ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 6, Issue 10 , October 2019

The Research of the Effect of Borning Charges Energy on the Relief and Quality of Ore Crushing

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ABSTRACT: The article presents the results of a study of the effect of the energy of drill holes on dilution and quality of ore crushing. When developing thin vein deposits in weak host rocks, ore dilution and crushing are considered the main indicators of the effectiveness of the development systems used. It has been established that in order to reduce ore dilution and improve crushing quality in unstable rocks, it is necessary to significantly reduce the total charge energy and sharply reduce the seismic effect of the explosion on the host rocks.

KEY WORDS: rocks, crush, magnitude, solid, ore, igdanite, dentonite, spirometer, cartridge.

I. INTRODUCTION

The main criteria for the efficiency of using the simplest and blasting explosives in boreholes of various diameters and structures are the productivity of downhole workers, the output of ore to the spurometer, the utilization rate of bore-holes, and the dilution and crushing during ore blasting.
The research has established that in strong ores and stable host rocks, rational use of blast energy of blast-hole charges is easily achieved using smaller-diameter holes, selecting the standard diameter of high explosive cartridge, etc. Attempts to change the design and magnitude of the charges under these conditions by using air gaps, reducing the density of explosives in the cartridge led to a noticeable decrease in the blast hole efficiency ratio, an increase in the consumption of drilling and poor-quality explosions. When developing thin vein deposits in weak host rocks, dilution and crushing of ore are considered to be the main indicators of the effectiveness of the development systems used. It has been established that in order to reduce the dilution of ore and improve the quality of crushing in unstable rocks, it is necessary to significantly reduce the total charge energy, and to sharply reduce the seismic effect of an explosion on host rocks.

The first stage of the research involved the determination of the comparative effectiveness of columnar solid charges of the simplest explosives and the most common patronized blasting explosives, as well as their influence on the quality indicators of breaking. In experiments on production, high efficiency of blast-hole blasting was achieved using the simplest explosives. Analysis shows that the replacement of the 15A10 dentonite with an igdanite does not require a significant change in the blasting parameters. At the same time, the quantitative and qualitative indicators of breaking are significantly improved. The magnitude of the excess dilution during the blasting of ores with igonic solid igdanite charges is markedly reduced in comparison with the dentonite 15A10.

II. SIGNIFICANCE OF SYSTEM

The analysis of the graphs shows (Figure 1) that the use of igdanite when blasting ore in unstable host rocks is one of the most important measures in improving the quality of broken ore. This is primarily due to the features of the physics of the explosion of the charges of the simplest explosives. The reduction of excessive dilution of ore during blasting with igdanite occurs due to a decrease in the initial pressure of the explosion and an increase in the time of its impact on the exploding mass of rock. At the same time, the charge energy of the simplest explosive is more fully used for crushing the battered massif and, to a lesser extent, than the high blasting explosive, for the cracking of lateral rocks beyond the design contour of the stope. With a decrease in the strength of the ore, the magnitude of the excessive dilution of the ore increases in a logarithmic relationship (Figure 1).However, during the detonation of ore, this growth

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
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occurs more intensively.This can be explained by the natural tendency of unstable host rocks to intense cracking and to easier crushing if more shock loads are applied to them.

The diameter of the hole is, as you know, one of the most important energy parameters of the blasting and determines not only the indicators of labor productivity, but also the quality of the ore being fought off. Studies have revealed that when excavating gangue deposits in difficult geological conditions, the use of holes of increased size (38–44 mm) and conventional charge structures inevitably causes an increase in ore dilution, regardless of the type of explosive used.

III. METHODOLOGY

The results of experimental work to determine the magnitude of the mixing ratio of waste rock during ore blasting with igdanite and dentonite in holes of various diameters showed that the dilution of ore increases with increasing diameter of boreholes. From the analysis of the obtained dependences it is clear (Figure 2) that when ore is crushed in rocks below the average fortress of the bore-holes with a diameter of 32 to 44 mm, the use of ignanite makes it possible to reduce the ore dilution by 5-10% in comparison with the 15A10 dentonite. With an increase in the diameter of the charge (hole), the difference in the amount of dilution when using the compared types of explosives becomes less noticeable(graph 2 in Figure 2).

