12th Scientific/Research Symposium with International Participation
„METALLIC AND NONMETALLIC MATERIALS“ B&H, 19th-20th April 2018

OPTIMIZATION OF PROCESS PARAMETERS IN THE PRODUCTION OF POWDERED EXPLOSIVES IN PS VITEZIT

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Keywords: explosives, process parameters, quality control

ABSTRACT

Parameter monitoring and testing of explosive substances under certain conditions, as well as control of raw materials used in the production process, contributes to obtaining the finest quality product.
The aim of this paper was to test the key parameters in the process of explosive production and compare the results with the standard (reference) values, all with the aim of optimizing the process parameters in the production of powder explosives in PS Vitezit. The examination of mentioned parameters was carried out in the premises of the company PS Vitezit in Vitez during the period from October 9 to November 9 2017.
In the experimental part is analyzed the chemical composition of powdered explosive methane vitezit-1(MV-1): ethereal extract, aqueous extract and residue and it was analyzed moisture and sodium chloride content in powdered explosive (MV-1). From technical mining characteristics, it was determined the rate of detonation transfer and the safety on ignition of methane and dangerous coal dust.

1. INTRODUCTION

Explosive (lat. exploder - decay) is a chemical compound or mixture which under the influence of an external impulse in the form of heat, impact and friction can cause extremely rapid chemical reaction or explosion. This reaction is followed by the release of large amounts of heat and the emergence of heated gaseous products at a pressure much higher than the pressure of the environment. Because of this pressure difference, the gases are rapidly spreading and part of the energy is turned into work, resulting in destruction. Explosives are used for different purposes in [1]:

- construction,
- mining and
- the most important and widespread use is in war technique.

Methanvitezit (MV-1) is a safety powder-based explosive based on trinitrotoluene (TNT). MV-1 contains [2,3]:

- ammonium nitrate (NH_4NO_3) which has a low temperature of explosion and with many organic matter is able to form a paste,

- sodium chloride (NaCl) which has the ability to absorb some of the energy of an explosive disintegration and thereby lower the temperature of the explosion, which is a very important factor for the safety of explosives due to the possibility of igniting the methane and coal dust particles in the mines,
- wood flour or wood shavings - when the explosive is detonated, the wood shavers burn and contribute to increasing the reaction heat and reacting temperatures two to three times and have hygroscopic properties,
- spherical oil - reduces dusting during processing in colloders and to some extent protects explosives from hardening,
- carboxymethyl cellulose - it belongs to the carbide group which is so far proved to be the most successful agent for preventing the ammonium nitrate powder detonation,
- calcium stearate and zinc, aluminum oxide, clay – reduces the hardening of ammonium nitrate in explosives,
- organic and inorganic substances that will give appropriate color to explosive.

Production of methanvitezit MV-1 implies a batch process, homogenization of powdered components (sensitizers, oxidants, fuels) into an explosive mixture where each component in the mixture has its own characteristics.

2. EXPERIMENTAL PART

In the experimental part, the quality control of the powder explosive MV-1 was performed. The sampling, testing and reception method is prescribed by the internal standard for sampling and reception of explosives, and the test methods are prescribed by JUS and technical conditions.

2.1. Analyzed parameters and examination methods

The explosive mass is taken with wooden spoon from every other canister. It is not taken from the surface, but is pushed deeper into the mass with the spit. From each bidon, is taken one spoon into a plastic bag and it is formed a common pattern of one batch [3]. The following parameters for the powder explosive MV-1 were investigated:

- chemical composition of explosive: ethereal extract, aqueous extract and residue,
- moisture content,
- sodium chloride content,
- testing safety on ignition of methane and hazardous coal dust and
- detonation transfer.

