LAGRANGIAN-EULERIAN APPROACH TO MODELING THE CYLINDER-TEST EXPERIMENT FOR VALIDATION OF THE PARAMETERS OF THE EQUATION OF STATE OF DETONATION PRODUCTS

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The experimental cylinder test method is the most popular technique for assessing the propellant ability of explosives (HE) is the main method for determining the parameters of the equation of state of explosion products (EP) of various HE. Various methodologies for determining the parameters of the EOS of EP are being developed, analytical and semi-analytical using numerical modeling, but the validation of the obtained parameters is always carried out using numerical modeling of the problem in a formulation corresponding to the cylinder test experiment. This is especially relevant for new HE, for which there is no reliable reference data.

To validate the parameters of the EOS JWL, a numerical simulation of the cylinder test experiment was carried out for various explosives and tube geometries.

The cylinder test belongs to the class of coupled fluid-structure interaction problems, which require a joint calculation of the interaction between gas and a deformable solid body. This paper presents a software package that implements independent calculations of the Lagrangian and Eulerian domains of the coupled fluid-structure interaction problem using proprietary software modules. These modules are supplemented with a boundary condition coupling module that describes the exchange of energy and momentum at the contact boundaries at each computational time step. To describe the flow of condensed media, a mathematical model of two-dimensional elastoplastic flow in Lagrangian coordinates was used [1, 2]. For gas flow, a mathematical model of two-dimensional gas-dynamic flow in Eulerian coordinates was employed. In both cases, the system of equations of continuum mechanics is formulated to account for the irreversibility of real physical processes, incorporating non-equilibrium stresses that consider the finite relaxation time of the system to an equilibrium state. The numerical solution of the proposed mathematical model in Lagrangian and Eulerian coordinates is implemented using a semi-analytical method [2], which differs from traditional methods in that only the spatial derivatives are replaced by finite differences. As a result of this approach, the partial differential equations are reduced to a system of ordinary differential equations, which has an approximate analytical solution for a small-time interval.

References

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