

IAF SPACE PROPULSION SYMPOSIUM (C4)
Hypersonic Air-breathing and Combined Cycle Propulsion, and Hypersonic Vehicle (7)

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DESIGN, COMBUSTION SIMULATION AND NUMERICAL ANALYSIS OF THE ROTATING
DETONATION ENGINE

Abstract

Over recent years, a transition has occurred in the research of Rotating Detonation Engine (RDE) as it has the potential to revolutionize the aerospace propulsion system. The study for the paper was done keeping in mind the likelihood of replacement of the conventional propulsion system with that of more efficient and lightweight rotating detonation system in future.

Computational Fluid Dynamic - Supersonic Combustion Simulation and numerical analysis on the rotating detonation engine is described in the paper using Hydrogen-air as the propellant. A detailed study was performed and the designing was done, starting with main parameters - engine and the pre-detonator (attached tangentially to the chamber), a system of injecting fuel and oxidizer and an annular combustor was required too for the proper functioning of the engine and the analysis to be carried out. The design was validated using Computational Fluid Dynamics (CFD) and Finite Element Analysis.

For the execution of combustion simulation a detailing of the chemistry, unstructured meshing and Adaptive Mesh Refinement (AMR) were used advantageously. Prediction of the height of detonation waves and frequency in RDE was done using CFD software. The simulation showed that the ignited flame travelled up the pre-detonation tube and later transitioned into detonation. It then entered annulus to initiate a rotating detonation wave. An axial thrust is produced as injected propellant gets detonated by a detonative wave. Since no purging is required between detonations, hence it can prove to be more efficient than Pulse Detonation Engine.