plan transport 506	-35.12	411	Gal. dir. Oriz. V	-45.74
98	Plan transport 506	-35.74	412	Gal. dir. Oriz. V, Suitor 217	-45.74
99	Plan transport 507	-36.13	413	Gal. dir. Oriz. V. Suitor 216	-45.74
100	Plan transport 507	-38.61	415	Gal. dir. Oriz. V. Suitor 215	-45.74

Table no. 1 - Data related on nodes

3D-CANVENT-2K

File: Salina Tg. Ocna 2020 - Situatia actuala - 2020 - Branch Results

Branch From:	To:	Description:	Symbol:	Resistance [$Ns^2/M8$]:	Quantity [m^3/s]:	Pressure Drop [PA]:	Air Power [KW]:	Annual Cost [$]:
116	117	Plan Inclinat 511		0.0002	55.52	0.61	0.03	204
116	291	Gal. leg. Oriz. VI		0.0797	1.87	0.28	0.00	3
117	118	Plan Inclinat 511		0.0001	55.52	0.44	0.02	148
118	119	Plan transport 512		0.0002	55.52	0.59	0.03	197
119	120	Plan transport 512		0.0005	55.52	1.68	0.09	561
120	121	Plan transport 512		0.0002	55.51	0.52	0.03	173
120	281	Gal. leg. oriz. VII	I	99999.0000	0.01	11.34	0.00	1
121	122	Plan transport 512		0.0001	55.51	0.33	0.02	111
122	123	Plan transport 512		0.0002	55.51	0.46	0.03	154
123	124	Plan transport 512		0.0007	55.51	2.07	0.11	690
124	125	Plan transport 512		0.0002	55.51	0.54	0.03	179
125	126	Plan transport 512		0.0001	55.51	0.44	0.02	148
126	127	Plan transport 512		0.0002	55.51	0.55	0.03	185
127	128	Plan transport 519		0.0005	55.51	1.63	0.09	542
128	130	Plan transport 519		0.0002	52.58	0.53	0.03	168
128	266	Galerie legatura Oriz. VIII		0.0916	2.93	0.79	0.00	14
129	323	Bretea Oriz. V		0.0002	0.28	0.00	0.00	0
129	308	Gal. dir. Oriz. V		0.0001	0.56	0.00	0.00	0
130	131	Plan transport 519		0.0001	52.58	0.38	0.02	120
131	132	Plan transport 519		0.0001	52.58	0.33	0.02	105
132	133	Plan transport 519		0.0008	52.58	2.24	0.12	707
133	134	Plan transport 519		0.0002	52.58	0.53	0.03	168
134	135	Plan transport 519		0.0002	52.58	0.41	0.02	131
135	136	Plan transport 519		0.0001	52.58	0.20	0.01	63
136	137	Plan transport 519		0.0005	52.58	1.29	0.07	409
137	138	Plan transport 519		0.0001	48.40	0.22	0.01	65
137	248	Galerie legatura Oriz. IX		0.0001	4.18	0.00	0.00	0
138	139	Plan transport 519		0.0001	48.40	0.20	0.01	57
139	140	Plan transport 519		0.0001	48.40	0.20	0.01	57
140	141	Plan transport 519		0.0001	48.40	0.20	0.01	57
141	142	Plan transport 519		0.0005	48.40	1.19	0.06	347
142	143	Plan transport 519		0.0001	48.40	0.14	0.01	41
143	144	Plan transport 519		0.0001	48.40	0.31	0.01	90
144	145	Plan transport 519		0.0001	48.40	0.28	0.01	82
145	146	Plan transport 519		0.0005	48.40	1.12	0.05	327
146	147	Plan transport 519		0.0001	48.40	0.28	0.01	82
147	148	Plan transport 519		0.0001	48.40	0.25	0.01	74
148	149	Plan transport 519		0.0001	48.40	0.20	0.01	57
149	150	Plan transport 519		0.0002	48.40	0.46	0.02	135
150	151	Plan transport 519		0.0006	39.13	0.93	0.04	218
150	162	Gal leg. Oriz. X	DD	0.1500	9.27	12.90	0.12	719

