EFFECT OF THE DESIGN OF A COLUMN CHARGE
ON THE ENERGY OF THE DETONATION PRODUCTS
FORMING THE AIR BLAST WAVE

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According to present ideas, the mechanism of the effect of an explosion in a solid medium is a complex physical process. In the initial stages of its development, wave perturbations appear in the medium and subject the rock mass being blasted to preliminary or partial disintegration. Final disintegration of the medium is effected by the piston effect of the detonation products (DP). Thus when an explosive charge is fired, part of its potential energy is transformed to a shock wave through the rock mass, part remains in the detonation products, and part is consumed on thermal, chemical, and other losses.

Information in the literature on the quantitative distribution of the explosion energy experimentally reflects only that part which is converted to the shock wave through the rock mass. The energy remaining in the DP is accorded a secondary role, the assumption being made that up to 50% of the explosion energy remains there [1]. There is no experimental confirmation of these conclusions.

Quantitative determination of the DP energy will enable us to solve (both more completely and in a more specific manner) the problems involved in an increase in explosion efficiency, to calculate the intensity of air blast waves, to establish the radius of their destructive effect, etc.

To determine the DP energy in the explosion of charges for blastholes and shotholes in relation to their design and the firing conditions, we have made practical investigations in the Kirov and V. I. Lenin mines in the Krivbass. The experiments were performed by our own procedure, as described below.

It is known that the detonation of column charges gives rise to air blast waves with the following basic parameters: the pressure at the front, the duration of action, and the velocity of the wave. These parameters constitute the air-blast-wave pressure pulse, which is the area bounded by the curve of the action of the wave [2] in time:

\[ I = \int_{t_1}^{t} \Delta P d = N \cdot \text{sec}/m^2 \]  

(1)

and equal to the momentum of the current of air entrained by the air blast wave

\[ I = mv = N \cdot \text{sec}/m^2 \]  

(2)

where \( \Delta P \) is the excess pressure at the air-blast-wave front, in Nsec/m²; \( t_1 \) and \( t \) are respectively the beginning and end of the process under investigation, in seconds; \( m \) is the mass of air moving behind the air-blast-wave front, in kilograms; and \( v \) is the mean velocity of the air current, in meters per second.

Equations (1) and (2) indicate that the air-blast-wave pulse is its energy characteristic.

Underground experiments performed by the authors showed that when explosive charges are fired, the air-blast-wave pulse in mine workings obeys the following equation:
Fig. 1. Typical oscillograms of recording of the air-blast-wave pressure during firing of borehole charges: a) without stemming; b) with concrete stemming.

Fig. 2. Effect of type of explosive on the angle of deflection of pendulum: 1) Detonit 10 A; 2) Ammonite 6ZhV; 3) Dinaftalit.

Fig. 3. Degree of conversion of explosive energy to the air blast wave when charges of different explosives are fired: O) Ammonite 6 ZhV; △) ledge rock Ammonite No. 1; O) Dinaftalit; ●) Detonit 10 A; ▲) Zernogranulit 79/21 and Granulit AS-8.

Fig. 4. DP vs charging density; O) borehole charges; △) shothole charges.

\[ I = 0.6 \cdot 10^{-3} \frac{E_n}{S} e^{-\frac{6R}{25d_w N^2}} \text{ sec/m}^2 \]  

where \( E \) is the energy of the explosive charge fired, in joules; \( n \) is the coefficient of conversion of the explosion energy to the air blast waves; \( S \) is the cross section of the working, in square meters; \( B \) is the roughness coefficient of the working; \( R \) is the distance to the site of the explosion, in meters; and \( d_w \) is the diameter of the working, in meters.

Thus knowing the air-blast-wave pulse, we can determine the explosive energy lost on formation of the air blast waves.