Mechanism of creating the prefracture zone of rock formations with magnetic and hydrocavitation load

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Abstract

The results of studies on the establishment of the earth's formations prefracture zone with magnetic-hydrocavitation load on the example granite are given in the article. It is determined that when processing only with the cavitation load only local defects are produced, the average amount of which is 4 units per 1mm^2 with an average length of 90 mkm. When combining magnetic and hydrocavitation load, local defects are formed with the average amount of 20 units per 1mm^2 and a length of 100 mkm. The analysis of the results obtained based on the research of scientists who have studied the magnetic and cavitation processes. They are I. M. Fedotkin, J. I. Frenkel, V. I Classen and others.

Keywords: ROCK FORMATIONS, DEFECT CAVITATION, PREFRACTURE ZONE

Relevance of work

Ukraine annually obtains about 104 million tonnes of granite, 1.6 million tonnes of peat, 0.7 million tonnes of coal and other minerals [1]. However, the domestic mining industry still uses such fracture techniques that have high energy intensity of several thousand MJ/m^3 [2]. So, the task of developing energy-saving methods of earth's formations destruction remains relevant. It also confirmed in the resolution [3]. This article proposes the use of an additional magnetic-hydrocavitation load (MHCL) for the rock destruction. The aim is to weaken the rock mass by creating a zone of prefracture with magnetic-hydrocavitation load. In the study takes into account the results of research of the scientists who have studied the magnetic and cavitation processes such as I. M. Fedotkin, J. I. Frenkel, V. I Classen and others [4-8].

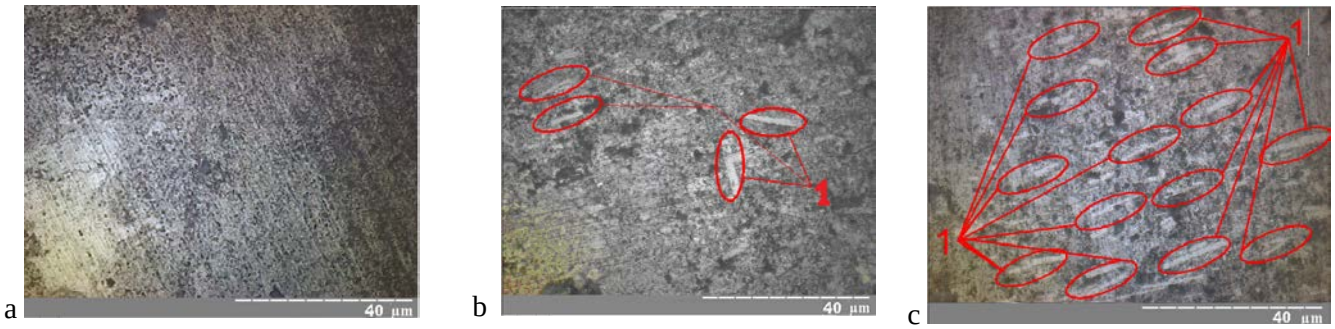

Figure 1. Photo of granite samples: a - before magnetic-hydrocavitation load; b - after hydrocavitation load; c - after magnetic-hydrocavitation load

Figure 1a shows a sample of granite before processing (control sample). From Figure 1b you can see that after processing of the rock by hydrocavitation load the local gathering of defects or prefracture zone appeared on the sample (position 1). The number of local defects is 4 units per 1mm^2, the average length is 90 mkm. These defects are caused by the collapse of cavitation bubbles, which is accompanied by energy outbreaks. When processing with hydrocavitation load adding action of the magnetic induction (experimental value 8 mT), Figure 1c, the local defects are produced in a larger amount than when using only hydrocavitation load. As shown by the experiments the number of local defects is 20 units per 1mm^2, the average length is 100 mkm. The result is explained by the physical processes are described by I. M. Fedotkin, Y.I. Fedotkin, J. I. Frenkel and others in their works [4-5]. On the surface of the cavitation bubbles in the circulation of fluid around the cavity an electric charge appears. They are grouped along the circulation flows, creating a circulating current. During the collapse of cavitation bubbles (with reduction of their sizes), there is a concentration of the electric field. Under the action of this electric field gases inside the bubble are activated and ionized, which complete with electric discharge. As a result, there is an electrical breakdown, which is accompanied by a trivalent oxygen O_3. Thus, the number of cores cavitation increase. Accordingly, the cavitation process intensified. This is also confirmed by studies V. I. Klassen, R. Sh Shafeev, G. N. Charzynski, B. M. Koryukin and others [6]. They proved experimentally using the method of Winkler and pyrogallic method [6] that the concentration of oxygen in the water at the magnetization grows on (6 ... 20)% of the initial value.