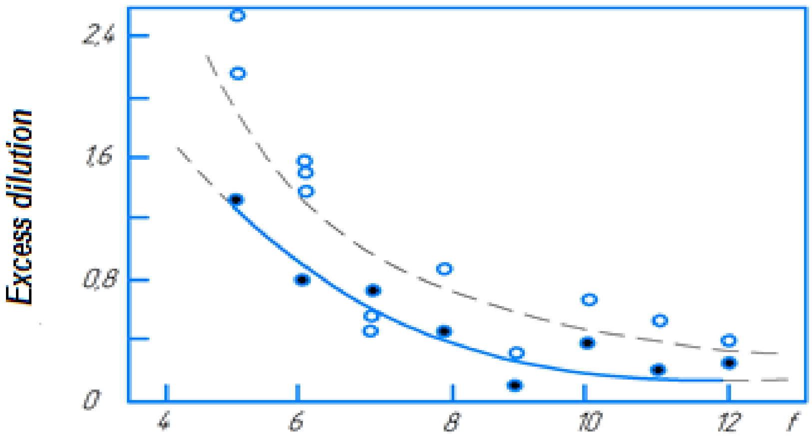

Figure 1.Dependence of the dilution value on the coefficient of the ore fortress at the following impact: igdanite (1) and dentonite 15A10 (2) dm = 36 mm

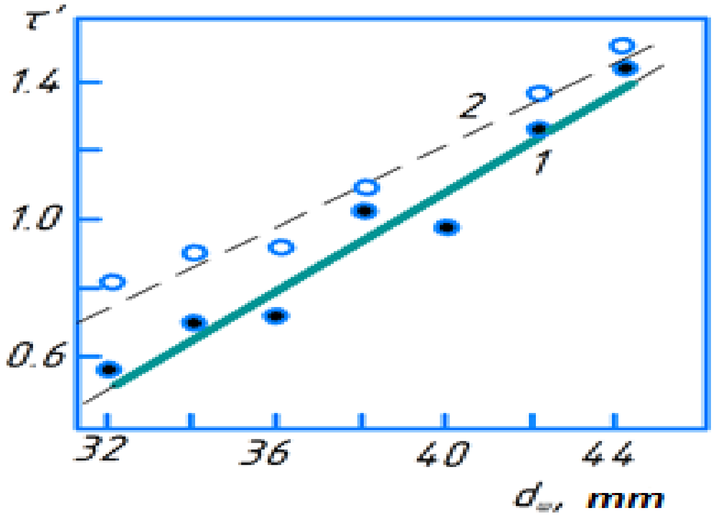

Figure2. The change in the mixing ratio of waste rock depending on the diameter of the blast-hole charge, during ore blasting: 1 - with igdanite;2 - dentonite 15A10.

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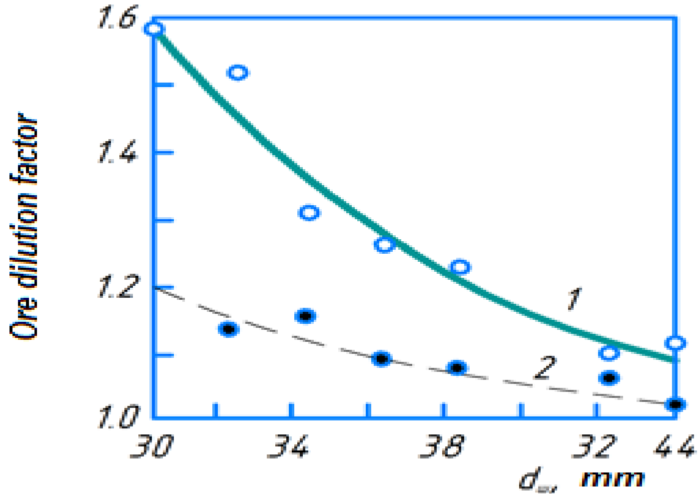

Figure3. Comparative indicators of the dilution of ore by dentonite 15A10 and igdanite, depending on the diameter of the blast-hole charge, during breaking: 1 - in unstable host rocks;2 - in hard rock

From the given dependences it is seen that with decreasing hole diameter the difference in the dilution value between the compared explosives increases. Moreover, during the breaking of ore in unstable rocks (graph l, f = 5; f = 7), the relative value of dilution grows more intensively than during the breaking of strong ores (graph 2).

