FEATURES OF LOW-VELOCITY DETONATION OF GRAINED SINGLE-BASE PROPELLANTS

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Abstract: Numerical modeling of low-velocity detonation of grained single-base propellants has been fulfilled. It is shown that the effect of thickness of initiating layer of high explosive on velocity of low-velocity detonation is the consequence of two factors: rather low intensity of chemical conversion and insufficient length of the charge (120 mm in experiments). Under these conditions, the detonation reaction zone has no time to be totally developed and the wave characteristics continue their active change. Evolution of the wave manifests itself evidently through developing the pressure profile, but the flame front trajectory, with the exception of the initiation stage, demonstrates almost linear shape, with the wave velocity of near constant value. In order to get steady mode, one needs the charge of 1-meter length. Analysis of the flow structure at the low-velocity detonation front has shown that the structure responsible for the gas-phase mechanism is typically observed in calculations, when the propellant burning is initiated by heat transmitted from the high-velocity high-temperature gas flow generated before the flame front. And only at porosity 0.2 and less, the solid phase mechanism (initiation due to dissipation during the viscous plastic deformations of the porous body) has been observed. The situations are considered when in the course of developing, the low-velocity detonation, these two mechanisms replace one the other.

Keywords: low-velocity detonation; single-base propellant

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References

1. Okunev, V. A. 1989. Razvitoe konvektivnoe gorenie i perekhod v nizkoskorostnuyu detonatsiyu v poristyukh porokhovykh zaryadakh [Developed convective burning and transition into low-velocity detonation in porous propellant charges.] D.Sc. Diss. Moscow. 143 p.
2. Martynyuk, V. F., A. A. Sulimov, C. V. Chekanov, and M. K. Sukoyan. 1992. Struktura nizkoskorostnoy detonatsii v pyroksilinovykh porokhakh [Structure of low-velocity detonation wave in pyroxylin powders]. *Khim. Fiz.* 11(2):293.

3. Ermolaev, B. S., V. F. Martynyuk, A. A. Belyaev, and A. A. Sulimov. 2014. Nizkoskorostnye rezimy detonatsii zernennogo pyroksilinovogo porokha [Low-velocity detonation modes of grained pyroxylin powders]. *Russ. J. Phys. Chem. B* 8(3):376.
4. Ermolaev, B. S., A. A. Sulimov, V. A. Okunev, and B. A. Khasainov. 1987. O mechanizme nizkoskorostnoy detonatsii v krupnozernenoy nitrokletchatke [On the mechanism of low-velocity detonation of coarse-grained nitrocellulose]. *Fundamental problems of shock physics*. Chernogolovka: Dep. of IChP RAS. 1:40.
5. Ermolaev, B. S., A. A. Belyaev, and A. A. Sulimov. 2004. Chislennoe modelirovanie perekhoda goreniya v detonatsiyu v pyroksilinovykh porokhakh [Numerical modeling of deflagration-to-detonation transition in pyroxylin powders] *Khim. Fiz.* 23(1):67.
6. Orlenko, L. P., ed. 2002. *Fizika vzryva* [Physics of explosion]. Moscow: Fizmatlit. Vol. 1. 823 p.

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