Simulation of Gas-liquid Reaction Flow Field for Combustion and Propulsion Processes of Bulk-loaded Energetic Liquid

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Abstract: To investigate the action mechanism of combustion chamber geometries on the stabilities of combustion and propulsion processes of bulk-loaded energetic liquid, based on theory of hydrodynamics and component transport equation, a two-dimensional axisymmetric model for gas-liquid two-phase flow and combustion was established. Numerical simulations for the chemical reaction flow fields in the cylindrical and multi-stage stepped-wall combustion chambers were conducted. The distribution characteristics of temperature, velocity, pressure, as well as volume fraction were studied via tracking of the expansion of gas cavity and movement of burning surface. The influence rule of combustion chamber geometries on the evolution processes of flow fields was analyzed. Results show that gas cavity formed after ignition and combustion of energetic liquid expands rapidly in the liquid, when the combustion gas cavity penetrates the liquid and develops to projectile bottom, the burning surface along the axial of the combustion chamber grows rapidly, the Kelvin-Helmholtz's instability effect occurs due to the tangential velocity difference between gas and liquid, whereas stepped-wall combustion chamber is helpful for inducing radial turbulence, slowing the axial expansion velocity of gas cavity, suppressing axial Kelvin-Helmholtz's instability effect, and enhancing the stabilities of the combustion and propulsion processes of bulk-loaded energetic liquid. The calculated results are in good agreement with the experimental data.

Key words: energetic liquid; turbulent combustion; combustion stabilities, numerical simulation

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