With a decrease in the diameter of the hole from 44 to 32 mm in the conditions of the experimental unit (graph 1), the dilution increased by 32%, and during the breaking of strong ores - by only 13% (graph 2).These data confirm the need for further improvement of ore blasting in adverse geological conditions and finding effective ways to improve the quality of ore mined. The results of numerous observations on the quality of crushing of the rock mass by the compared types of explosives in various mining and geological conditions of mining the vein deposits suggest that the yield of ore fines and medium fractions of broken ore (+ 50-300 mm) are the main criteria for the quality of ore breaking.

Analysis of experimental data revealed that the yield of unsorted ore fines is mainly determined by the diameter of the hole, the energy parameters of the charge and the size of the line of least resistance (burden).The calculations confirmed that the cumulative effect of these factors on the output of fines averages 86% of all influencing factors for the experimental blocks .Moreover, the influence of two (the diameter of the hole and the weight of the charge) of the main factors is almost 70%.This suggests that the output of fines is not determined by the total energy consumption for ore crushing, but by the parameters of a single blast charge and that the largest number of small fractions is formed in the immediate vicinity of explosive charges. From this we can conclude that in order to reduce the yield of fines, it is necessary to use such explosives and charge structures that would allow the ore mass to be repelled with a minimum yield of fine fractions.

The dependence of the yield of various fractions of broken ore on the diameter of the charge (hole) of the simplest explosives when blasting vein deposits (Figure 1) shows that more uniform ore crushing can be obtained using igdanit in core solid small-diameter charges (32-34 mm), with increasing however, the diameter of the hole charge and the concentration of energy in the hole sharply increases the yield of small stuff.

IV. EXPERIMENTAL RESULTS

The improvement in the quality of ore crushing with igdanite (Figure 2) was obtained when the ores were crushed in rocks of medium strength.With the same value of blast hole efficiency ratio (0.85-0.95), the burden values, when blasting core solid charges, igdanit turned out to be 8% higher for these conditions than when using dentonit 15A10.This resulted in a 36% reduction in the specific drilling rate and a 34% reduction in the cost of blasting with igdite.At the same time, the quality of crushing of the ore mass has improved by reducing the yield of unsorted ore fines.At the same time, the area of optimal burden values (0.7–0.8) was clearly revealed, at which the igdanite bore-hole charges (diameter 36 mm) give the best granulometric composition of the ore.The study of the quality of ore crushing by the considered types of explosives (Figure 2) in rocks and ores of medium strength and strong revealed that,

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International Journal of Advanced Research in Science, Engineering and Technology
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despite the high energy concentration in the igdanite charges, it provides a more uniform crushing of the ore mass and a decrease in the yield of unsorted fines.

The results of the experimental work revealed a clear discrepancy between staffed high-explosive explosives (such as dentonites and the like) used in mines for breaking vein deposits in unstable host rocks. Under these conditions, the use of dentonite on the ore blasting causes an unacceptably high yield of unsorted ore fines (-50 mm) even when using small diameter holes (charge diameter 24 mm).Reducing the diameter of the charges of dentonite from 32 to 24 mm reduced the yield of fines by only 12-18% (from 77 to 65% or from 89 to 76%).The use of the same charge of ammonite No. 6 of reduced density and igdanite makes it possible to more significantly reduce the yield of ore fines (by 40-60%).

