Usage of Colloidal Gunpowder Released from Utilized Ammunition in the Mining Industry

Davit Khomeriki1, Sergo Khomeriki1, Nikoloz Chikhradze1,2, Davit Supatashvili3, Avtandil Khvadagiani3, Nikoloz Elizbarashvili1

1Grigol Tsulukidze Mining Institute, 7, Mindeli St., Tbilisi, 0186, Georgia
2Georgian Technical University, 0175, Tbilisi, Georgia
3State Military Scientific-Technical Center “Delta”, 0144, Tbilisi, Georgia

davitkhomeriki@yahoo.com

Abstract. Disposal of obsolete munitions is a permanent process, during which colloidal gunpowder are liberated and accumulated. Especially large quantities of such materials were accumulated in the countries of the former Soviet Union, including Georgia. Warehousing and storage of such materials and/or direct application may cause a serious threat /risks in terms of ecological and unauthorized use. Therefore, today’s colloidal gunpowder is mainly stored and the expenses of their storage permanently increase, in addition, there is a permanent threat of their unauthorized use, because they belong to the class of explosives. The long-term storage of the overdue gun powders and rocket fuels contains self-blasting risks. So, this problem is urgent at the local and global levels. Traditional ways of problem solution area simple creation of new explosive materials on the base of the application of ingredients possessing better properties. In distinct from the traditional methods, the essence of the offered works is a creation of new type industrial explosive compounds and application of fuel removed from utilized missiles/shells of military designation in the role of components of explosive materials. A number of hints have been identified in the process of studying the exploitation of industrial explosives on the base of gunpowder and solid rocket fuel. They have created a prerequisite that the cartridges made on the basis of colloidal gunpowder can be initiated using the malware. This method of initiation allows us to a gradual increase of the gas pressure in the chamber of the critical size at which the pressure of the gas will break through the impact of the shaft and thus the breaking of the rock. In the process of research, explosives characteristics of pyroxylene and ballistic fuel mixtures have been studied. It was established that the granulomatrium composition of the mixture is significantly influenced by these characteristics. For example, if the diameter of the granules varies between 3-20 mm, the reaction of the collapse of the mixture is carried out steadily with blast mode, without switching to the detonation. If 10% or more granules in the explosive mixture are smaller than 1 mm, the combustion process can be transferred to the detonation.

1. Statement of Problem

Disposal of obsolete munitions is a permanent process, during which colloidal gunpowder are liberated and accumulated. Especially large quantities of such materials were accumulated in the countries of the former Soviet Union, including Georgia. Warehousing and storage of such materials and/or direct application may cause a serious threat /risks in terms of ecological and unauthorized
use. Therefore, they are subject to unquestionable recycling or destruction according to international conventions and agreements. There are lots of efforts of their reusing, including manufacturing of household materials (varnishes, paints, etc.). But the existing technologies of chemical processing contain a high risk of environmental pollution and development of uncontrolled processes, of which there are plenty of examples. That is why the existing technologies of recycling are prohibited by the relevant agencies. There are two ways of their destruction: explosion or burning. Explosion and burning in an open environment are accompanied by a large concentration of poisonous gases and emissions of toxic solid detonated products, which is prohibited by the environmental laws / regulations. Safe disposal of gunpowder by burning is allowed in special factories, chambers, which are quite expensive (requiring only 8 million of capital expenditures) and they have limited capacity, low productivity and are associated with additional operating costs. Therefore, this method is mainly used in Western European countries. Therefore, today colloidal gunpowder is mainly stored and the expenses of their storage permanently increase, in addition, there is a permanent threat of their unauthorized use, because they belong to the class of explosives. The long-term storage of the overdue gunpowders and rocket fuels contains self-blasting risks. So, this problem is urgent at the local and global levels [1, 2].

Today Georgia is not producing the powerful, cheap and environmentally safe industrial explosives. High prices of such industrial explosives significantly increase the prime cost of the products, which depend on explosion technologies and prevent the development of the mining industry, which represents a significant segment of the economy of the country. In addition, colloidal gunpowder is a powerful source of potential energy, by treatment of which environmentally safe ("green") and relatively cheap explosive substances can be made.

