CALCULATION RESULTS OF GAS DYNAMIC PARAMETERS IN SHPUR'S CHARGE CHAMBER AND NUMERICAL MODELING OF GAS DYNAMIC PROCESSES

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АННОТАЦИЯ

В данной статье установлено, времени выхода продуктов детонации из полости при взрыве прямоточного заряда в зависимости от типа используемой пробки позволил установить закономерности изменения давления на стенке ответвителя. На основе численного моделирования установлено, что непрерывное воздействие продукта детонации на минный массив в стадии затухания волны зависит от типа используемой пробки.

ABSTRACT

In this article, it was established that the time of release of detonation products from the cavity during the explosion of a direct-flow charge, depending on the type of plug used, allowed us to establish patterns of pressure changes on the wall of the coupler. Based on numerical modeling, it has been established that the continuous impact of the detonation product on the mine mass during the wave attenuation stage depends on the type of plug used.

Ключевые слова: шпур, тип породы, плотность, трещина, контурные заряды, контурными шпурами, выработка, заходка, нормативный перебор, щелеобразования, инициированием зарядов.

Keywords: borehole, rock type, density, crack, contour charges, contour holes, working out, penetration, standard enumeration, fissuring, charge initiation.

The possibility of theoretical production in the framework of non-stationary gas dynamic processes is connected with the introduction of new tools of computing techniques and information processing on the numerical modeling of the process of rock fragmentation appeared in the last decade. strengthened the work [1]. Similarly, in the work, the calculated model of the dynamics of rock fragmentation predicts the changes in the stress state of the environment and the numerical modeling of the formation process. In his work, N.I. Muskhelishvili gave the solution of non-stationary two-dimensional problems of gas dynamics by one-step "large particles" method [2].

From our side, a research was carried out to determine the loads applied to the walls of spurs during the explosion of charges of various designs by numerically solving gas dynamic processes and non-stationary two-dimensional problems. In the study of the solution of the tasks, wave and gas pressure processes and their exit processes were considered, and the parameters that created the gas pressure loads and shock-wave and wave processes that occur on the basis of calculations were determined.

Based on the quantitative methodology of numerical modeling, gas pressure parameters were calculated taking into account the parameters of pressure loads applied to the wall of the cavity in different ways of triggering explosives and detonating charges of different constructions. Figure 1 shows the calculated point location schemes for the integrated design of the charge (point 2 corresponds to the location of the combat cartridge), as well as the calculated graph of the pressure change on the spur wall during detonation without a plug. Calculations were made for four points placed along the charge axis. The 2.5-meter-deep spur is charged with granulite AC-8; the length of the charge is 2 meters. Forward and reverse charge excitation is considered.

Figures 2, 3 and 4 show the design of the charge calculated with points, and the graph of the pressure change on the spur wall as a function of time.

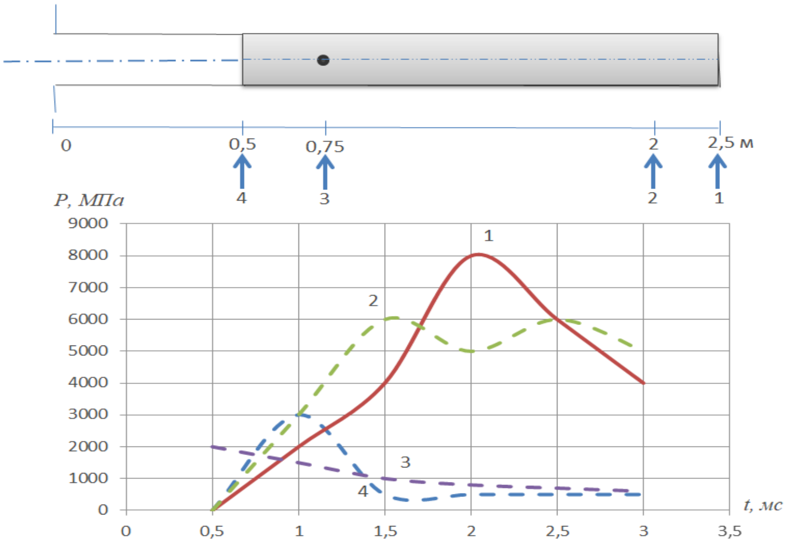


Figure 1. The calculated graph of the change of pressure on the spur wall during the construction of a charge without a plug in the correct method of excitation and the explosion without a plug in the correct method of excitation: at points 1, 2, 3, 4, it is considered corresponding to the length of the charge

