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

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NOVEL PULSE DETONATION ENGINE DESIGN FOR OPTIMIZED PERFORMANCE AND ENERGY REGENERATION.

Abstract

A pulse detonation jet engine [PDE] is a concept currently in active development to create a jet engine that operates on the supersonic detonation of fuel. It is a type of propulsion system that uses a detonation wave to combust the fuel and oxidizer mixture. The combustion process in the pulse detonation engine is one of the most important phenomena as it produces reliable and repeatable detonation waves. PDE utilizes a repetitive detonation wave to produce propulsion thrust. One of the major setback of the PDE is its immense fuel consumption and insufficient power output hence proving to be inefficient, PDE also releases high heat energy and vibrational energy which cause loss of energy, thus a novel design for the engine is considered which will not only increase the efficiency of the engine but also recover and utilize the dissipated energy for various aircraft functioning. This engine architecture designed and modelled with the following configuration features. The PDE is attached to a control tube whose frequency resonates with the frequency of the PDE. To procure power output over one complete set the system utilizes another PDE with a phase reversal of 180. The overall system will generate a continuous compression and rarefaction, the frequency of which will match the detonation frequency of the engine. The engine architecture was developed, followed by parametric analysis and design for a subscale prototype, followed by mechanical design and iterative optimization by thermostructural, combustion and flow simulations to obtain a final design effectively recovering engine vibrations via load paths, combined operation providing efficiency higher than conventional PDE efficiencies by order of comparable magnitudes. Additionally, the structure was further optimized to reduce material to reduce overall mass without compromising structural stability of the engine. The integrated combustion chamber design is a key subsystem designed and validated for performance. Piezoelectric devices are incorporated to recover the vibrational energy then transduced to electrical energy to power low power electrical and electronic components of the aerospace vehicle, designed for airflight assisted launch techniques. Using this novel design, the overall efficiency in terms of technological and operational performance and economic value of the PDE technology is escalated significantly and will be a well-suited engine for long-range missiles as well, to augment this already research intensive fraction of the aeronautics domain to one step ahead towards maximum efficiency and performance.