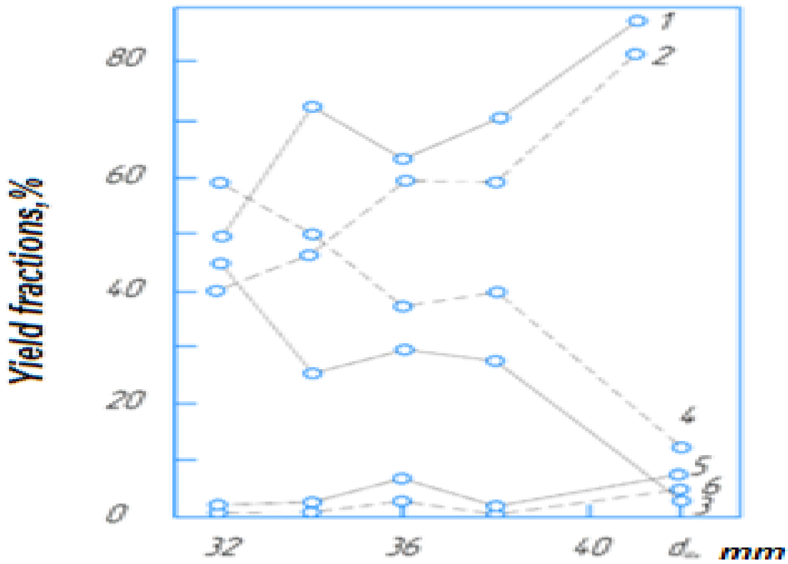

Figure 4.Dependence of the yield of different fractions of the ore mass on the diameter of the blast-hole charge during blasting with detonite 15A10 and igdanite:small: 1 - dentonite; 2 - igdanite;average:3 - detonite;4 - igdanite;oversized pieces: 5 - detonite;6 - igdanite

The maximum improvement in the quality of crushing occurs during the explosion of the pre-charge low-blasting explosive charges with air gaps due to the creation of more favorable conditions for a sharp decrease in peak pressures and a maximum increase in the blast time, i.e. the maximum reduction of harmful blasting forms of the explosion.

Experiments have shown that the use of airborne patronized charges improves the quality of ore crushing when using any type of standard explosives.At the same time, the comparative indicators of charges with air gaps of igdanit are 1.5–2 times better than the same charges of dentonite 15A10.Indicators of ammonite charges № 6 ferruginous water-resisting ferrous occupy an intermediate position. The results of experimental work revealed that with more stable ore bodies and host rocks (groups III and IV), the use of patronized charges with air gaps from ammonite No. 6 ferruginous water-resisting ferrous gives relatively good quality indicators. Under the same conditions, the igdanite solid charges of small diameter (28-30mm) and the combined charges of the simplest explosives and cartridge packed ammonite No. 6 ferruginous water-resisting ferrous showed higher efficiency. The latter are the most promising for improving the quality indicators in the rocks of medium strength.

The output of oversized fractions of broken ore when excavating vein deposits in weak host rocks also depends on the type of explosives used, potential energy and charge design.Increased yield of oversize is observed when using standard charges blasting explosives of any diameters.

Studies have found that when using the widely used in industry, ammonite No. 6 ferruginous water-resisting ferrous charges with a diameter of 32 mm and even core solid igdanite charges with a diameter of 38-34 mm (with a high concentration of energy), along with overmilling of ore, there is an increased oversize from 2-4 to 8%and more.Even in the presence of optimal parameters for the above charge diameters (burden values of the drilling pattern, their explosive fill ratio), the source of oversized pieces in the ore mass are explosion-destroyed unstable host rocks.

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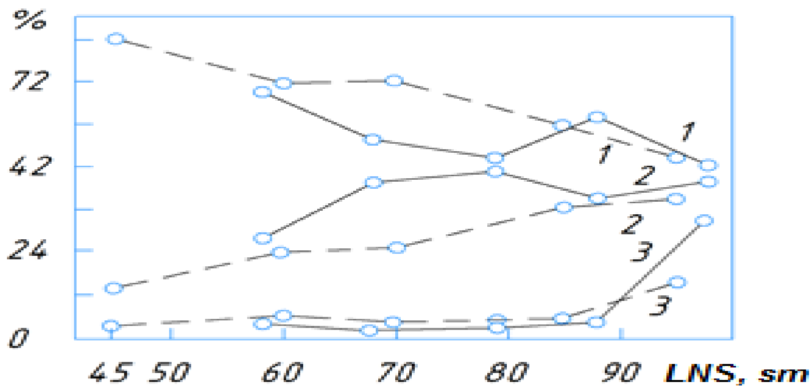

