COMPUTATIONAL-EXPERIMENTAL METHOD TO DETERMINE HIGH EXPLOSIVE CRITICAL DIAMETER

V. I. Chufarov, E. B. Smirnov, Yu. A. Belenovsky, I. A. Akhlyustin

FSUE «RFNC – VNIITF named after Academ. E. I. Zababakhin», Snezhinsk, Russia

The critical detonation diameter, d_{crit}, is the least diameter of high explosive (HE) cylindrical charge, in which propagation of self-sustaining detonation is still possible. The parameter d_{crit} is the most important characteristic of HE charge detonability. Experimental determination of d_{crit} is technologically challenging for the HEs with high detonability, when there is a need to manufacture high-density charges with a diameter of less than 5 mm. For charges with low detonability, it is necessary to manufacture charges of large diameter (100 mm or more) and relatively large mass, which makes it impossible to conduct such experiments in laboratory conditions [1].

Prediction of d_{crit} values using calculations is necessary to reduce the number of experiments when developing new HEs.

The paper presents a computational-experimental method for determining the HE critical diameter, based on the existence of a minimum critical radius of detonation front curvature, R_{crit}, at which detonation propagation is still possible [2].

At the limit of detonation propagation the front is spherically shaped with curvature radius, R_{crit}, while the angle of detonation front inclination to the generatrix of the HE charge cylindrical surface is equal to the so-called acoustic angle, φ, at which an acoustic flow regime of shock-compressed HE is implemented behind the shock at the charge edge [1].

$$d_{crit} = 2R_{crit}\cos\varphi. \quad (1)$$

This approach to determine dcrit involves obtaining the dependence of the normal component of detonation velocity on the curvature along the radial coordinate, which is derived from the experimental data on profiles of detonation wave front and detonation velocities in HE cylindrical samples of different diameters.

Table 1 shows the calculation results for dcrit using the above method.

Table 1

Calculation results and experimental data

HE	Critical curvature, k_{crit}, mm^{-1}	Calculated value, d_{crit}, mm	Experimental data, d_{crit}, mm
TATB	0.246	5.6	6–10
TATB-and HMX-based thermoplastic HE	0.192	6.4	5–6
TATB-based thermoplastic HE	0.072	17.9	15–20
TATB-based plastisol HE	0.014	91.8	90–100

The obtained calculation results for d_{crit} show a satisfactory agreement with the known experimental data. Thus, this method allows preliminarily estimating the critical detonation diameter.

References

1. **Kobylkin, I. F.** Calculation of the critical detonation diameter of explosive charges using data on their shock-wave initiation [Text] // Fizika goreniya i vzryva [Combustion, Explosion, and Shock Waves]. – 2006. – Vol. 42, No. 2. – P. 112–115 (in Russian).

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