Furthermore, under the action of magnetic induction dissolved impurities precessing occurs with a frequency of about (10^8 ...10^9) Hz. This causes the subresonant oscillations to the natural frequency of the oscillations of a crystal lattice. Due to this there is an activization of internal and external energy flows, and as a result, the weakening of the surface layer of rock sample. Another reason for the intensive formation of local defects in MHCL is the small-scale turbulence near the surface water impurities. This phenomenon is described in the works of N. F. Bondarenko, E. S. Hak and others [4-5]. Scientists note that when creating in fluid of the electromagnetic field at the interfaces (e.g., liquid - gas, liquid – solid body) the induction currents appear with a density j_0 within the liquid and j_{if} on the interfaces [6] A/m^2:

$$j_0 = \sigma_0 \cdot (\vec{V}_0 \cdot \vec{B}_0); \quad (1)$$

$$j_{if} = \sigma_{if} \cdot (\vec{V}_{if} \cdot \vec{B}if), \quad (2)$$

Where σ_0 та σ_{if} – electroconductivity in a volume of fluid and interface boundaries accordingly 1/Ohm;

$\vec{V}_0$ та $\vec{V}_{if}$ - velocity of liquid in the volume and on interface boundaries accordingly m/s;

$\vec{B}0$ та $\vec{B}if$ – magnetic induction in a volume of fluid and interface boundaries accordingly T.

As a result, macro- and microscale turbulization occur throughout the volume of fluid. It is characterized by increased intensity under the conditions of cavitation. In researches [4, 6] shown that due to the impact of the electromagnetic field fluid turbulization with deaeration is accelerated in 2-3 times. Process is accompanied by high energy reactions during the collapse (collapsing) cavitation bubbles: specific capacity of the cavitational flow is about (104 ... 105) kW/m ^{3}, the rate of bubbles is (550 ... 650) m/s and the pressure is (800 ... 1000) MPa [4].
Furthermore, under the MHCL local defects of the granite (Figure 1C) are mainly arranged in one direction. This is explained by the orientation of motion of the cavitation cavities at the Larmor circumference, it follows from the analysis of the following physical phenomena. According to Reis electrokinetic effect [7], the magnetization (electrification) of suspended solids liquid, gas bubbles (cavitatings - nucleons radius of 10^{-9} m [4]), colloidal particles or droplets of other liquid occur under the influence of the electromagnetic field. The magnetic moments of above mentioned objects (further impurities), according to the Richardson-Einstein-de Haas effect [7] are oriented along the direction of magnetic induction lines. This leads to the ordering changes in their mechanical moments. At the same time, the total mechanical momentum must remain the same. Consequently, the body receives torque motion and begins to precess. It is also confirmed by the Larmor theorem [8] and the Theory of the effect by Wechler-McMillan [7]. According to the effect of the Wechsler-McMillan, if the motion velocity vector of a particle has a charge q and mass m_p, forms a right angle with the lines of magnetic induction vector, then trajectory of the particle is the circle radius R, m. The parameter R is the radius of the Larmor precession (or cyclotron radius), along which the orientation of the movement of cavitation bubbles takes place. This

is due to the location of the local defects in the same direction when using MHCL.

Conclusion

1. Under the influence of hydrocavitation load on the surface of the granite prefracture zone appears represented by local defects average number of which is 4 units per 1mm^2 with an average length of 90 mkm. When using magnetic-hydrocavitation load, the average amount of local defects is 20 units per mm^2 with an average length 100 mkm.

2. Local defects with magnetic-hydrocavitation load are mainly arranged in one direction. This is explained by the orientation of motion of the cavitation cavities at the Larmor circumference by magnetic induction action.

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