Figure 5.The change in the granulometric composition of the ore mass from the BURDEN during the blasting with colonized solid charges of Igdanit (solid lines) and patronized charges of detonite 15A10 (dotted lines): 1 - the output of unassorted stuff(-50 mm);2 - yield of medium fractions (+ 50-300 mm);3 - oversize output (+300 mm)

From the above data, it follows that the igdanite column continuous charges (Figures 4 and 5, graphs 1), possessing a higher specific potential energy, produce a more intensive crushing and, consequently, overgrinding of the ore mass (under the considered conditions).High quality of crushing of the ore mass is obtained when using igdanit'scartridge-packed charges with two air gaps.The yield of unsorted ore fines during blasting with these charges is reduced in comparison with the blasting rates of core igonic ignition charges 34-38 mm in diameter by 36 and 42%.The combined charges of patronized igdanite and ammonite No. 6 (graphs 2) also provide good quality crushing of the ore mass, close to the indicators of the packaged charges with air gaps (Figure 7 and 8).The physical meaning of the resulting improvement in the quality of crushing the ore mass by an explosion under the conditions considered can be explained by a decrease in the initial pressure of the explosion products due to a change in the charge design, a decrease in the diameter of the blast-hole charge and the use of the simplest explosive compositions (igdanite).This reduces not only the specific pressure, but also the energy density per unit surface of the charge contact with the medium being destroyed.At the same time, the exposure time of explosion products of the simplest explosive compositions to the array is multiplied by reducing the peak pressure of the explosion pulse.

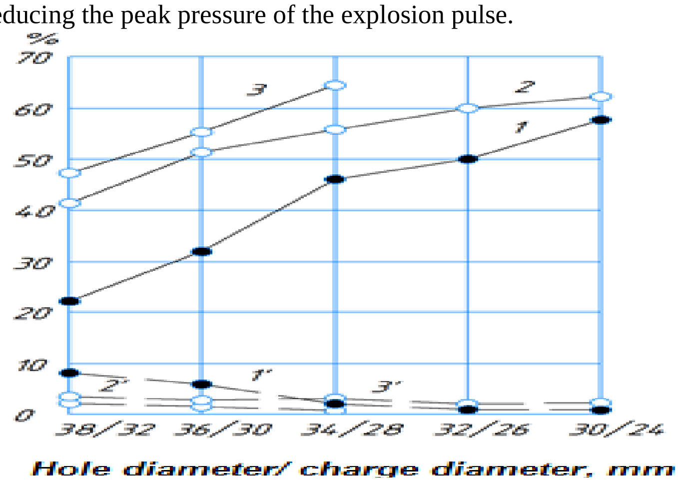

Figure 6.The dependence of the yield of fractions of ore mass (+50 - 300 mm) and oversize (graphs with strokes) on the diameter of the charges of various designs: 1 - core solid igdanite charges;2 -patched combined charges(igdanite - ammonite number 6);3 - igdanita's patronized charges with two air gaps of 10 cm each

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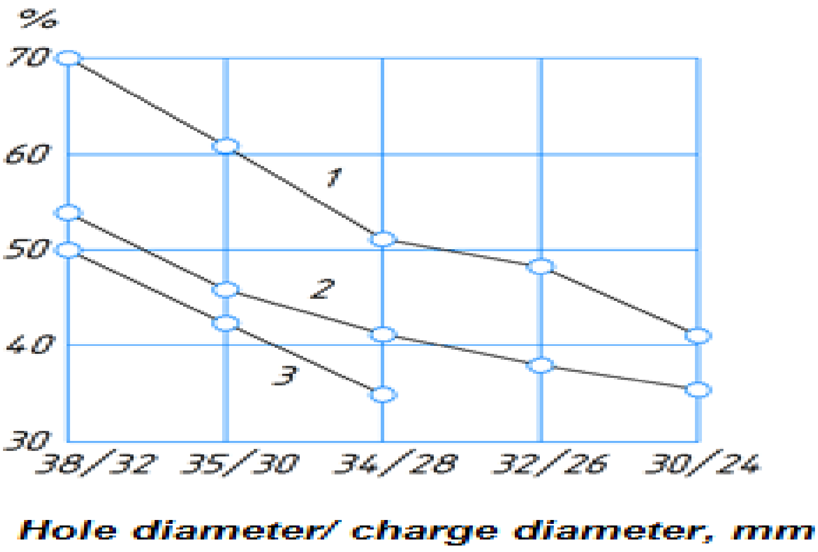

