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ELECTROIMPULSE GRINDING AND REDUCTION OF NATURAL MINERALS

K.Kusaiynov, B.R.Nusupbekov, G.M.Shaimerdenova, G.A.Bulkairova, K.K.Sadenova

Karaganda State University named after E.A. Buketov, Universitetskaia Str. 28, Karaganda, 100026, Kazakhstan,
Kamshat0686@mail.ru

Results of investigation of electro hydraulic destruction features, grinding of natural minerals and results of laboratory tests, given at different values of fraction diameters of natural minerals, and inter electrode distance on air discharger are described.

Keywords: grinding, fraction, electro hydraulic destruction, aqueous suspension, minerals.

Development of industry and increase of power safety of Kazakhstan depends on broad and effective usage of natural resources. Most regions of the country possess great resources of industrial minerals. Urgent organization of production and enrichment of minerals on Kazakhstan ore deposits is needed. Application of reduced mineral in different fields will make it possible to obtain new production with valuable properties and will help technical progress in a number of industry fields. Moreover deficiency of natural minerals in European countries allows considering mineral as object of export.

Rational and effective use of mineral resources of Republic of Kazakhstan requires creation of new, ecologically clean technologies, which is the main objective. Impulse effect in technological processes of grinding and reduction is based upon use of high pressures following high-voltage electric charges in multicomponent liquid with non-linearly distributed characteristics. Natural minerals used as harmless, ecologically clean materials in various electro technical, heat isolation and building materials are investigated as solid disperse phase.

Mineral with rare and unique natural properties – wollastonite is produced on the territory of Central Kazakhstan. Wollastonite is a calcium silicate, chemical composition of which is determined by formula CaSiO_3 . Uniqueness of wollastonite among industrial minerals consists in combination of white color, needle-shaped form of crystals with ratio of length to diameter depending on grade (l/d)= 3:1 to 20:1 and alkali content of pH. Needle-shape is the determining factor for increasing durability and wear-resistance of dyes in some industry branches. Wollastonite is ecologically clean substituent for asbestos and fibre talc. Because of its properties it can partly replace titan dioxide in some fields. Finely grinded wollastonite as well as largely grinded grades is accessible in silane and organic-silane treatment for improvement compatibility with organic matrices. In practice, reduced wollastonite mineral in the form of certain size fractions is used in asbestos-cement, rubber, paper productions and for heat isolation [1].

Next investigated natural mineral is quartz – the most distributed mineral with chemical composition SiO_2 (46,7%-Si; 53,3%-O₂). Quartz crystals rarely fit this composition, because they usually consist of various components: bubbles of gases and liquids, sometimes remains of mica. Quartz of high chemical purity and thermally stable is used in semiconductor industry as a material for crucible, furnace cameras, holders and etc. Quartz in the form of quartz glass is one of the essential materials in optical industry. It is used in production of optical equipment, telecommunication devices, diffraction lenses, projection displays, scanning devices and printers, lasers, photo cameras, video cameras, super flat TV displays, flame control devices and etc. the most important application of quartz is its usage in techniques, especially as piezoelectric. Ceramics uses various types of quartz feedstock: quartz sand, vein-quartz, quartz wastes, produced during of kaolin's enrichment, Tripoli and diatomite. Low grade quartz is mainly used in metallurgy as flux

and raw for technical silicon and cashable production, in chemical industry as flux, in building and glass production [2].

Electric charge in liquid is the main working mechanism in many native and foreign technologies. Among the broad complex of phenomena occurring in liquid at electric charge is used as direct transformation of electric power into the pressing power of knock waves.

Phenomena occurring in zone of high-voltage spark charge in liquid media. At the initial stage of this research it was detected that at liquid disruption high-pressure zone occurs around the charge channel, its diameter is proportional to the power of impulse. Liquid takes acceleration from rapidly widening charge channel moves away from it and forms large hollow space called as cavity and causes first (main) hydraulic blow.

Water media in which high-voltage electric charge takes place is transformer of energy evolved in the charge channel and as a result of low compressibility brings to sudden growth of pressure. Electric hydro impulse way of grinding makes it possible to regulate granulometric composition of product with high selectivity [3,4].

One of the features of the process is transformation electric energy to mechanic energy is carried out without intermediate links, which efficiency of the setup and provides safe, durable work. Suggested way of grinding minerals is based upon usage of energy of impulse knock wave, occurring as a result of spark electric charge in liquid. This method of grinding is perspective, economically efficient, ecologically clean and easily included in the setup.

Universal experimental board was constructed in laboratory of electric dynamics of Engineering thermal physics chair of Akylbayev Zh.S. of Karagandy State University of E.A. Buketov for conducting laboratory research.