Table no. 2 - Data related on branches

3D-CANVENT-2K

File: Salina Tg. Ocna 2020 - Situatia actuala - 2020 - Fan Results

Fan Name:	Branch From:	To:	Pressure [Pa]:	Quantity [m^3/s]:	Air Power [KW]:	Cost [$]:
fixed	221	232	700.00	32.46	22.72	136498
fixed	237	556	730.00	39.57	28.89	173532
V3 - 56200 - D.A	334	337	1671.08	81.32	135.88	816239
fixed	606	581	500.00	24.96	12.48	74975

Table no. 3 - Data related on fans

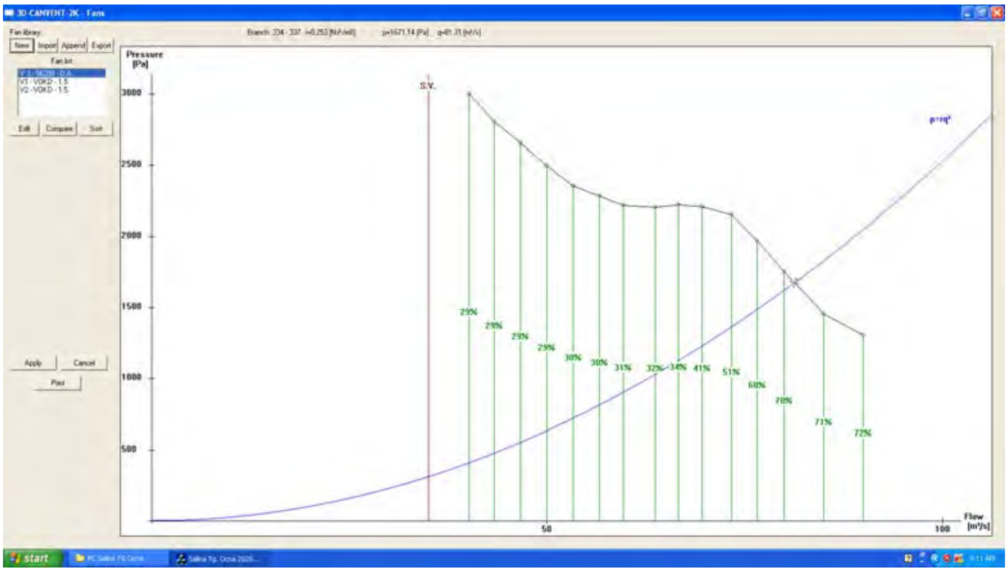

Fig. 5 - Characteristic curve of the active fan V 562 D.A.,

After solving of the ventilation network related to the Trotuș salt mine, the following results were obtained:

• The air flow on the Coastal Gallery 101, for fresh air supply, was 69.46 m^3 / s.
• The air flow on the Unirea Coastal Gallery, fresh air supply, was 5.65 m^3 / s.
• The air flow on the Coastal Gallery 401, fresh air inlet, was 3.77 m^3 / s.
• The air flow on Ocnița Well, fresh air inlet, was 0.45 m^3 / s.
• The air flow on the Mina Pilot II access gallery, fresh air inlet, was 2.31 m^3 / s.
• The air flow on the Mina Pilot I access gallery, of exhaust air, was 0.18 m^3 / s.
• The air flow at the level of the Moldova Veche Mine, for fresh air inlet, was 0.33 m^3/ s.
• The air flow at the level of the Moldova Nouă Mine, for fresh air inlet, was 0.64 m^3 / s.
• The air flow on gallery 405 on behalf of the Moldova Nouă Mine, for the evacuation of vitiated air, was 4.02 m^3 / s.
• The air flow on the Plan 502 for access to Horizon I, for fresh air inlet, was 2.13 m^3 / s.
• The air flow on the access gallery to horizon II, for fresh air inlet, was 2.79 m^3 / s.
• The air flow on the access gallery to horizon III, for fresh air inlet, was 2.64 m^3 / s.
• The air flow on the access gallery to horizon IV, for fresh air inlet, was 3.74 m^3 / s.
• The air flow on the access gallery to horizon V, fresh air inlet was 0.71 m^3 / s.
• The air flow on the access plan to horizon V, for fresh air inlet, was 0.0 m^3 / s, closed work with isolation dam.
• The air flow on the access gallery to horizon VI, for fresh air inlet, was 1.86 m^3 / s.
• The air flow on the Access Plan to horizon VI, for fresh air inlet, was 0.0 m^3 / s, closed work with isolation dam.
• The air flow on the access gallery to horizon VII, for fresh air inlet, was 0.0 m^3 / s, closed work with insulation dam.
• The air flow on the Access Plan to horizon VII, for fresh air inlet, was 1.2 m^3 / s.
• The air flow on the access gallery to horizon VIII, for fresh air inlet, was 2.92 m^3 / s.
• The air flow on Plan 513 for access to horizon VIII, for fresh air inlet, was 0.39 m^3 / s.
• The air flow on Gallery 464 for access to horizon VIII, fresh air inlet, was 1.05 m^3 / s.
• The air flow on the access gallery to horizon IX, for fresh air inlet, was 4.0 m^3 / s.
• The air flow on Gallery 466 for access to horizon IX, fresh air inlet, was 1.42 m^3 / s.
• The air flow on the access gallery to horizon X, fresh air inlet, was 9.35 m^3 / s.
• The air flow on the access gallery to horizon XI, for fresh air inlet, was 19.27 m^3 / s.
• The air flow on the access gallery to horizon XII, for fresh air inlet, was 19.67 m^3 / s.

