Paper ID: 14055
student

SPACE PROPULSION SYMPOSIUM (C4)
Propulsion System (2) (2)

Author: Mr. Junhai Li
China Academy of Space Technology (CAST), China, lijunhai@sa.buaa.edu.cn

Mr. Nanjia Yu
Beijing University of Aeronautics and Astronautics (BUAA), China, ynj@buaa.edu.cn
Mr. Dalin Rao
Beijing University of Aeronautics and Astronautics (BUAA), China, cover0270@163.com
Mr. Junfeng Wu
Beijing University of Aeronautics and Astronautics (BUAA), China, woodriven@sa.buaa.edu.cn
Prof. Guobiao Cai
Beijing University of Aeronautics and Astronautics (BUAA), China, cgb@buaa.edu.cn

PERFORMANCE CHARACTERIZATION OF THE HYBRID ROCKET MOTOR WITH SECONDARY INJECTION

Abstract

The hybrid rocket motor with secondary injection is identical to the classical with an added aft oxidizer system. A portion of the oxidizer required for proper mixture ratio operation is primary injected into the head end of the fuel grain. The remainder of the oxidizer is bypassed and secondary injected into the aft mixing chamber. Mixing of oxidizer and fuel gases is enhanced by the secondary injection process, and a nearly constant mixture ratio can be maintained at all times during motor operation. In this paper, a CFD code is used to simulate the combustion flow field and performance characterization of the hybrid rocket motor with secondary injection, which applying 90% hydrogen peroxide (90%H2O2) as the oxidizer and hydroxyl terminated polybutadiene (HTPB) as the fuel. A parametric investigation examines the effect of the secondary injection location, angle and the mass flow proportion of the secondary injection. The results reveal that the injection of a portion of vaporized oxidizer into the aft mixing chamber is helpful in the combustion of certain unburned fuel species. The structures of the combustion flow field and temperature are affected by the varying secondary injection location and angle. The combustion efficiency increases when the mass flow proportion of the secondary injection is increased, but the fuel regression rate decreases and a large grain surface area must be provided. In conclusion, mixing of oxidizer and fuel gases is enhanced by the secondary injection process and high combustion efficiencies can be obtained at optimal conditions. A guide for the optimal design of the hybrid rocket with secondary injection based on the simulation results is proposed, and a series of experimental tests will be conducted to verify the effect of the secondary injection.