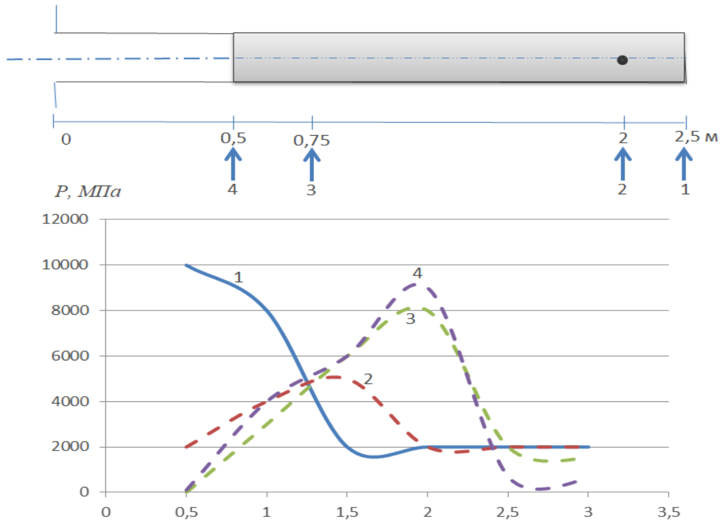


Figure 2. The calculated graph of the pressure change on the spur wall during the design of a plugless charge in the reverse method of excitation and the pressure change on the spur wall in the case of detonation without a plug in the reverse method of excitation: at points 1, 2, 3, 4, the charge is considered to be compatible along the length

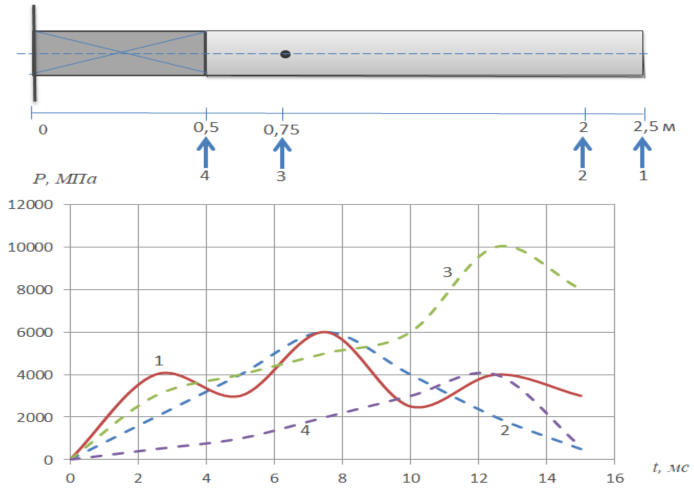


Figure 3. The calculated graph of the change in pressure on the spur wall during the explosion of the construction of a plug charge with the correct method of excitation and the use of a plug with the correct method of excitation: charge at points 1,2,3,4 corresponding to the length

