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EXPERIMENTAL STUDY ON FUEL SUPPLY CHARACTERISTICS OF MAGNESIUM POWDER RAMJET ENGINE

Abstract

In-situ resource utilization is currently considered to be an efficient technological approach for exploring Mars. By utilizing local resources on Mars to support large-scale missions, this will significantly reduce the time and cost of human exploration of Mars. Fortunately, Mars is a planet with an atmosphere, 95% of which is composed of carbon dioxide. Therefore, an attractive air-breathing propulsion system for Mars exploration, the magnesium-carbon dioxide ramjet engine, has been proposed. Research on magnesium-carbon dioxide engines is still in its early stages, especially in terms of experimental research. Powder supply technology is currently a popular topic in experimental research. The stability, accuracy, and uniformity of powder supply play a crucial role in the combustion of magnesium-carbon dioxide engines. In order to study the powder fuel supply system characteristics of Mg-CO2 ramjet, a real-time monitoring system for the flow rate of powder, a high back-pressure simulation system and a powder injection visualization experiment system were built. The accuracy and stability of powder supply, powder supply state and powder injection characteristics under different carrier gas flow rates were analysed. Results show that the gas-solid two-phase flow choked supply method ensures that the supply system can supply powder stably and accurately in the high back pressure environment.For the stability of the engine, the combustion experiments should be carried out in the stable stage of the carrier gas pressure. During this process, the powder supply flow rate is only related to the piston speed and powder packing density. Although the carrier gas does not affect the flow rate of powder, it significantly changes powder injection characteristics. The injection speed ups linearly with the increase of the carrier gas flow rate, while the injection cone angle first decreases and then increases. In order to improve the theoretical combustion performance of the model ramjet, the ratio of carrier gas flow rate to powder flow rate should be chosen to be around 0.68 in the later combustion experiments.This study provides valuable reference for future development of the Martian stamping engine supply system design.