Figure 7.Dependence of the yield of unsorted ore fines on changes in the diameter of the barreled charge of various designs: the value of 1-3 is shown in figure 3

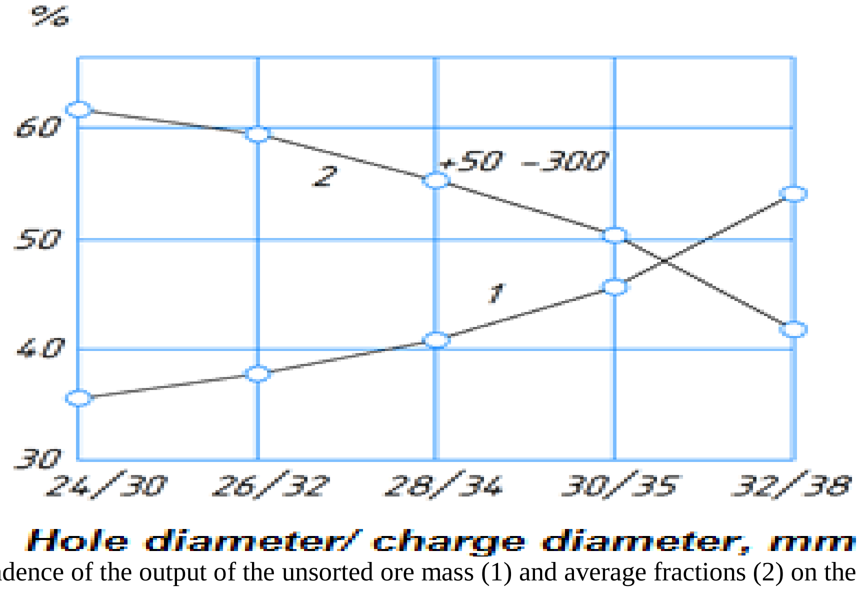

Figure 8.Dependence of the output of the unsorted ore mass (1) and average fractions (2) on the diameter of the cartridge-loaded combined blast-hole charge

As a result of the experimental work carried out to improve ore breaking in various geological conditions and the experience of introducing the simplest explosives in the mines, the following features and advantages of the ore breaking by the charges of the simplest explosives were revealed:

- the use of pre-charge igdanite charges with a diameter of 34 mm and below when blasting thin vein deposits, in addition to the known advantages, allows for more complete use of the energy of an explosion;
- blast hole charges of igdanite and granulite (pneumocharge) compared with the patronized charges of blasting explosives (detonits, ammonite No. 6 ferruginous water-resisting ferrous) in the holes of the same diameter have a large amount of potential energy;
- shpurovnyigdanita charges of reduced and small diameters in comparison with the packaged charges of high blasting explosives provide higher quantitative and qualitative indicators of breaking.

Thus, based on the above, it can be stated that the conducted study of the influence of the construction and energy of blast-hole charges of various types of explosives on the results of crushing the ore mass by an explosion revealed a noticeable improvement in the quality of ore blasting by blast-hole charges with a reduced energy concentration. The

ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

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highest quality indicators of blasting were achieved with the use of patronized charges of the simplest explosives (igdanite) with air gaps and combined patronized explosives (igdanite-ammonite No. 6 ferruginous water-resisting ferrous).A noticeable improvement in the quality of ore crushing by an explosion is also observed when using core solid igdanite charges of small diameter (28-30 mm).

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