Bulgarian Chemical Communications, Volume 52, Issue A (pp. 177-179) 2020 DOI: 10.34049/bcc.52.A.192

Electrohydropulse method for destruction of natural minerals

K. Shaimerdenova[1], B. Nussupbekov[1], G. Bulkairova[1], M. Stoev[2], A. Khassenov[1*], D. Karabekova[1]

[1]*Karaganda State University named after E.A. Buketov, Kazakhstan*
[2]*South-West University "Neofit Rilski", Blagoevgrad, Bulgaria*

Received, August 03, 2019; Accepted November 30, 2019

One of the methods for natural minerals crushing and grinding is considered. The proposed technique for ore reduction is based on the use of impulse wave energy. The natural minerals reduction range depending on the capacitor battery capacitance and the voltage of pulsed discharges are determined. The percentage composition of the studied samples before and after electrohydropulse processing is found.

Keywords: natural mineral, quartz, wollastonite, electric discharge, pulse technology

INTRODUCTION

Raw materials crushing and grinding is the main and most expensive ore pretreatment operation before beneficiation [1]. When crushing minerals, the problem of their specific breaking is of importance. This is due to the fact that standard mechanical methods for breaking are not selective and when they are used there occurs partial irregularity in the shape of crystals and grains of the extracted minerals, as well as contamination of processed products with equipment metal. In many cases, chemical purity of the processed products (quartz, wollastonite, etc.) is required. Standard disintegrating equipment cannot produce selective crushing and is generally intended to reduce the size of the starting raw materials, which leads to the destruction of useful minerals and an increase in their losses [2].

The development of the process technology of crushing, grinding and screening is extremely relevant; at present the processing procedure is increasingly involving raw materials with a low content of valuable components with a thin and extremely non-uniform dissemination. To improve The efficiency of these processes can be increased by introduction of new crushing, grinding and classifier equipment with higher productivity and lower energy consumption, which permits to achieve selective release of mineral chats [3].

One of the techniques for raw material selective crushing and grinding, which corresponds to the specified principles, is the electrohydropulse method [4-6].

In this regard, an electrohydropulse plant with a crushing device was developed to study breaking and grinding of natural minerals. The electro-hydropulse plant is made in the form of structural assemblies, consisting of a control unit, energy storage devices and a pulse voltage generator.

RESULTS AND DISCUSSION

An important part of the plant is the operating device (Figure 1), which is designed for grinding minerals by pulsed electrical discharges in an aquatic environment. The device works as follows. Shell 1 of the electrohydropulse device is filled with industrial water, the natural mineral is fed to the discharge grid or screening device 3 through the charging hopper 2; the pulse generator unit is activated, which supplies high voltage pulses to the installed at irregular height 3-electrode device 4 and the motor for rotating the electrodes is turned on. The natural mineral is broken between the rotating electrodes 4 and the screen plate 3. The shock wave propagates in the process water from the breakdown points in all directions and begins to crush the natural mineral. In the course of breaking, the crushed material falls through the screen plate due to its weight and the rotation of the three electrodes.

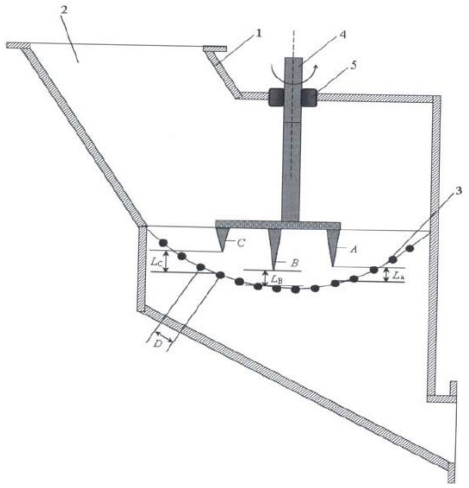


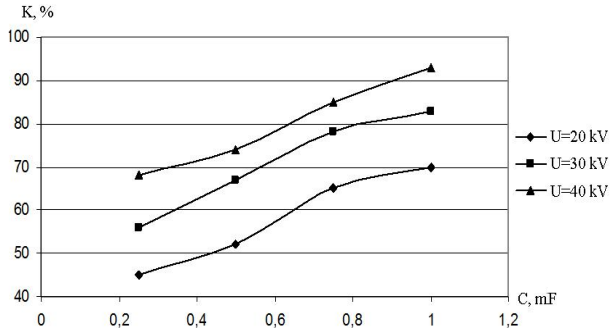
Fig. 1. Device for crushing and grinding of minerals

