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ELECTROPULSE TECHNOLOGY PROCESSING OF KIMBERLITE ORE

Muratova Aizada

"Техника және технология" мамандығының магистрі, Е.А. Бөкетов атындағы Қарағанды Университеті, Қарағанды қ., Қазақстан

Ғылыми жетекші: Нусупбеков Б.Р.

The article is devoted to the design and development of electro-pulse technology for processing natural and man-made raw materials. The proposed method of ore grinding is based on the use of the energy of a pulsed shock wave generated as a result of a spark electric discharge in a liquid. The results of the experiments conducted showed that this method of fragmentation and grinding is effective, economical, environmentally friendly, and suitable for any technological chain. The importance and peculiarity of the technology is based on the use of the energy of pressure released during electro-hydraulic action to process ores and man-made raw materials in a short time to obtain a product of the required size, ground, separated from impurities, and used for the next stage of enrichment.

Keywords: electro pulse method, ore, fractions, capacitor bank, grinding.

In recent years, much attention has been paid to improving the process of pretreatment of raw materials and waste disposal in order to extract minerals from a carrier rock in natural reservoirs. Due to the low mineral content of natural mineral raw materials extracted from the earth's crust, its direct use in production is inefficient. For these reasons, the mineral goes through several stages of the pre-beneficiation process. In the early stages of the process of enrichment of ore, the mineral is processed into mechanical disintegrants to various fractions. The only drawback of mechanical disintegrators and crushers is that the parts of the billet for crushing and crushing wear out over time, and the parts damaged as a result of crushing during the grinding process become more complicated during processing. For the above reasons, the mechanical disintegrator is stopped, and the deformed parts are sorted and replaced with new ones.

The article is devoted to the design and manufacture of electro pulse technology for processing natural and man-made materials. The proposed method of grinding ore is based on the use of the energy of a pulsed shock wave generated by spark damage in a liquid. Experimental results show that this method of disassembly and grinding is

effective, economical, environmentally friendly and suitable for any process chain. The importance and peculiarity of the technology lies in the fact that the processing of ore and technogenic raw materials using the energy of radiated energy under electrohydraulic influence is short-term, is separated from impurities and is based on the production of the necessary product for the next stage of enrichment.

Northern Kazakhstan is a diamond-bearing province. In the 70–80s. last century, a new geological and industrial type of industrial diamonds was identified here, associated with ancient metamorphic rocks of the Zerenda series, 40 km southwest of Kokshetau. The Kumdykol zone (60 km×15 km) was identified, in which the "Kumdykol", "Shalkar" deposits and a group of diamond manifestations as well as spatially combined modern and ancient placers of mainly small diamonds were discovered.

Numerous finds of small, so-called industrial diamonds are known in modern river and lake sediments (Lake Zhukey, Kayrakty River, Lake Kumdykol), in the weathering crusts of serpentinite massifs (Chernoyarsky, Madaniyatsky and others), in the weathering crusts of gold deposits and ore occurrences (Shaitandy, Pervomayskoye), in productive sands of the Obukhovskaya titanium-zirconium placer, in Cretaceous sedimentary deposits (Lake Zhaksytuz area), in the flotation concentrate of gold-quartz ores of the Bestobe deposit. Most of these finds are of practical interest not only for their diamond content, but also for the presence of gold and other metals in these ores, as evidenced by the area of distribution and various sources of origin in sedimentary strata.

Since the original diamond-containing ore had a large volume and weight, it was crushed into certain fractions mechanically before the studies.

The experiments were carried out at different values of discharge energy, capacity of the capacitor bank, interelectrode distance on the switching device, and the frequency of the electro pulses was also changed.

The applied voltage value to the switching device was regulated from 10 to 40 kV. The dependences of the degree of ore grinding on the electrical and geometric parameters of the installation were obtained, where W is the released energy on the switching device, K is the fraction share of the total volume, L is the fraction share of the initial material, Lp is the length of the discharge gap on the switching device.

The experiments showed that with specific energy consumption within the range of ~0.7¸5×103 J, the voltage on the capacitor banks is 45 kV at a constant solution concentration.

The experiment shows the distribution of particles by their sizes, which have a clearly defined maximum of an asymmetric shape with a steep decline towards small fractions and gentler one towards large ones, the maximum shifts towards small particles with an increase in specific energy. In this experiment, the initial diameter of kimberlite particles in an aqueous solution was on average 8 mm. It has been established that the degree of grinding increases with the increase of energy

introduced into the discharge channel. This is explained by the fact that initially in the processed ore a network of microcracks is formed in the field of passage of the shock wave, which creates a continuous stress state.

Sample processing and analysis of processing results were carried out using the following methods.

Initial weight 20–60 kg (average 40 kg). The sample material after crushing (combined crusher SMD (smaller than 4 mm) was fed to a roller crusher and brought to a size less than (equal to) 0.63 mm and after 5-fold quartering, a 170-220 g sample was fed for thermochemical analysis, and a 90-140 g sample after grinding to a size of minus 0.074 mm was fed for spectral analysis and graphite content. First, thermochemical decomposition of 200-gram sample samples was carried out with the separation of diamond-containing powder at the end of the process, then manual classification of the powder under a binocular microscope according to the boundary class of 20 μm. All diamonds larger than 20 μm were weighed on scales, smaller ones were burned in a tubular furnace at a temperature of 900-950 °C, which guaranteed the preservation of moissanite - the only mineral in the powder, containing carbon similar to diamond. The amount of diamonds was determined by diamond carbon by burning diamond-containing powder on the gas express analyzer AC-7933 designed by TNIGRI. In terms of accuracy, the method belongs to the 3rd category. The detection limit of diamonds was 7 10–5 grams. With a sample weight of 200 g, the sensitivity of the potentiometric determination was at least 4.5 carats/t.

