IAF MICROGRAVITY SCIENCES AND PROCESSES SYMPOSIUM (A2)
Fluid and Materials Sciences (2)

Author: Ms. Elena Mikhalchenko
Scientific Research Institute for System Analysis, Russian Academy of Sciences (RAS), Russian Federation

Dr. Valeriy Nikitin
Lomonosov Moscow State University, Russian Federation
Prof. Sungwoo Park
Korea Aerospace University, Korea, Republic of

NUMERICAL SIMULATION OF A DETONATION ENGINE ON AN ACETYLENE-OXYGEN MIXTURE, COMPARISON WITH EXPERIMENT

Abstract

As an alternative to the traditional combustion of fuels in a turbulent flame, the method of their combustion in continuously rotating transverse detonation waves is currently being considered. It allows intensive, more thermodynamically favorable and stable combustion of various fuels in annular chambers of small dimensions, determined by the characteristic size of the detonation wave front. The rotating detonation wave engine has attracted increasing attention over the past two decades. Currently, most RDE studies are based on hydrogen and ethylene, and kerosene-based mixtures are also being considered. In early research, the addition of hydrogen or oxygen was the primary method of initiating liquid kerosene/air spinning detonation. For example, Bykovsky et al. experimentally initiated rotating detonation waves on kerosene, they reported that rotating detonation waves could only be obtained by increasing the mass ratio of oxygen/nitrogen to 1:1. Their subsequent research continued to use the addition of some more active propellants, i.e. hydrogen or synthesis gas to produce self-sustaining rotating detonation waves. In this paper, a three-dimensional numerical simulation of the detonation combustion chamber was carried out, the study of which was carried out experimentally by Bykovsky and his collaborators. The diameter of the chamber is 10 cm, the length is 10 cm and the initial width of the channel is 0.5 cm. Oxygen was considered as an oxidizer, hydrogen or acetylene was considered as a fuel. The obtained results are compared with experimental data. This work was supported by the subsidy of the Ministry of Science and Education of Russian Federation on the topic: “Investigation and development of detonation combustion chambers being used in perspective aerospace propulsion systems” (No. 075-15-2021-1385). We would like to express our gratitude to the Center for Collective Use of the Joint Supercomputer Center of the Russian Academy of Sciences for the provided computing resources.