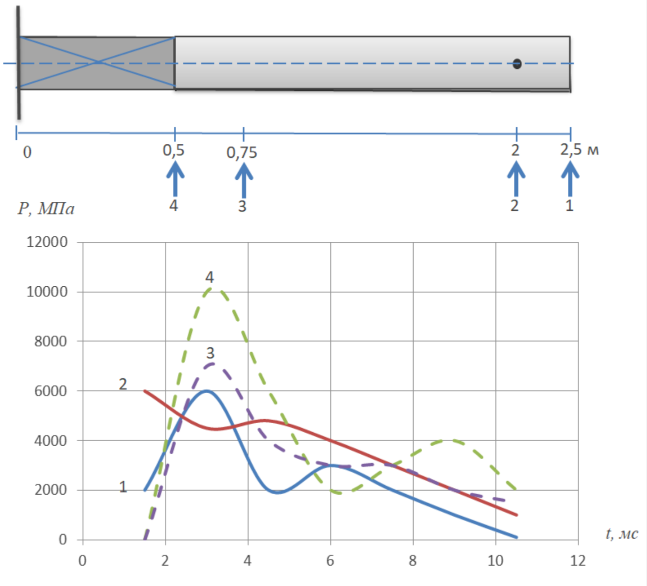
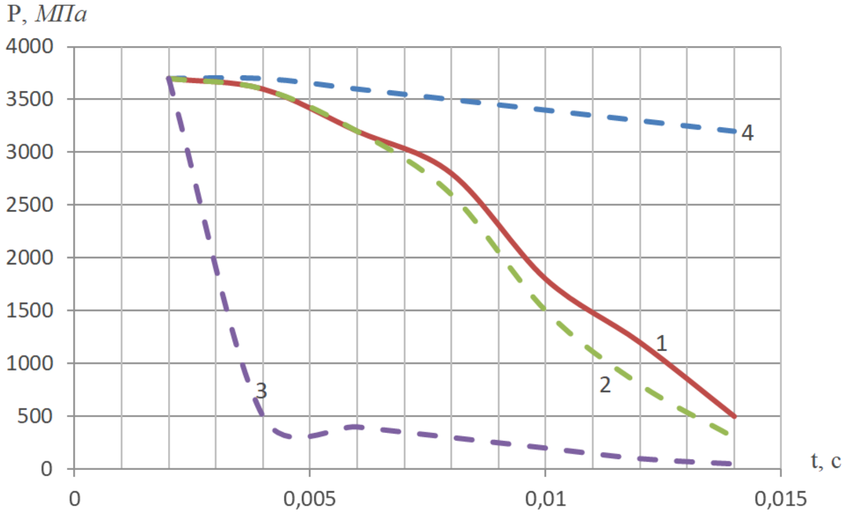


Figure 4. The calculated graph of the change in pressure applied to the spur wall during detonation with the construction of a plug charge in the reverse excitation method and the use of a plug in the reverse excitation method: at points 1, 2, 3, 4, it is considered consistent along the length of the charge

The analysis of the results shows that the presence of a plug in the spurs ensures the quality of the gas dynamic process. After interaction of detonation waves with clay plugs, the parameters of shock waves reflected at the bottom of the spur are equal to the parameters of detonation waves. The pressure in the cross-section of the plug is very different from the pressure in the wall of the spur near the plug, and it decreases sharply with the probability that it will come out.

The time dependence of the average pressure on the spur wall (curve 1 in Fig. 5) shows that the pressure drop is negligible when sufficiently strong plugs are used, and intensive pressure drop is observed only when the charge is detonated without a plug (curve 3). This is confirmed by the appearance of curvature in the application of various plugs. As a way to reach the end, the cases of forming a solid wall instead of completely sealing the detonation product were considered. The difference between the corresponding end-to-end cases, curve 4 in Figure 5, and curves 1 and 2 describes the pressure drop in the explosive cavity due to the flow of detonation products through the spur channel in terms of the probability of plug rupture. Part of the detonation product in the spur and the complete eruption of the plug are attenuated by intense wave processes in the explosive cavity at the final stage..



1 – profiled plug charge; 2 – sand-clay plug charge; 3 — charge without plug; 4 - complete closure of the detonation product

Figure 5. A graph of the general effect of gas product pressure on the spur wall depending on the design of the charge

Therefore, it should be noted that changing the length of the charge with a constant diameter of the spur or maintaining the ratio of the diameter of the charge to the length of the spur leads to a change in the temporal characteristics of the detonation speed, while maintaining all qualitative characteristics in the development of gas pressure processes.

