World Conference on Mechanical Engineering

Berlin, Germany 09-11 Dec 2022

Numerical Study of Nozzle Flow for a Rocket Engine Operating with Liquid Oxygen/Methane Propellants

Abderrahmane Zidane, Feriel Hasballaoui and Mohamed Reda Abtouche

Thermal Energy Department, University of Science and Technology Houari Boumediene, Algeria

Abstract

The present work is an investigation of the reacting nozzle flow for a rocket engine using liquid oxygen and methane as propellants. The RL10A-3-3A rocket engine is selected as the baseline of this study, due to the availability of its nozzle profile. The simulations in this study were carried out using the commercial CFD software ANSYS Fluent. The first case is the simulation of the actual rocket engine nozzle flow with hydrogen. For this case, the reduced Evans and Schexnayder reaction model, with 6 species and 8 reactions, is used. Keeping the same chamber pressure, methane is then used as fuel instead of hydrogen for the second case. The third case is for a much higher chamber pressure using methane. A reduced model of the reaction mechanism for oxygen/methane combustion, with 8 species and reactions, is employed. A comparison of the obtained results for the three cases shows that the expansion of the hot gases produced in the combustion chamber through the nozzle is much more important for the hydrogen case compared to the methane case. Nonetheless, a much higher chamber pressure improves the hot gases expansion of the methane case. Finally, results show that liquid methane can be a viable replacement for hydrogen as a reusable rocket propellant.

Keywords: Reacting flow, Numerical Simulation, RL10A rocket engine.