• The air flow at the level of the Ventilation Suite 238 that connects the horizons XII-XI and on which is placed a WAT 1250 activation fan, for exhausting the vitiated air, was 24.96 m^3 / s.

• The air flow on the access gallery to horizon VI, for fresh air inlet, was 1.86 m^3 / s.

• The air flow on the Access Plan to horizon VI, for fresh air inlet, was 0.0 m^3 / s, closed work with isolation dam.

• The air flow on the access gallery to horizon VII, for fresh air inlet, was 0.0 m^3 / s, closed work with insulation dam.

• The air flow on the Access Plan to horizon VII, for fresh air inlet, was 1.2 m^3 / s.

• The air flow on the access gallery to horizon VIII, for fresh air inlet, was 2.92 m^3 / s.

• The air flow on Plan 513 for access to horizon VIII, for fresh air inlet, was 0.39 m^3 / s.

• The air flow on Gallery 464 for access to horizon VIII, fresh air inlet, was 1.05 m^3 / s.

• The air flow on the access gallery to horizon IX, for fresh air inlet, was 4.0 m^3 / s.

• The air flow on Gallery 466 for access to horizon IX, fresh air inlet, was 1.42 m^3 / s.

• The air flow on the access gallery to horizon X, fresh air inlet, was 9.35 m^3 / s.

• The air flow on the access gallery to horizon XI, for fresh air inlet, was 19.27 m^3 / s.

• The air flow on the access gallery to horizon XII, for fresh air inlet, was 19.67 m^3 / s.

• The air flow at the level of the Ventilation Suite 238 that connects the horizons XII-XI and on which is placed a WAT 1250 activation fan, for exhausting the vitiated air, was 24.96 m^3 / s.

• The air flow at the level of the Ventilation Suite 204 that connects the horizons IV-III, for the evacuation of the vitiated air, was 67.58 m^3 / s.

• The air flow at the level of the Ventilation Suite 204 that connects the horizons III-II, for the evacuation of the vitiated air, was of 70.22 m^3 / s.

• The air flow at the level of the Ventilation Suite 204 that connects the horizons II - Connection plan to Gallery 405, for the evacuation of vitiated air, was 73.3 m^3 / s.

• The air flow at the level of the Connection Plan at Gallery 405, for the evacuation of the vitiated air, was 73.3 m^3 / s.

• The air flow at the level of the Plan 501 connecting to the Pilot Mine, for evacuating the vitiated air, was 1.81m^3 / s.

• The air flow on the main transversal gallery at the Aeration Well, horizon I Mina Pilot, for the evacuation of the vitiated air, was 79.33 m^3 / s.

• The air flow at the level of the Aeration Well, horizon I Mina Pilot, for the evacuation of vitiated air, was 79.33 m^3 / s.

• The air flow at the level of the main aeration station VOKD 1.5 short-circuit with the surface was 1.63 m^3 / s.

• The air flow at the level of the short-circuit aeration well with the surface was 0.37 m^3 / s.