By ether extraction, soluble substances in ether (TNT) are converted to the solution. The obtained values for the % of ether extract should be about 12% with a deviation of ± 1. The aqueous extract represents the total amount of all substances contained in the explosive that dissolve in hot water (NH_4NO_3, $NaNO_3$, NaCl). The obtained values for the % of aqueous extract should be about 83% with a deviation of ± 1. Substance content after the etheric and aqueous extract is expressed as the residue, and its composition includes: nitrocellulose, wood flour, dyes and inert additives. Values for % of residue should be about 3% with a deviation of ± 1. Determination of moisture content is a very important parameter because on it depends whether the produced explosive is correct. In the period when the increasing amount of moisture in the air occurred, producing powdered explosives had to stop because they showed a constant moisture content more than the permissible, up to 0.6%. The etheric extract, the aqueous extract, residue content, moisture content were determined according to the method used in PS Vitezit [4].

In the percentage content of NaCl in the composition of safety explosives should be carefull, because if the content of the inert salt is very high it is difficult to provide sufficient detonation sensitivity. The uneven distribution of salt in the mixture can cause the deterioration of the explosive properties in terms of security of ignition of methane and coal dust. The content of chlorides in the powder explosive should range from 29 to 31%. The content of NaCl in the methanolic powder explosive is determined by the Mohr method of direct determination of chloride ions by titration with standard $AgNO_3$ solution with potassium chromate as an indicator [4].

Examination of technical-mining properties of explosives is carried out on a daily basis in the production of explosives on special polygons owned by explosive plants [4]. Safety explosives are used for mining in coal mines with the occurrence of methane and hazardous coal dust. The most important requirement for these explosives is that they do not allow their detonation to cause an explosion or ignition of methane and dangerous coal dust.

Figure 1. Trial platform [4]

Testing safety on ignition of methane and hazardous coal dust is carried out in the test platform (Figure 1).

The detonation transfer is carried out according the standard method. The test is considered completed when the distance in cm is determined, in which three detonation transmissions occur in three consecutive tests. Complete transfer of detonation is controlled through a control cartridge which also detonates, while in case of incomplete detonation the control cartridge is only damaged and discarded [5].

3. RESULTS AND DISCUSSION

Determination of the ether extract yielded a reference value of about 12% with a deviation of ± 1%. Determination of the aqueous extract yielded a reference value of about 83% with a deviation of ± 1%, and the reference value of the residue is about 3% with a deviation of ± 1%. On the basis of the obtained results it can be concluded that they are the same in accordance with the given values and that there is no need for further examination.

Moisture content can be determined by using following formula [4]:

$$\%\, moisture\ content = \frac{(a-b)\ \cdot 100}{m} \quad (1)$$

a-mass of the hour glass with sample before placing it in exicator,

b-mass of the hour glass with sample after drying when the constant mass is obtained,

m-mass of sample.

In the Table 1 it is given moisture content in powdered explosive MV-1.

Table 1. Determination of moisture content in powder explosive MV-1

Date	Batch	m[g]	a [g]	b [g]	Moisture content (%)
09.10.2017.	1.	7.7727	63.7233	63.7049	0.23
	2.	8.6448	63.8742	63.8566	0.20
10.10.2017.	1.	8.7207	63.5820	63.5563	0.29
	2.	7.4364	50.9393	50.9102	0.39
11.10.2017.	1.	6.9530	59.7593	59.7267	0.46
	2.	6.2101	45.4851	45.4628	0.35
12.10.2017.	1.	6.5393	59.3460	59.3153	0.46
	2.	6.4896	62.4426	62.4254	0.23
13.10.2017.	1.	6.9372	61.1608	61.1418	0.27
	2.	6.4690	61.7714	61.7380	0.51
	3.	8.2080	66.4358	66.4043	0.38
16.10.2017.	1.	9.4873	65.4322	65.4092	0.28
	2.	5.8474	49.3493	49.3245	0.42
	3.	8.6528	66.8800	66.8477	0.37
18.10.2017.	1.	8.1039	75.0536	75.0261	0.34
	2.	7.7849	63.0862	63.0513	0.44
	3.	8.6730	63.5343	63.5026	0.37
19.10.2017.	1.	7.7073	63.6604	66.6253	0.45
	2.	7.9210	60.7277	60.7088	0.24
20.10.2017.	1.	6.7621	67.0045	66.9873	0.25
	2.	9.6460	64.9494	64.92220	0.24
26.10.2017.	1.	8.4132	75.3017	75.3374	0.29
	2.	7.5094	46.7836	46.7671	0.22
	3.	8.2835	66.1291	66.1128	0.20
27.10.2017.	1.(from 26.10.)	8.8348	62.3771	62.3408	0.41
28.10.2017.	1.	7.0559	62.0091	61.9859	0.32
	2.	8.8659	66.6701	66.6498	0.22
08.11.2017.	1.	8.7848	66.5883	66.5588	0.33
	2.	5.4000	48.9007	48.8825	0.33
09.11.2017	1.	6.7085	53.1361	53.1150	0.31
	2.	7.2445	61.7744	61.7463	0.39

