USAGE OF EMULSION EXPLOSIVES ON SURFACE MINE "ZELENIKOVEC" - SKOPJE

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ABSTRACT

This paper describes the advantages of using emulsion explosives on the surface mine "Zelenikovec".
A comparison has been made with the other types of explosives regarding the cost of drilling, blasting, environmental protection and the safety while using them.
In the estimates, the criteria for using this type of emulsion explosives on the surface mine "Zelenikovec" have been met.

Keywords: *Explosives, emulsion, open pit mine, Zelenikovec, blasting.*

1. INTRODUCTION

In recent years the emulsion explosives have had a large increase in the usage on surface and underground mines. The reason for this are the great advantages that emulsion explosives offer compared to other types of explosives on the market. The advantages of emulsion explosive include safety and security, excellent resistance to water, increased velocity of detonation, transport, handling and storage, savings in drilling operations and low gas emissions.
From the beginning, the surface mine "Zelenikovec" uses Ammonium nitrate cartridge explosives with combination of ANFO, but due to constant growth on gas price, which is an important feature of the final price of the product, a solution for decreasing the price costs for drilling and blasting is inevitable.

The purpose of this study is to present the theoretical and practical experience reached here and abroad, in order to use emulsion explosives on the surface mine "Zelenikovec", and to present the possibilities for using emulsion explosives on other surface mines in our country.

2. BASIC FEATURES OF EMULSION EXPLOSIVES

The usage of emulsion explosives has numerous advantages. After the price of the explosive, most important parameter that directly affects for its usage are its blasting characteristics. We will mention the safety, high velocity of detonation, water resistance, low gas emissions, transport, storage, fast charging time and etc.

2.1 Safety

The emulsion is stable and does not explode in the standard striking tests. The emulsion does not explode while burning, but there is a possibility of an explosion if it is in contact with materials as detonators, dynamites or aluminum powder.

2.2 Velocity of detonation

The velocity of the detonation increases by decreasing the size of the particles which are contained in explosives. Emulsion particles are small, therefore the velocity of blasting is high. Bulk emulsion explosives detonate with a higher VOD than Ammonium nitrate cartridge and ANFO under the same conditions.

2.3 Water resistance

The emulsion has excellent water resistance. Boreholes can be successfully filled with emulsion even if there is water inside.

2.4 Gas emission

The structure of the emulsion allows optimal oxygen balance, thus significantly lowers the emissions of carbon and nitrogen gases.

2.5 Transport and storage

The emulsion is classified as an oxidizer, so transport and storage does not lead to danger of explosion. The emulsion becomes an explosive when it is pumped in the borehole. The emulsion can be stored at temperatures between -20º C to 50º C.

3. COMPARISON BETWEEN AMMONIUM AND NITRAT EMULSIVE EXPLOSIVES

A techno - economic comparison is made on blasting series and blasting 10.000 m^3 of material from the surface mine "Zelenikovec". In the comparison it is only the cost that has been taken into consideration required for the procurement of explosives and the fuel needed for drilling boreholes. In Table 1 the input parameters required for the calculation has been shown.

Table 1: Entry parameters

	Rock characteristics (limestone)	**Value**
1	Seismic wave velocity	**4000** ($m^{'}/s$)
2	Density	**2730** (kg/m^3)

	Charging parameters	**Value**
1	Blast hole diameter	**0,089** ($m^{'}$)
2	Explosive diameter	**0,07** ($m^{'}$)

	Other blasting parameters	**Value**
1	Max. fragmented rock size	**0,8** ($m^{'}$)
2	Bench height	**10** ($m^{'}$)
3	Drill angle	**75** (^{0})
4	Fuel consumption	**1,5** ($l/m^{'}$)
5	Fuel price	**1,14** (€/l)

The calculation of drilling and blasting parameters are based on the energy distribution from the explosion in the rocky massif, thus defining the specific explosive consumption as a basic parameter of the fragmentation degree of the material that has been blasted.
The calculations of drilling and blasting parameters for ammonium nitrate cartridge explosives are given in Table 2, and for emulsion explosives in Table 3.