• The air flow at the level of the main aeration station V 562 D.A., was 81.33 m^3 / s.

In the last column of table no. 2, presents the annual cost of air circulation on each branch of the aeration network (at an average price of 0.48 lei / kWh), as follows:

• The annual cost of air circulation on the Coastal Gallery 101, for fresh air supply, was 2,414 lei.

• The annual cost of air circulation on the Unirea Coast Gallery, for fresh air supply, was 1,949 lei.

• The annual cost of air circulation on the Coastal Gallery 401, for fresh air inlet, was 458 lei.

• The annual cost of air circulation on Ocnița Well, for fresh air entry, was 54 lei.

• The annual cost of air circulation on the 405 contour gallery of the Moldova Nouă Mine, for the evacuation of the vitiated air was 3,367 lei.

• The annual cost of air circulation on Plan 502 for access to Horizon I, for fresh air entry, was 42 lei.

• The annual cost of air circulation on the access gallery to horizon III, for the entry of fresh air, was 7 lei.

• The annual cost of air circulation on the access gallery to horizon IV, for the entry of fresh air, was 27 lei.

• The annual cost of air circulation on the Plan for access to horizon V, for fresh air inlet was 2 lei, closed work with insulation dam.

• The annual cost of air circulation on the access gallery to horizon VI, for fresh air entry, was 3 lei.

• The annual cost of air circulation on the Plan for access to horizon VII, for fresh air entry, was 4 lei.

• The annual cost of air circulation on the access gallery to horizon VIII, for the entry of fresh air, was 14 lei.

• The annual cost of air circulation on Gallery 464 for access to horizon VIII, for fresh air entry, was 3 lei.

• The annual cost of air circulation on Gallery 466 for access to horizon IX, for fresh air entry, was 203 lei.

• The annual cost of air circulation on the Gallery of access to horizon X, for fresh air entry, was 719 lei.

• The annual cost of air circulation on the access gallery to horizon XI, for the entry of fresh air, was 517 lei.

• The annual cost of air circulation on the access gallery to horizon XII, for the entry of fresh air, was 644 lei.

• The annual cost of air circulation at the level of the Ventilation Suite 238 that connects the horizons XII-XI and on which is placed a WAT 1250 activation fan, for the evacuation of the vitiated air, was 74,975 lei.

• The annual cost of air circulation at the level of the Ventilation Suite 241 that connects the horizons XI-X and on which is placed a WAT 1600 activation fan, for evacuating the vitiated air, was 136,498 lei.

• The annual cost of air circulation at the level of the Ventilation Monitor 243 that connects the X-IX horizons and on which a WAT 1600 activation fan is placed, for the evacuation of the vitiated air, was 173,532 lei.

• The annual cost of air circulation at the level of the Ventilation Suite 204, which connects the horizons IX-VIII, for the evacuation of the vitiated air, was 379 lei.

• The annual cost of air circulation at the level of the Ventilation Suit 204 that connects the horizons VIII-VII, for the evacuation of the vitiated air, was 403 lei.

• The annual cost of air circulation at the level of the Ventilation Monitor 204, which connects the horizons VII-VI, for the evacuation of the vitiated air, was 757 lei.

• The annual cost of air circulation at the level of the Ventilation Suit 204 that connects the horizons VI-V, for the evacuation of the vitiated air, was 825 lei.

• The annual cost of air circulation at the level of the Ventilation Suite 204, which connects the horizons V-IV, for the evacuation of the vitiated air, was 914 lei.

• The annual cost of air circulation at the level of the Aeration Suite 204, which connects the horizons IV-III, for the evacuation of the vitiated air, was 1,011 lei.

• The annual cost of air circulation at the level of the Ventilation Suit 204 that connects the horizons III-II, for the evacuation of the vitiated air, was 1,134 lei.

• The annual cost of air circulation at the level of the Ventilation Monitor 204 that connects the horizons II - Connection plan to Gallery 405, for the evacuation of the vitiated air, was 2,212 lei.

• The annual cost of air circulation at the level of the Connection Plan to Gallery 405, for the evacuation of the vitiated air, was of 19,172 lei.

• The annual cost of air circulation on the main transversal gallery at the Aeration Well, horizon I Pilot Mine, for the evacuation of vitiated air, was 30.58 lei.

