SPACE PROPULSION SYMPOSIUM (C4)
Hypersonic and Combined Cycle Propulsion (5)

Author: Mr. Wei Lin
College of Aerospace and Materials Engineering, National University of Defense Technology, China, linweiqy@163.com

Dr. Zhiyong Lin
China, linzy96@nudt.edu.cn
Prof. Jin Zhou
China, zhoujin@sina.com

THRUST MEASURE AND CAPABILITY ANALYSIS OF H2/AIR MIXTURE CONTINUOUS ROTATING DETONATION WAVE MODEL ENGINE

Abstract

Detonation is widely focused for its high cycle efficiency and quick energy release rate, and continuous rotating detonation wave engine is one of the very prospective engines in future aerospace or airbreathing propulsion system using this combustion mode. Based on the steady detonation initiation by H2/O2 hot-shot jet, propulsion results of both experimental and three-dimension numerical investigations on H2/air mixture continuous rotating detonation wave model engine are presented. In continuous rotating detonation experiment, the effect of backpressure, with atmosphere backpressure and atmosphere backpressure, on thrust is considered. At very wide working ranges of H2 from 6.77 to 7.38 g/s, air from 160 to 435 g/s with atmosphere backpressure and H2 from 7.465 to 7.612 g/s, air from 185 to 523 g/s with less than 11 kpa vacuum backpressure, thrust performance under three detonation propagation modes-single wave, double wave and multi-single/double wave lasting for 300ms is directly measured with high frequent thrust sensor, and an experimental thrust pool in different propagation modes and molar ratios is statistically established. Thrust of a continuous rotating detonation lasting for about 2000 ms is measured, getting a steady one-dimension thrust. As the injecting pressure and flux increase, the thrust rise apparently, as well as the ratio pulse and the ratio of thrust to gravitation. Comparing with the result got from experiment, thrust is indirectly deduced from the measured flow field parameters via high frequent pressure sensors and common pressure sensors, together with the thrust calculated from corresponding three-dimension simulation flow field, the thrust of continuous rotating detonation wave engine is investigated in detail. To verify the efficiency of detonation, the whole thermodynamics cycle analysis of continuous rotating detonation is discussed, according to the measured flow field parameters and the numerical flow information. When in simulation, the resolution method of mass flow, ratio mass flow, thrust, ratio pulse and parameters at exit of continuous rotating detonation wave are firstly defined. The results show that the thermodynamics cycle efficiency of continuous detonation is not as high as the theoretic result, though it is surely higher than equal pressure cycle. This work can offer certain direct instruction to the research of continuous rotating detonation wave engine in engineering.

Keywords

Continuous rotating detonation, H2/air mixture, thrust, experimental investigation, three-dimension simulation, thermodynamics cycle analysis