Basic experiments on the grinding and destruction of wollastonite ore were carried out for Bosaginsk ore deposits collected in "Centregeologosyemka" joint-stock company, Karaganda.

The degree of grinding of wollastonite, which was determined by the number of particles of a certain diameter d was investigated in experiments. Figure 1 shows the results of laboratory tests conducted at different values of energy level of switching device.

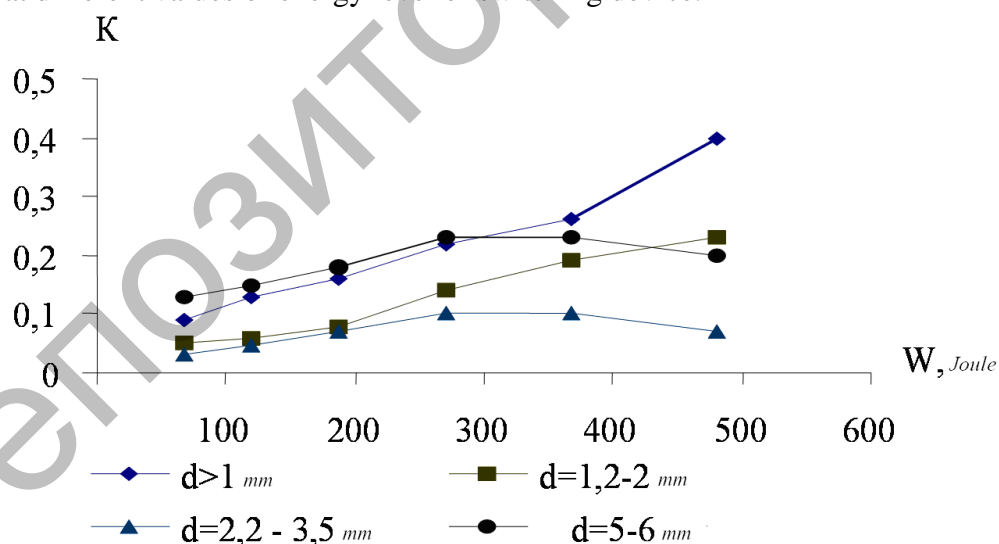


Fig. 1. Graph of dependency of grinding's degree from charge energy: $C=0,4 \mu\text{F}$, $d_{fr}=5\div 6$ mm

Studies have shown that in addition to energy the basic parameter that determines the intensity of crushing wollastonite ore, is the frequency of electrical discharges (Fig. 2).

As can be seen from the figure increasing frequency of impulse repetition causes uniform crushing of ore [5].

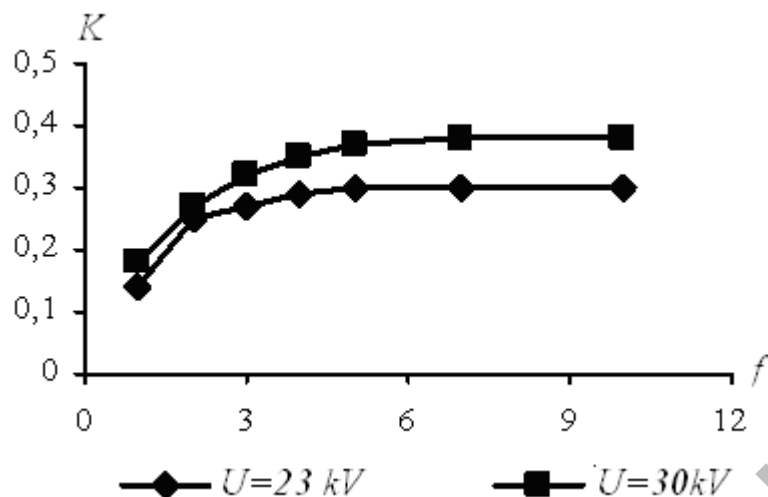


Fig. 2. Graph of dependency of wollastonite ore's grinding from frequency of impulse repetition

The following figure 3 shows the results of laboratory tests for mineral quartz, held at different values of interelectrode distance (l) on switching device of electro-hydraulic setup at $C = 0.25 \mu\text{F}$ capacity of condenser.