• The annual cost of air circulation at the level of the Aeration Well, horizon I Pilot Mine, for the evacuation of vitiated air, was 530,636 lei.

• The annual cost of air circulation at the level of the main aeration station VOKD 1.5 short-circuit with the surface, was 12,970 lei.

• The annual cost of air circulation at the level of the short-circuit aeration well with the surface was 3,057 lei.

• The annual cost of air circulation at the level of the aeration channel afferent to the main aeration station V 562 D.A., was of 145,839 lei.

• The annual cost of air circulation at the level of the main aeration station V 562 D.A., was 816,239 lei.

5. DISCUSSION

After solving of the ventilation network related to the Trotuș Salt Mine, it was observed that the fan V - 56200 D.A. achieves a flow rate of 82.46% of the maximum flow that such a type of fan can achieve.

In this sense, at the level of the main ventilation station, a flow of 81.33 m^3 / s is circulated at a developed depression of 1671.02 Pa and a total resistance of the ventilation network of 0.253 Ns^2 / m^8.

Also, after solving of the ventilation network related to Trotuș Salt Mine, it was observed that the direction of air circulation is normal as well as the fact that the air flows are at a relatively good level, sufficient for the ventilation of the ventilation network. Also, the gases resulting from the exploitation area are not circulated on the routes of the mining works related to the sanatorium located at the level of horizon IX.

At the level of the Sanatorium, a total air flow of 5.66 m^3 / s is circulated.

At the same time, it was found that the high flow rate achieved by the main fan is determined by the fact that the sections of the mining works for introducing fresh air and exhaust air are large.

6. CONCLUSION

• For the modeling and solving of the ventilation network of the Trotuș Salt Mine, which presents an extremely high degree of complexity, the method of the iterative technique and that of the successive approximations was used, which is the basis of the 3D-CANVENT ventilation network solving program.

• When drawing up the aeration scheme related to the Trotuș Salt Mine, topographic plans were used for each horizon, based on which the nodes and branches of the network were established, resulting in a number of 492 nodes, respectively 697 branches.

• The elements necessary for running the program consist of flowmetric and depressiometric measurements performed in situ.

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

• For the economic characterization of the ventilation process of the Trotuș Salt Mine, an average energy price of 0.48 lei / kWh was taken into account.

• The ventilation network related to the Trotuș Salt Mine includes three old mines: the Ocnița Mine, the Moldova Veche Mine and the Moldova Nouă Mine. It also consists of the Pilot Mine with two horizons, namely Horizon I and Horizon II. The central area of the operation comprises 12 horizons from Horizon I to Horizon XII. The active horizons are Horizon IX - Sanatorium, Horizon XI and Horizon XII.

The salt mine has 2 main aeration stations, namely: the main aeration station V 562 D.A.- active and the main aeration station VOKD 1.5.

After solving of the ventilation network, the results were obtained, of which the following are presented:

• The air flow at the level of the main aeration station V 562 D.A., was 81.33 m^3 / s.

• The annual cost of air circulation at the level of the main aeration station V 562 D.A., was 816,239 lei.

• After solving of the ventilation network related to the Trotuș Salt Mine, it was observed that the fan V - 56200 D.A. achieves a flow rate of 82.46% of the maximum flow that such a type of fan can achieve.

• At the level of the main aeration station, a flow of 81.33 m3 / s is developed at a developed depression of 1671.02 Pa and a total resistance of the aeration network of 0.253 Ns2 / m8.

• Also following the solution of the ventilation network related to the Trotuș Salt Mine, it was observed that the direction of air circulation is normal as well as the fact that the air flows are at a relatively good level, sufficient for the ventilation of the ventilation network. Also, the gases resulting from the exploitation area are not circulated on the area of the mining works afferent to the Sanatorium located at the level of horizon IX.

• At the level of the Sanatorium, a total air flow of 5.66 m3 / s is circulated.

GRATITUDE

The project regarding the solving of the ventilation network afferent to the Trotuș salt mine was realized from the funds of the National Salt Authority - Tg Ocna subsidiary. We would like to thank the management of the Tg Ocna subsidiary as well as INCD INSEMEX Petroșani, without whose support this complex project could not have been completed.

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