Table 2: Calculated values on drilling and blasting parameters for Ammonium nitrate cartridge explosives

	Explosive characteristics	**Value**
1	Velocity of detonation (VOD)	**3600** (m'/s)
2	Density	**1100** (kg/m^3)
3	Specific energy	**4,24** (MJ/kg)
4	Explosive price	**1** (€/kg)

	Obtained results	**Value**
1	Hole depth	**11,0** (m')
2	Sub-drilling	**1,0** (m')
3	Stemming	**3,0** (m')
4	Length of the charge	**8,0** (m')
5	Burden	**2,8** (m')
6	Spacing	**3,5** (m')
8	Charge for 1 m'	**5,0** (kg/m')
9	Total charge / borehole	**40,0** (kg/b.h.)
10	Specific consumption of explosive	**0,38** (kg/m^3)
11	Blasted volume / borehole	**98,0** (m^3/b.h.)
12	Number of boreholes	**102**
13	Fuel consumption / borehole	**16.5** (l/b.h.)
14	Fuel price / borehole	**18,81** (€/b.h.)
15	**Total fuel prices / blasting field**	**1.919** (€)
16	Explosive costs / borehole	**40,0** (€/b.h.)
17	**Total explosive costs / blasting field**	**4.080,0**(€)
18	**Total costs / blasting field**	**5.999,0** (€)

Table 3: Calculated values on drilling and blasting parameters Emulsion explosives

	Explosive characteristics	Value
1	Velocity of detonation (VOD)	**4200** (m/s)
2	Density	**1250** (kg/m^3)
3	Specific energy	**4,9** (MJ/kg)
4	Explosive price	**1,4** (€/kg)

	Obtained results	Value
1	Hole depth	**11,0** (m)
2	Sub-drilling	**1,0** (m)
3	Stemming	**3,0** (m)
4	Length of the charge	**8,0** (m)
5	Burden	**4,0** (m)
6	Spacing	**4,5** (m)
8	Charge for *1 m*	**6,0** (kg/m)
9	Total charge / borehole	**48,0** (kg/M.D.)
10	Specific consumption of explosive	**0,28** (kg/m^3)
11	Blasted volume / borehole	**180,0** (m^3/M.D.)
12	Number of boreholes	**56**
13	Fuel consumption / borehole	**16,5** (l/M.D.)
14	Fuel price / borehole	**18,81** (€/M.D.)
15	**Total fuel prices /blasting field**	**1.053,0** (€/M.P.)
16	Explosive costs / borehole	**67,2** (€/M.D.)
17	**Total explosive costs /blasting field**	**3.763,0** (€/M.P.)
18	**Total costs / blasting field**	**4.816,0** (€/M.P.)

From these calculations, we can see the difference in the geometry of drilling, which is a clear indication for the potential savings in drilling and blasting. The calculated geometry of drilling Ammonium nitrate is 3,5 x 2,8 m, and the emulsion is 4,5 x 4,0 m.

Figure 1 graphicaly shows the drilling geometry using Amonium nitrage cartrige and Emulsion explosives.

