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STUDY ON REBURNING PHENOMENON OF THE BOTTOM OF A LIQUID ROCKET DURING ITS ASCENT PHASE

Abstract

ZhuQue-2 (ZQ-2) launch vehicle is the world's first liquid-oxygen methane (LOX+LCH4) launch vehicle to successfully enter space orbit. Its first stage employs four LOX+LCH4 engines of open-cycle in parallel. The reburning phenomenon that occurred at the bottom of the launcher body 15s after the engine ignition. In order to delve into the causes of reburning and the impact on the thermal environment of the bottom, this paper imposes a three-dimensional CFD coupled combustion method to simulate the phenomenon of reburning at the bottom during the ascent phase of the rocket.The results of numerical calculations show that the reburning phenomenon at the bottom of the liquid rocket engine is mainly due to the reaction between the incoming air and the combustion-rich exhaust gas at the exhaust outlet of the turbine. In the process of the rocket's accelerated ascent, the coiling effect of the incoming air to the bottom is enhanced, and the flame at the outlet of the turbine moves upward, which eventually causes the phenomenon of reburning at the bottom. The simulation results show that the highest heat flow density at the bottom of the open-cycle engine can reach 400KW during the ascent process. The calculated results are highly consistent with the flight test data, which verifies the effectiveness of the numerical model and provides a theoretical basis for the thermal protection design of LOX+LCH4 rockets.