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NUMERICAL SIMULATION OF CATALYTIC DECOMPOSITION AND COMBUSTION PROCESS IN AN HYDROXYLAMMONIUM NITRATE (HAN)-BASED MONOPROPELLANT THRUSTER

Abstract

Hydroxylammonium Nitrate (HAN)-based liquid propellant, one of the most promising green propellants provides simple, safe, reliable, non-toxicity and high performance monopropellant systems. In this paper, the gas-liquid-solid multiphase flow, catalytic decomposition and combustion in the HAN-based thruster is numerically studied. A simplified chemical mechanism is obtained and used in the CFD work. In order to simulate the phase transition during the catalytic decomposition and combustion process, a three-dimensional model for HAN-based thruster working process is developed via coupling the porous medium model with the multiphase model. The final distribution of pressure, temperature and mass fraction of all species is revealed in both axial and radial direction of the thruster. The calculations and experiments are in qualitative and quantitative agreement, which verifies the accuracy of the simulation result. Furthermore, the effects of inlet mass flow rate, catalyst bed preheating temperature and porosity of porous media on the catalytic decomposition and combustion process are investigated. The findings can assist in the design and test of non-toxic aerospace monopropellant thrusters meeting various performance and emission requirements.