SPACE PROPULSION SYMPOSIUM (C4)
Propulsion Technology (3)

Author: Mr. Nanjia Yu
Beijing University of Aeronautics and Astronautics (BUAA), China, ynj@buaa.edu.cn

Prof. Guobiao Cai
Beijing University of Aeronautics and Astronautics (BUAA), China, cgb@buaa.edu.cn
Mr. Guozhou Zhang
China, ynj@buaa.edu.cn
Mr. Bin Ma
China, mabin@buaa.edu.cn

INVESTIGATION OF HYDROGEN/OXYGEN SMALL THRUST ROCKET ENGINE USING GAS DYNAMIC RESONANCE TECHNIQUE

Abstract

To utilize non-poisonous propellants is the orientation of future small thrust rocket engine, especially when applied to manned-spacecraft and space station. Hydrogen/oxygen small thrust rocket engine is an important embranchment of small thrust engine. Hydrogen/oxygen are non-hypergolic bipropellants requiring of certain ignition devices. Since conventional electrical ignition devices have partly restricted the development of advantageous small hydrogen/oxygen rocket engine in dimension, weight and reliability, gas dynamic resonance ignition technology is adopted. As a pure gas dynamic repeated ignition method, gas dynamic resonance ignition device has simple structure and high reliability, and is adaptive to ignition of hydrogen and oxygen. By means of analysis and research on multiple hydrogen and oxygen resonance ignition schemes, the coaxial hydrogen/oxygen resonance igniter was selected as the adaptive ignition method for the head of hydrogen/oxygen small thrust rocket engine. Through gas dynamic resonance heating experiments, the minimization of coaxial hydrogen/oxygen resonance igniter was accomplished; meanwhile the optimal parameter matches between structure dimensions and inlet pressure have been determined. Based on ignition tests of coaxial hydrogen/oxygen resonance igniter, ranges of both hydrogen and oxygen inlet pressure and their operation sequence have been investigated and optimized. The starting response time was finally restricted in 0.17 second. By means of analysis of special impulse and combustion gas temperature in different mixture rate of hydrogen and oxygen, system parameters of hydrogen/oxygen small thrust rocket engine are confirmed. Hot firing tests of hydrogen/oxygen small thrust rocket engine and pulse ignition tests are developed in different thrust operation conditions. Through changed the flow rate of hydrogen and oxygen, the thrust of hydrogen/oxygen rocket engine was changed. Four thrust conditions were confirmed, which are 100%, 75%, 50%, and 33% thrust condition. Hydrogen/oxygen small thrust rocket engine started stably in different thrust conditions. In pulse ignition tests, the hydrogen/oxygen small thrust rocket engine was started 10 times continuously and the span of two pulses was 0.5 second. It can be confirmed that hydrogen/oxygen small thrust rocket engine can realized multi-start and performance stably, which verify the reliability and feasibility of the hydrogen/oxygen small thrust rocket engine.