2. Technical Description
Traditional ways of problem solution is a simple creation of new explosive materials on the base of the application of ingredients possessing better properties. In distinct from the traditional methods, the essence of the offered works is the creation of new type industrial explosive compounds and application of fuel removed from utilized missiles/shells of military designation in the role of components of explosive materials. Such an approach reduces the economic and ecological problems connected with the destruction of obsolete missiles (it is known that ecologically safe destruction of obsolete military ammunition requires great resources for the creation of special technical means, the value of which reaches 8 million EURO). This approach will contribute to a sharp decrease of the price of industrial explosives and it will favour to the progress of small and average capacity enterprises in mining sphere High prices of energy carriers, including explosive materials is one of the powerful reasons of non-compatibility of the above-stated enterprises. [2]

Scientific Research works have been carried out in the Mining Institute for receiving laboratory samples of various explosive substances on the base of colloidal gunpowder. For open mining works were defined as optimal recipes of new type explosive materials on the base of the carried-out experiments and their hydrodynamic parameters were defined. At the terms of zero oxygen balance their explosion energy varied within 3200-3700 J/kg, detonation rate is within 5,2-5,6 km/sec and 2.8-4.2 km/sec.

The implemented works prove also that the new explosive materials can also be used in any natural condition, while application of available emulsion explosives in water wells, in aggressive media (sulfide medium) is connected with the risk of self-explosion since the components existing in them react with sulfide rocks. [3, 4]

3. The breaking cartridge on the base of colloidal gunpowder and from utilized ammunition
Nowadays in the world there are several companies which produce so-called “Green Non-explosive materials” like: NONEX Srl green breaktechnology (Italia); The AutoStem Cartridge Non-Detonating
Solutions (Pty) Ltd / Green Break Technology (Pty) Ltd (South Africa); Green Break Technology (GBT), (India); etc. The main idea of the above-mentioned technologies is to use a special cartridge with chemical compound which is not blasts but gives enough energy to break rocks and usually use them for mining process.

A number of hints have been identified in the process of studying the exploitation of industrial explosives on the base of gunpowder and solid rocket fuel. They have created a prerequisite that the cartridges made on the basis of colloidal gunpowder can be initiated using the malware. This method of initiation allows us to a gradual increase the gas pressure in the chamber of the critical size at which the pressure of the gas will break through the impact of the shaft and thus the breaking of the rock.

In the process of research, explosives characteristics of pyroxylene and ballistic fuel mixtures have been studied. It was established that the granulomatium composition of the mixture is significantly influenced by these characteristics. For example, if the diameter of the granules varies between 3-20 mm, the reaction of the collapse of the mixture is carried out steadily with blast mode, without switching to the detonation. If 10% or more granules in the explosive mixture are small than 1 mm, the combustion process can be transferred to the detonation.

During the experiment, specialbreaking cartridges were developed, using polymer hose slice of 20 cm in length, the external diameter was 0.33 cm and the internal 0.27 cm. In the hose section, the weight of the tested component was equal to 0.85 g / cm3, the weight of the charge shifted to an average of 30 - 80 grams. The blast temperature of black gunpowder is 100°C more than pyroxylene fuel, but the inflammation of black gunpowder, whichhas a canine surface, can be easier. This is a defining factor, to use black gunpowder as an initial part in the cartridge (Figure 1, 2).

![Figure 1. The Design of Cartridge - Construction](image1.jpg)

- 1. Rubber coat
- 2. Flammable section
- 3. Black gunpowder
- 4. Basic charge
- 5. Conductor
- 6. Bung

![Figure 2. The Design of Cartridge - flaming construction](image2.jpg)

1. Wire
2. Isolation
3. Jumper

The electric flaming consists of the two isolated conductors, the ends of which are purified 10 to 20 mm from isolation and are in close proximity to each other. The end of the conclusions is connected...
with the flammable section. For the flammable section can be used 15 - 20 mm long and 1 mm diameter nichrome, whose characteristics are given in Table 1.

**Table 1. Features of Nichrome Conductor**

| Characteristics                  | Unit of Measurement | Points  |
|----------------------------------|--------------------|---------|
| Character resistance             | ohm ⋅ mm²/m        | 1,15    |
| The resistive temperature coefficient | ---               | 1.3 ⋅ 10⁻⁴ |
| Density                          | g/cm³              | 8,4     |
| Specific Capacity                | Cal/C⁰             | 0,11    |
| Melting temperature              | C⁰                 | 1410    |

The pressure is gradually increased during the deflagration of the cartridge, resulting in the collapse of the membrane and the compressed gases hit on the chamber walls. The process leads to the collapse of the cartridge and accordingly to the crashing of the rock. Gas pressure on the walls of the borehole is determined by the formula received in ballistics [1].