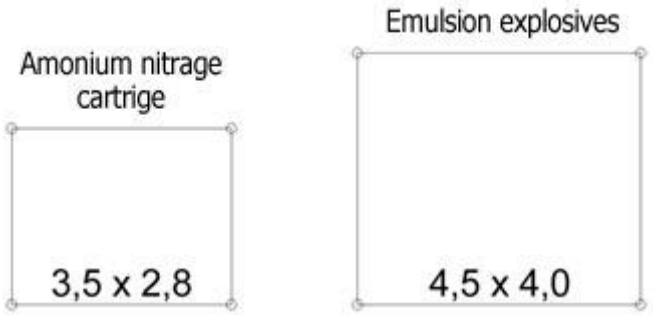


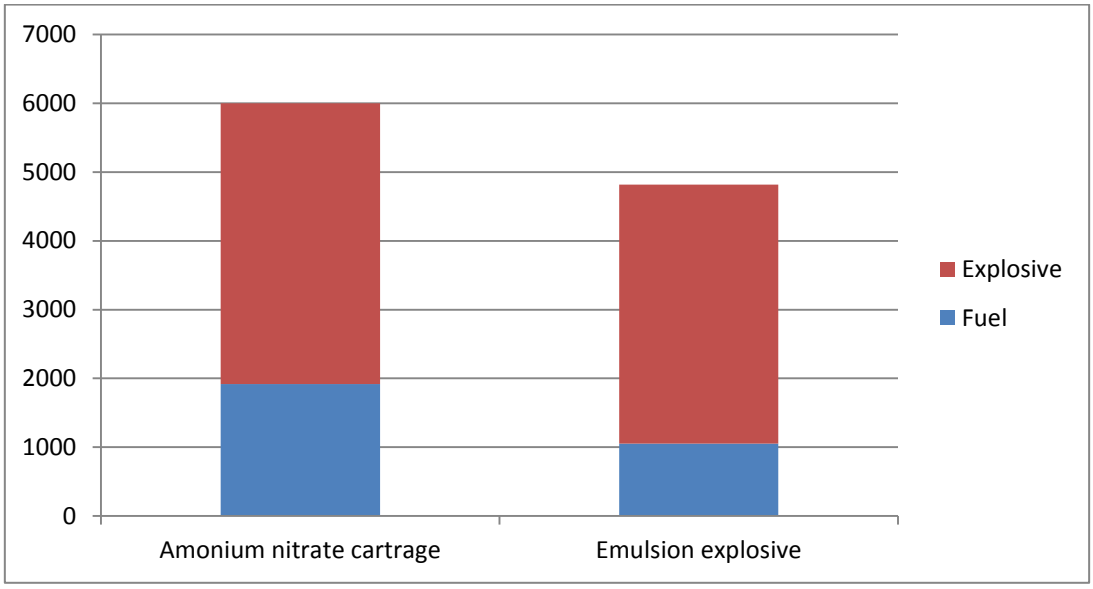
Figure 1: Comparison between the drilling geometry using Amonium nitrage cartrige and Emulsion explosives (m)

According to the obtained results, we can see that although the price for 1kg emulsion is 40% more expensive, the overall cost required to procure explosives is 8% lower, or 317 euros.

The biggest savings are obtained in the fuel consumption for drilling the boreholes. If you use ammonium nitrate cartridge explosives, it requires drilling 102 boreholes. The required fuel for drilling costs 1.913 euros. If you use emulsion explosives, we need less than half boreholes otherwise 56, and the price for the fuel costs 1.053 euros.

When you add up the costs for fuel and explosives, the total price of mined material for getting 10.000 m3 of limestone from the mine "Zelenikovec" using Ammonium nitrate cartridge is 5.999 euros, while by using the emulsion explosives the total price is 4.816 euros. In percentage, the savings using emulsion is about 25%, or in our case 1,183 euros.

Figure 2 Graphically shows the comparison between the total costs (€) with using ammonium nitrate cartridge and emulsion explosives



The price of the final product will be a few percents cheaper if we take into consideration all the parameters (e.g., labor, time, initial funds, etc...).

Figure 3: Blasted material from the blasting field using emulsion explosives on surface mine "Zelenikovec".

4. CONCLUSION

The usage of emulsion explosives in mining industry is increasing, especially in surface mines. The features as well as the advantages, which emulsion explosives have compared to the other explosives on the market, are the reason for the usage of emulsion explosives in mining.

The usage of emulsion explosives provides better technical and economic indicators of mine surface "Zelenikovec", which results in increasing the work efficiency.

The usage of emulsion explosives on the surface mine "Zelenikovec", due to increased drilling geometry, allows considerable fuel savings in the drilling process and its duration.

In addition, emulsion explosives meet all criteria for the protection of the environment which is a requirement for implementing the ISO 14000 standard.

In the estimates, the criteria for using this type of emulsion explosives on the surface mine "Zelenikovec" are met and saving a minimum of 25% of the final product is the main reason for its usage.

5. REFERENCES

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