Based on Figure 2 it can be seen that values for the moisture content are within the reference value (up to 0.6%) and the produced explosives can be used for the foreseen purposes.

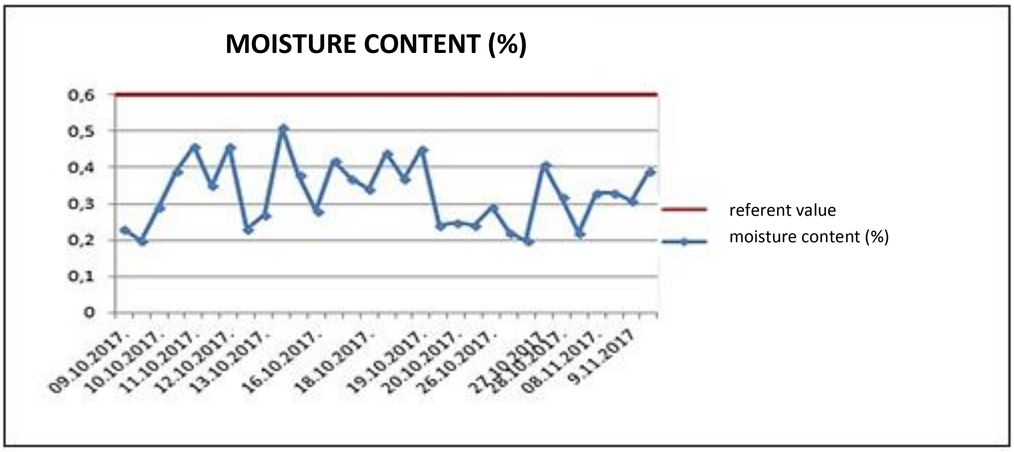

Figure 2. Moisture content in powder explosive MV-1

Chloride content can be determined using following formula [4]:

$$\% NaCl = \frac{a \cdot F \cdot 5{,}85}{G} \qquad (2)$$

a – the volume of standard solution (cm^3),

G – explosive sample mass (g),

5.85- equivalent for NaCl,

F – factor of $AgNO_3$ solution (0.9920).

In Table 2 and in the diagram in Figure 3 are shown the values for the chloride content for a period from October 9 to November 9 2017. The obtained values are within the limits of chloride content (the reference value is 29 to 31%) in the explosive and there are no deviations.

Table 2. Determination of chloride content in powder explosive MV-1

Date	Batch	G[g]	a[cm^3]	Chloride content in powder explosive(%)
09.10.2017.	1.	2.2848	11.7	29.71
	2.	2.1306	11.3	30.70
	3.	2.2067	11.7	30.76
	4.	2.2143	11.1	30.46
10.10.2017.	1.	2.4949	12.8	29.77
	2.	2.1443	11.0	29.76
	3.	2.1786	11.3	30.10
	4.	2.2867	11.5	29.18

