COMPUTATIONAL MODELING OF EXPERIMENTS ON STUDYING DETONATION CHARACTERISTICS OF TG46 AND TG55 TNT-RDX COMPOSITIONS

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Detonation characteristics of TNT-RDX (TG) explosive compositions have been studied intensively in the period from 1960 to 1980. The experiments were conducted in order to confirm the hydrodynamic theory of detonation. According to this theory [1], a plane detonation wave (DW) has two characteristic zones, separated by the Jouguet state (plane), i. e. the stationary chemical zone (chemical peak) and the rarefaction wave. The pressure drop in the chemical peak is much faster than in the rarefaction wave, so more or less evident break in plane DW profiles defines the Jouguet state and chemical peak length. To obtain information on DW profiles, the parameters of shock waves in inert barriers adjacent to HE are measured. The results of different experiments have been widely discussed in open publications and are presented, for example, in the compendiume [2].

The experimental data, obtained by different authors, on reaction zones of the same HE differ essentially. Thus, the chemical peak width of the TG55 composition was 0.12 mm (spall method) [3], 0.64 mm (photoelectric method) [4] and 1.33 mm (electromagnetic technique) [5], i. e. the difference reaches an order of magnitude. The uncertainty in the width of the reaction zone of TNT-RDX compositions leads to spread in Jouguet pressures. Thus, according to different authors, $P_J = 26 \div 32$ GPa for the TG 46 of density 1.73 g/cm^3 [6].

The paper shows that this essential spread is related to non-ideal detonation of the studied HEs. Considering that the exothermal process of growth of ultradisperse diamond (UDD) clusters [7] is prolonged for microseconds, a significant portion of the heat of detonation (caloric power) is released in explosive products (EP) beyond the HE-EP chemical zone. This effect is accounted in the detonation model [8], specifically developed for high-density HE with oxygen deficiency.

The detonation wave profile experiments were modeled using different experimental techniques, and a good agreement was found between the design and experimental data.

References

1. **Veretennikov, V. A.** Applicability of hydrodynamic theory to the detonation of condensed explosives [Text] / V. A. Veretennikov, A. N. Dremin, O. K. Rozanov, K. K. Shvedov // Fizika goreniya i vzryva [Combustion, Explosion, and Shock Waves]. – 1967. – Vol. 3, No. 1, 19. – P. 3–10. (in Russian).
2. Physics of explosion [Text] ; ed. by L. P. Orlenko. – M. : Fizmatlit, 2004. (in Russian).
3. **Zubarev, V. N.** Width of stationary zone in detonation waves [Text] / V. N. Zubarev, N. V. Panov, G. S. Telegin // Fizika goreniya i vzryva [Combustion, Explosion, and Shock Waves]. – 1970. – Vol. 6, No. 1. – P. 107–112. (in Russian).
4. **Loboiko, B. G.** Reaction zones of detonating solid explosives [Text] / B. G. Loboiko, S. N. Lubyatinsky // Fizika goreniya i vzryva [Combustion, Explosion, and Shock Waves]. – 2000. – Vol. 36, No. 6. – P. 45–63. (in Russian).
5. **Dremin, A. N.** Measurement of Chapman-Jouguet pressure and reaction time in detonation wave of powerful explosives [Text] / A. N. Dremin, K. K. Shvedov // Prikladnaya matematika i tekhnicheskaya fizika [Journal of Applied Mechanics and Technical Physics]. – 1964. – No. 2. – P. 154–159. (in Russian).
6. **Shvedov, K. K.** Determination of the Chapman-Jouguet parameters in the detonation of condensed HE [Text] // Fizika goreniya i vzryva [Combustion, Explosion, and Shock Waves]. – 1987. – Vol. 23, No. 4. – P. 94–104. (in Russian).
7. **Aleshaev, A. N.** Application of synchrotron radiation for studying detonation and shock-wave processes [Text] / A. N. Aleshaev, P. I. Zubkov, G. N. Kulopanov et al. // Fizika goreniya i vzryva [Combustion, Explosion, and Shock Waves]. – 2001. – Vol. 37, No. 5. – P. 104–113. (in Russian).
8. **Grebenkin, K. F.** Model of slow energy release in detonation of HE with oxygen deficiency [Text] / K. F. Grebenkin, A. L. Zherebtsov, D. A. Varfolomeev, I. V. Derbenev // Collection of articles edit. by K. F. Grebenkin. Physical detonation models of heterogeneous crystalline matters. – Snezhinsk : RFNC – VNIITF Publ., 2017. – P. 165–189. (in Russian).