\[
P = \frac{P_0 \cdot V_0 \cdot T}{273} \cdot \frac{\Delta_0}{1 - \alpha \cdot \Delta_0 \cdot \beta \cdot \Delta_0} \text{, kg/cm}^3, \quad (1)
\]

where: \(P_0 = 1,0333\) kg/cm³ - normal pressure of the atmosphere; \(V_0 = 650\) L/kg - 1 kg of gunpowder or solid rocket fuel combustion gas emissions; \(T = 2100^\circ C\) - Absolute temperature of gases; \(\Delta_0\) Density of charge, g/cm³ - explosive mass ratio with the whole volume of the spice; \(\alpha\) - Gas volume, which is equal to \(\alpha = 0,001 \cdot \Delta_0\); \(\beta \approx 5,087\) the volume of solid blasting products. The volume of 4 cm diameter and 40 cm length borehole is 502.4 cm³, in case of 87 g mass charge

\[
\Delta_0 = \frac{87}{502,4} = 0,173
\]

In conjunction with the formula (1) of all matching values, we find that in the explosion of the colloidal gunpowder (the diameter - 4 cm and the length – 40 cm) pressure reaches on the walls equal to 7460 kg/m², or 746 MPa.

4. Analysis of the results of the industrial examination of the breaking cartridge

The designs of the developed cartridges were tested during the explosion in the limestone quarry of Caspi. The group explosion schemes of these charges were also checked. In the single-blast of the charge, the marginal value of the barrier line was determined. The length of the borehole in these experiments was 1,0 m, and the diameter was 0,04 m. The length of the charge was changed within the range of 0.25-0.85 m, which gave us an opportunity to measure the effect of the filler coefficient (Figure 3). The external diameter of the cartridge was 32 mm and the interior - 27 mm. The sequence and outcome of experiments are given in Figure 5. In the explosion of the group, we tried to find the conditions for the creation of the mains and the continuous cracks.

In all experiments, the lengths of the boreholes were 1,0 m, their diameter - 0,04 m and the coefficient of fillers - 0,25 – 0,75m. The purpose of these series experiments was to estimate the dependence between the length of the barrier line and optimal distance between boreholes. The
optimal gain between the boreholes was the maximum value in which the magisterial crack was on the flat surface of the boreholes and the newly formed surface thickness does not exceed the amplitude of 10 mm. (Figure 4).

Dependency of barrier line (W) on the borehole filler ($\alpha$)

Figure 3. Schedule 1

The optimal distance (a) dependence between the charge on the length of the barrier line (W)

Figure 4. Schedule 2
Particularly interesting is the fact that in the use of explosive substances, the gradual increase of the pressure leads to a certain degree, after which the outer membrane breaks out. It is especially important that this process was not accompanied by fire flames.

Below are given the illustrated results of experimental works (Figure 5).

![Figure 5. The illustrated results of experimental works](image_url)

5. Conclusions

1. The results of the study will allow us to reuse the expired and discharged power plants in the industry.

2. The majority of small and medium mining enterprises in Georgia have been suspended or have been working with a low profitability due to the high cost of producing. Preliminary studies have shown the new type of explosive. The potential customers of a new type of explosives and breaking cartridges are small and medium enterprises in Georgia and companies related to the construction of highways.

3. The increase of demand is expected for industrial explosives in the next two years due to the introduction of many new deposits into the privatization list by the Government of Georgia and the launch of the expected shoreline works and constructions of highways.

4. Many post-Soviet countries (Ukraine, Armenia, etc.), business and scientific organizations of Germany and Spain were interested in the creation technology of the new type of industrial explosives based on the colloidal gunpowder from the utilized ammunition.

It should also be noted that the success of the present project will support the process of utilization of ammunition led by NATO and other international organizations connected with weapon non-proliferation treaty.

References

[1] N. Chikhradze, S. K homeriki, S. Khvedelidze and D. Khomeriki, “Assessment of detonation ability of explosives prepared from utilized ammunition,” 17th International Multidisciplinary Scientific Geoconference (SGEM 2017), Conference proceedings, Volume
[2] S. Khomeriki, R. Mikhelson, N. Chikhradze, A. Khvadagiani and D. Khomeriki, “Production of industrial explosive substances on the basis of the powders and solid rocket fuel released from the utilization of the expired ammunition,” *World Multidisciplinary Earth Sciences Symposium, WMESS 2015*, Elsevier, Volume 15, pp. 738–741, 2015.

[3] N. Chikhradze, R. Mikhelson, S. Khomeriki, A. Khvadagiani and D. Supatashvili, “Ecological Aspects of Using Industrial Explosives Made on the Basis of Utilized Ammunition,” *International Multidisciplinary Scientific GeoConference: SGEM: Surveying Geology & mining Ecology Management; Sofia*, pp. 341-348, 2013.

[4] S. Khomeriki, R. Mikhelson and H. Tudeski, “Development of a technology and industrial explosives based on utilized ammunition,” *World of mining-clausthal zellerfeld*, 57 (4), pp. 264, 2006.