11.10.2017.	1.	2.2252	11.7	30.51
	2.	2.1264	11.1	30.29
	3.	2.1131	11.0	30.20
12.10.2017.	1.	2.2866	12.0	30.45
	2.	2.1793	11.3	30.09
	3.	2.1085	10.8	29.72
	4.	2.1809	11.4	30.33
	5	2.2601	11.6	29.78
13.10.2017.	1.	2.0651	10.7	30.06
	2.	2.1446	11.1	30.03
	3.	2.1938	11.4	30.15
	4.	2.2873	11.8	29.93
16.10.2017.	1.	2.2279	11.5	29.95
	2.	2.1836	11.4	30.29
	3.	2.2374	11.4	29.56
	4.	2.1502	11.2	30.22
18.10.2017.	1.	2.0702	10.8	30.27
	2.	2.4017	12.5	30.20
	3.	2.3259	12.2	30.43
20.10.2017.	1.	2.1019	11.0	30.37
	2.	2.0642	10.7	30.08
	3.	2.0131	10.6	30.55
26.10.2017.	1.	2.2170	11.4	29.84
	2.	2.2075	11.5	30.23
	3.	2.2614	11.7	30.02
	4.	2.3944	12.5	30.29
	5.	2.1982	11.3	30.38
27.10.2017.	1.	2.1602	11.4	30.62
	2.	2.2249	11.5	29.99
	3.	2.2355	11.8	30.63
08.11.2017.	1.	2.0627	11.0	30.94
	2.	2.1446	11.2	30.30
	3.	2.0424	10.5	29.83
	4.	2.1764	11.6	30.93
09.11.2017.	1.	2.3816	12.6	30.70
	2.	2.2736	11.6	29.60
	3.	2.1733	11.2	29.90
	4.	2.1996	11.5	30.34

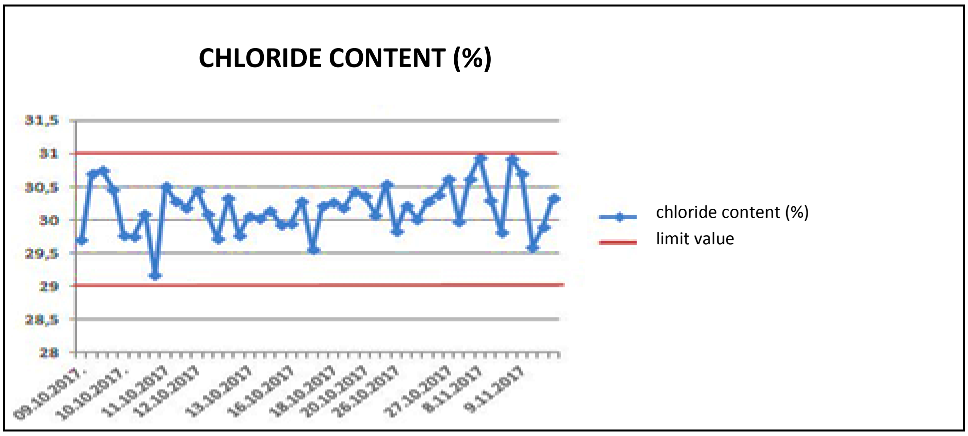

Figure 3. Chloride content in powdered explosive MV-1

Testing safety on ignition of methane and hazardous coal dust was carried out on 27.10.2017. year in the testing halls of the company Vitezit. During examination in test hall MV-1 showed good results, ie no ignition of methane with 500 g of methanvitezit-1 explosive, but the permissible use of this mine explosive at one mine hole is reduced by 100 g for a better safety and amounts 400 g.

In the company PS Vitezit, Vitez 27.10.2017, the investigation of the transfer of detonation at the learning station was carried out. The measured rate of detonation transfer should be within the range of 2700 to 3300 m/s. When measuring the transfer of 4 cm and 3 cm there was a transfer of detonation and the speed was within acceptable limits. When the transfer between the cartridges at 2 cm was reduced, the speed was higher than the permissible and it is thus concluded that it is allowed to transfer the detonation to 3 and 4 cm.

4. CONCLUSION

In this paper control of certain parameters of powder explosives was performed. The following methods were used in the experimental part:

- Determination of ethereal extract, aqueous extract and residue,
- Determination of moisture content,
- Determination of sodium chloride content in safety explosives,
- Testing safety on ignition of methane and hazardous coal dust and
- Determination of detonation transfer.

Based on the obtained results, a general conclusion can be made that powder explosives manufactured in PS Vitezit in Vitez produced in the period from October 9 to November 9 2017 can be used for the foreseen purposes.

5. REFERENCES

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