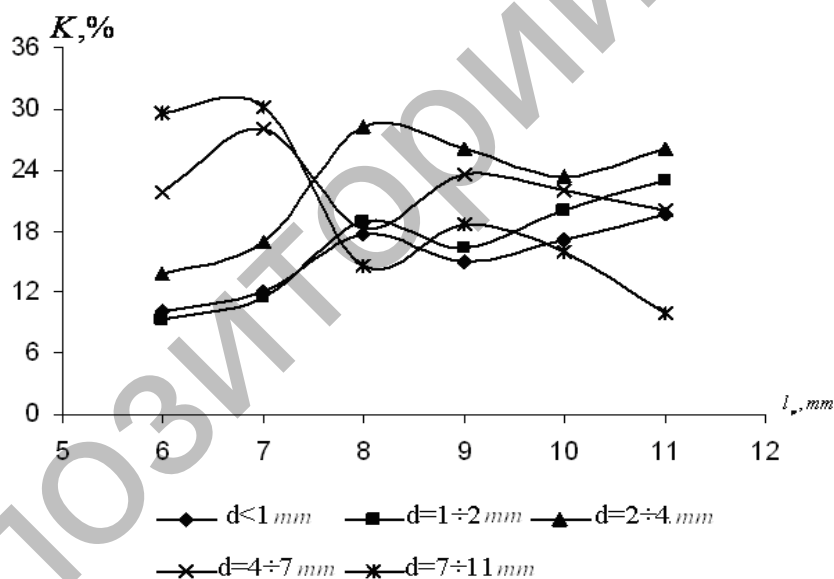


Fig. 3. Dependency of degree of grinding of quartz from the inter electrode distance: $C=0,25\mu\text{F}$, $d_{\text{fr}}=15 \text{ mm}$

Further investigations of microstructure of mineral quartz of Nadyrbay deposits have been conducted on scanning electron microscope JSM 5910.

Figure 4 shows electron micrographs of quartz grains of mineral at multiple scales crushed in electro hydraulic setup.

From the micrographs it can be seen that the surface of quartz particles after grinding, has become more cleaved, and the edges of highly amorphous, sharp corners and facets are absent. Further increase in these hilly areas also shows that they possess crystal structures. Electro hydraulic impact of given power grinds and reduces natural mineral to a certain size in the existing self-similar hierarchy [6].

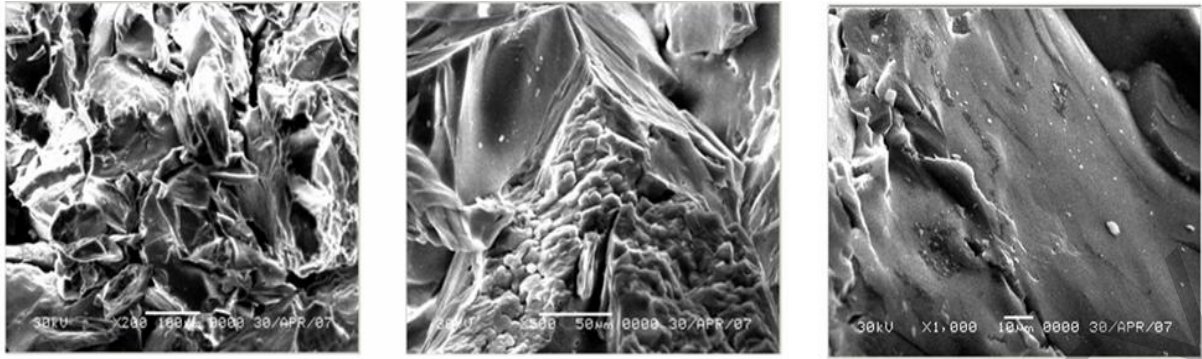


Fig. 4. Electron micrographs of quartz sample of Nadyrbai ore deposit after grinding on electro-hydraulic setup

The following conclusion can be drawn: the most optimal value of inter electrode distance on the switching device is $10^{-2}m$, and the diameter of fractions, undergoing the most intensive destruction is $d_{pp} = 10 \cdot 10^{-3}m$, grinding degree increases with specific energy introduced into the charge channel, which is explained by the fact that a network of micro cracks in the path of the shock wave, which creates a continuous state of stress, is formed in the structure of substance. As a result of impact of a series of impulses ($10^{-5} \div 10^{-4}$ s) on solid fractions plastic deformations in the initial phase, which on one hand increases its strength, and on the other hand stresses that destroy the natural minerals arise in the areas of defect structures. During electro hydraulic impact on solids in aqueous solution the intensity of grinding process is enhanced by the impact of additional pressure associated with cavitations. Indeed, micro cavity occurs during each solid particle, which enhances mechanical impact.

The proposed method of electro hydraulic treatment of aqueous suspension of natural minerals allows to obtained nano-particles of certain sizes quickly and cost-effectively, while improving sanitary conditions and significantly reducing environmental pollution.

Technological process of electro-hydro-impulse technology can be easily automated; maintenance does not required large number of highly skilled workers.

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