The sensitivity of the method was verified by analyzing more representative samples weighing up to 0.5–1.0 kg.

As a result of geological exploration and study of the selected samples, it was revealed that this deposit is large in terms of diamond reserves (many hundreds of millions of carats), the average content fluctuates from 19 to 27 carats/t.

The grain size distribution of the initial ore prepared for the studies is given in Table 1.

Table 1. Grain size distribution of the initial ore

Size fractions, mm	Fraction yield, %	Sum by plus, %	Fraction yield in the finished product (in class -1.6 mm), %	Sum by plus, %
+10.0	29.4	29.4	-	
+5.0	13.0	42	-	
+3.0	11.5	53.9	-	
+1.6	9.5	63.4	-	
+1.0	8.4	71.8	22.8	22.8
+0.5	12.7	84.5	34.7	57.5
+0.2	9.5	94.0	26.0	83.5
+0.1	4.3	98.3	11.8	95.3
-0.1	1.7	100	4.7	100

As can be seen from the table, the yield of the finished product (class -1.6 mm) in the original ore was 36.6%, and the yield of sludge fractions (-0.2 mm) in this finished product was 16.5%.

Thus, it has been established that for fine crushing of ore using the capacity of a capacitor bank (C=0.6 μF) it is optimal in terms of the yield of the finished product and its granulometric composition due to the low yield of the sludge fraction.

Geological studies have revealed that the Republic of Kazakhstan has the largest reserves of wollastonite ore in the world, about 70 million tons, which will allow Kazakhstan to take a leading position in the production of a new product - wollastonite. World experience shows that foreign countries suffer from a shortage of natural wollastonite in its production and use, since the production of its synthetic analogue is 15-20 times more expensive.

Therefore, the consumption of non-metallic wollastonite materials, which are fundamental for the development of modern industry, requires an increase in the volume of mining and enrichment of minerals. The processing of most mined ore masses involves grinding and crushing as a process of preparing it for further enrichment. These processes are very expensive operations and account for up to 50% of all costs at enrichment plants. For subsequent technological operations, the grinding and crushing qualities that provide for the production of wollastonite products in a given fraction without re-crushing are of great importance

The main results of theoretical and expert studies show that the crushing and grinding process can be enhanced using additional pressure associated with cavitation, which regulates short-term, high-amplitude shock microwaves, with unchanged geometric and electrical parameters of the electrohydraulic device. Conducting these studies and implementing their results at the enterprise will contribute to technical progress in the industry.

In this regard, the possibility of using electrohydraulic efficiency for crushing and grinding natural minerals was discussed with us in an expert manner.

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ЭЛЕКТРОИМПУЛЬСНАЯ ТЕХНОЛОГИЯ ОБРАБОТКА КИМБЕРЛИТОВОЙ РУДЫ

Муратова Айзада Канатовна

Статья посвящена проектированию и изготовлению электроимпульсной технологии обработки природного и техногенного сырья. Предлагаемый способ измельчения руды основан на использовании энергии импульсной ударной волны, генерируемой искровыми разрушениями в жидкости. Результаты экспериментов показывают, что этот метод разборки и шлифования эффективен, экономичен, экологичен и подходит для любой технологической цепочки. Важность и особенность технологии заключается в том, что обработка руды и техногенного сырья с использованием энергии излучаемой энергии при электрогидравлическом воздействии является кратковременной, отделяется от примесей и основана на производстве необходимого продукта для следующей стадии обогащения.

Ключевые слова: электроимпульсный метод, руда, фракции, конденсаторная батарея, измельчение.

КИМБЕРЛИТТІ КЕНДІ ӨҢДЕУДІҢ ЭЛЕКТРОИМПУЛЬСТІК ТЕХНОЛОГИЯСЫ

Муратова Айзада Канатовна

Бұл мақала табиғи және техногендік шикізатты өңдеудің электроимпульстік технологиясын жобалап, жасауға арналды. Кенді ұнтақтаудың ұсынылып отырған әдісі сұйықтағы ұшқынды электр разряды нәтижесінде пайда болатын импульсті соққы толқынының энергиясын қолдануға негізделген. Жүргізілген тәжірибелердің нәтижелері бөлшектеу мен ұнтақтаудың аталмыш әдісінің тиімді, үнемді, экологиялық таза, кез келген технологиялық тізбекке қолайлы екендігін көрсетті. Технологияның маңыздылығы мен ерекшелігі электрогидравликалық әсер кезінде бөлінетін қысымның энергиясын қолдану арқылы кенді және техногендік шикізатты өңдеу қысқа мерзімде ұнтақталған, қоспалардан ажыратылған, байытудың келесі сатысына пайдалануға арналған қажетті іріліктегі өнімді алуға негізделген.

Кілт сөздері: электроимпульстік әдіс, кен, фракциялар, конденсаторлар банкі, ұнтақтау.

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