Based on the calculations, the explosion impulse was determined for charges of different designs.

In general, the impact of the detonation product P(t) on the rock mass as a function of time I represents the pressure function of the detonation wave front generalized at time t,

$$I = \int_0^r P(t)dt \quad . \qquad (1)$$

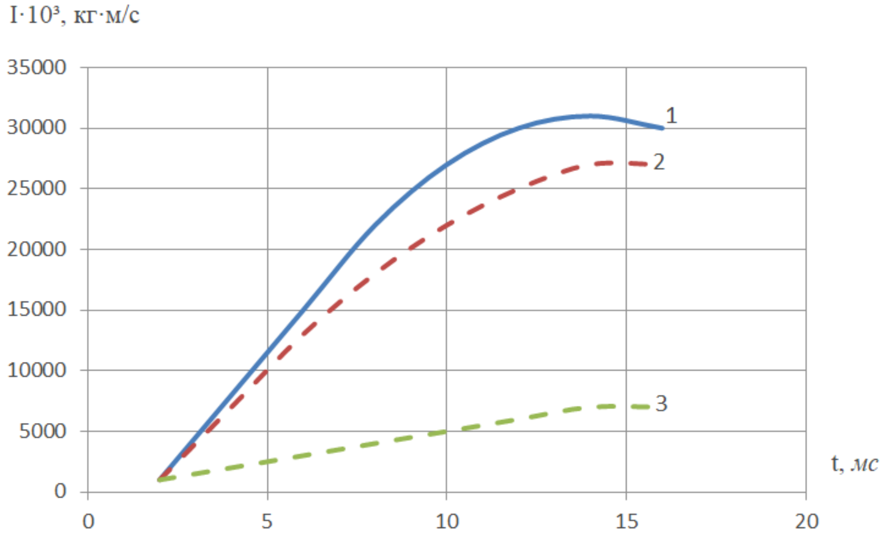
Based on the numerical results of the pressure generated in the charge cavity for charges of different designs (Fig. 5), the dependence of the pressure change over time was obtained:

$$P(t) = -1{,}937 \cdot 10^7 t^2 + 4.284 \cdot 10^4 t + 3750 \ ; \qquad (2)$$

$$P(t) = -6{,}7 \cdot 10^6 t^{1.75} \cdot e^{-5t} + 3750 \ ; \qquad (3)$$

$$P(t) = 4{,}1 \cdot 10^3 \cdot e^{-500t} \quad . \qquad (4)$$

Equation (2) describes the relationship for the design of the charge with a profiled plug, (3), (4) for sand clay and plugless charges, respectively. Based on the integration of these relationships over time (t = 0 ÷ 15 ms), we will be able to calculate the explosion pulse (Fig. 6).



1- profiled plug charge; 2 - sand-clay plug charge;
3 - charge without plug

Figure 6. A graph of the dependence of the explosion pulse on time and the charge structure

As a result of the conducted research, it can be concluded that the final time of the active impact of the explosion is 13 ms for plug charges, 11 ms for sand-clay plug charges, and 9 ms for non-plug charges.

Thus, if we enter the coefficient of detonation effect of non-plugged charges into the array and take it equal to one, then this coefficient is equal to 1.44 for hard-plugged charges and 1.22 for sand-clay-plugged charges, respectively. will be The received coefficient of impact of the explosion pulse allows to correct the calculation of the relative consumption of charges of different designs.

Conclusion:

The analysis of the time of detonation products exiting the cavity when the spur charge explodes, based on the type of plug used, made it possible to establish the laws of change of pressure on the spur wall. On the basis of numerical modeling, it was determined that the continuous impact of the detonation product on the mine array in the stage of wave extinction depends on the type of plug used. It was found that the values of the explosion impulse are 9 ms, 11 ms, 13 ms for charges without plug, sand-clay and profiled plug, respectively.

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