SUMMARY OF Ph.D. DISSERTATION

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Title

Numerical Investigation on Acceleration Performance and
Pressure Fluctuation Mechanism of Projectile Accelerator
Using Solid/Gas Two-Phase Flow Simulation

Abstract

The multi-dimensional solid/gas two-phase flow simulation codes are developed in this dissertation to simulate the propellant burning and the projectile acceleration process for the prediction of the interior ballistics performance of the projectile accelerators with solid propellant. The developed codes treat the gas as continuous phase and the propellant grains as discrete phase using the representative particles, and consider the mass, momentum and heat transfers between the two phases. The multi-dimensional two-phase flow simulations, which have the ability to reproduce the pressure waves behavior and the interactions between the two phases, give us the valuable information for the accelerator design, because the prediction of the generation of pressure fluctuations in the ignition stage is significant for the safety. The developed codes are validated by comparing the predicted results with the experimental data, and the pressure fluctuation mechanism and the effects of grain configuration on the acceleration performance are clarified from the simulated results.

The background and objectives of this study are described in the chapter 1.

Fluid dynamics simulation model, the interphase models and the numerical calculation method are presented in the chapter 2.

The developed simulation codes are validated in the chapter 3, using the predicted results by the other simulation codes for the AGARD model condition, which is used widely as the benchmark model. From the comparison with the lumped parameter model results, the features and advantages of the two-phase flow simulation are shown.

In the chapter 4, the simulation results shows that the motion of the propellant grains accelerated by the igniter flow causes the generations of pressure fluctuations in the chamber.

Using the simulated data of the projectile launch tests, the features of long tubular solid propellant for the projectile accelerator are discussed in the chapter 5. The projectile mass effects on the acceleration performance are investigated numerically.

In the chapter 6, the suitable model to simulate the diaphragm opening is discussed using the experimental results, and simple prediction method for the projectile muzzle velocity in the ballistic range accelerator is proposed.

The conclusions of this dissertation are described in the chapter 7.