DETERMINATION OF THE JONES–WILKINS–LEE EQUATION OF STATE FOR THE HMX WITH A PLASTIC BINDER

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Abstract: The paper presents a method for determining the parameters of the Jones–Wilkins–Lee (JWL) equation of state (EoS) for a high-energy explosive composed of HMX. The study relies on cylinder-test experiments utilizing both electrical contact sensor (ECS) and Photon Doppler Velocimetry (PDV) techniques. In one experiment, the velocity of the free surface of a thin aluminum foil mounted on the end of the charge was recorded through a lithium fluoride window using the PDV technique. Using the experimental data from the T20 and T60 settings, the authors calculated isentropes in the form of the EoS JWL with their propriety software. A good agreement between the calculation and experiment was observed in numerical two-dimensional modeling. The proposed computational and experimental technique is suitable for engineering analysis of the impact of detonation products on the environment.

Keywords: Chapman–Jouguet pressure; detonation products isentrope; laser-heterodyne technique; mass velocity profile; equation of state of detonation products; cylinder test; electrical contact sensor

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Figure Captions

Figure 1 Schematic of the experimental setup: *1* — electric detonator; *2* — booster charge; *3* — plastic-bonded high melting explosive charge in a copper tube; *4* — PDV collimators; *5* — needle-type electrical contact sensors; *6* — aluminum foil (10 μm thick); and *7* — lithium fluoride window

Figure 2 Results of the 20-millimeter diameter cylinder test: (*a*) displacement of the outer boundary of the shell; and (*b*) radial velocity of the outer boundary of the shell (*1* — PDV ch1–ch14 (experiments); *2* — PDV (approximation); *3* — ECS (experiments); and *4* — ECS (approximation))

Figure 3 Comparison of T20 and T60 results considering the scale factor (SF) (averaged data): (*a*) displacement of the outer boundary of the shell; and (*b*) radial velocity of the outer boundary of the shell (*1* — 20-millimeter cylinder test, PDV (experiments); *2* — T20, wedge (experiments); *3* — T20, wedge (calculation by Eq. (4)); and *4* — 60-millimeter cylinder test, PDV at SF = 3 (experiments))

Figure 4 Particle velocity profile at the detonation products / lithium fluoride interface

Figure 5 User interface of the MakeJWL software

Figure 6 Typical representation of results in the MakeJWL software

Figure 7 Calculation results of detonation product isentropes for a plasticized HMX: *1* — 20-millimeter cylinder test, PDV; *2* — T20, wedge; and *3* — 60-millimeter cylinder test, PDV

Figure 8 Comparison of numerical simulation results with the M40 technique experiment: *1* — M-40 experiment; *2* — detonation products EoS based on T20 wedge data; *3* — detonation products EoS based on 20-millimeter cylinder test, PDV data; and *4* — detonation products EoS based on 60-millimeter cylinder test, PDV data

Table Captions

Table 1 Approximation coefficients for the 20-millimeter diameter cylinder test

Table 2 The JWL isentrope coefficients for a plasticized HMX

Table 3 Calculation results for plate acceleration in the M-40 configuration

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