* To whom all correspondence should be sent.
E-mail: ayanbergen@mail.ru

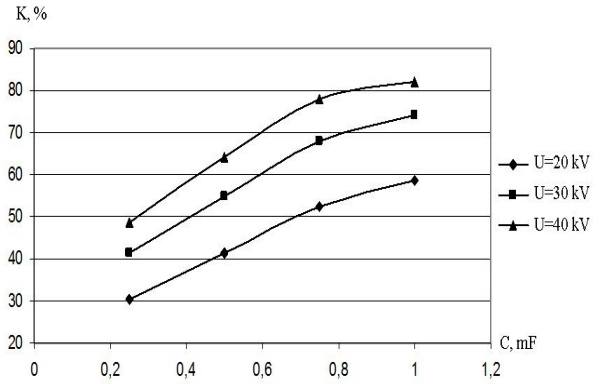
As a result of the tests, it was found that with an increased distance between the central electrode 4C and the grid 3, the gap between them is not blinded by the processed materials, since the rotating electrode pushes the mineral through the sieve and it does not remain in the grid. Due to a rather good removal of the finished product, it does not overgrind and the crusher's productivity increases. Sometimes the raw feedstock is rather sizable; in this connection, the upper limit of the proposed ratio of sizes is taken as Lc/D=6.0, at which the crusher's productivity does not decrease, but on the contrary it increases.

The use of the three-electrode device in breaking natural minerals (quartz, wollastonite, etc.) provides intensified grinding and crushing of materials. During the operation of the crusher with a rotating element, the level of process water in the crusher shell should provide a submerged state with three electrodes 3 located at irregular heights.

During the research, natural wollastonite and quartz minerals were used. The initial particle diameter of minerals in the conducted tests was 10 mm on the average; and the final particle size of the obtained product was 1 mm. The feed mass in the electrohydropulse plant device was 1 kg; and the processing duration was 5 minutes.



a) wollastonite



b) quartz

Fig. 2. Dependence of the reduction range of natural minerals on the capacitor battery capacitances and the voltage of pulse discharges.

Experiments at the electrohydropulse plant were carried out at different values of the capacitor bank capacitance (from 0.25 μF to 1 μF). The voltage of the pulse discharges was regulated from 20 kV to 40 kV (Figure 2).

The experimenters also studied the elemental composition of minerals after electrohydropulse processing and compared it with the initial composition (Tables 1 and 2).

Table 1. Elemental composition of wollastonite before and after electrohydropulse processing

Element, (%)	Before processing	After electrohydropulse processing
Silicon	44.5	44.8
Aluminum	3.35	4.12
Magnesium	1.05	1.3
Calcium	44.7	42.7
Iron	3.29	4.12
Titanium	0.188	0.205
Manganese	0.10	0.143

Table 2. Elemental composition of quartz before and after electrohydropulse processing

Element, (%)	Before processing	After electrohydropulse processing
Silicon	98.96	99.68
Aluminum	0.28	0.05
Iron	0.28	0.08
Titanium	0.16	0.06
Manganese	0.1	0.03

CONCLUSION

As a result of the experiments, the degree of destruction of mineral fractions depending on capacitor battery capacitances (0.25÷1 μF) was found and its optimum value of 0.75 μF was determined. With rising voltage, an increase in the intensity of the crushing of raw materials was observed, which makes for choosing the optimal value of the capacitor battery capacity required to carry out the experiments. The obtained data show that the elemental composition of minerals before and after processing by the electrohydropulse method does not change.

REFERENCES

1. V. I. Kurets, Electropulse crushing and grinding of materials. Innovative processes of complex and deep processing of mineral raw materials, International Conference "Plaksinsky readings-2013" - Russia, 2013, p. 103.
2. A. Y. Yushkov, *Modern Scientific Research and Innovations - Moscow*, **4**, 67 (2015).
3. E. B. Volkov, S. A. Lyaptsev, Investigation of the movement of an ore particle in a vibrating screen,.

Materials of the International Scientific and Practical Conference: Ural Mining School for Regions – Yekaterinburg, 2011, p. 370.
4. L. A. Yutkin, Electrohydraulic effect and its application in industry, L: Engineering, Leningrad Branch, 1986, p. 253.
5. B. R. Nusupbekov, K. Kussaiynov, S. E. Sakipova, A. K. Khassenov, A. Zh. Beisenbek, *Metallofizika i Noveishie Tekhnologii – Kyiv*, **36**(2), 275 (2014).
6. I. P. Kurytnik, B. R. Nussupbekov, D. Zh. Karabekova, A. K. Khassenov, A. Sh. Kazhikenova, *Archives of Foundry Engineering – Warszawa*, **18** (1), 61 (2018).