Microturbine Jet Engine Afterburner Noise Reduction

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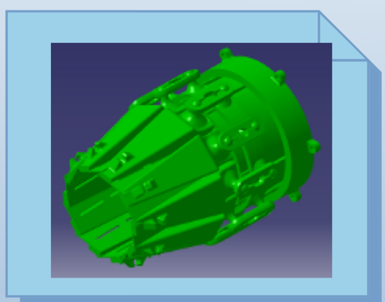
Abstract

This project will focus on the reduction of noise and wall heat transfer of afterburners. For this project, the JetCat P300-PRO micro jet turbine was chosen due to its low cost and professional performance characteristics. Noise reduction was chosen as the primary research focus because noise levels of aircrafts, especially during takeoff with afterburners, is a serious problem [1]. The secondary focus of heat flow was chosen due to the limiting factor of lifetime for afterburners is heat. Reducing the heat signature is also a valuable topic, especially for military jet aircraft [2]. Once designs for an afterburner have been chosen, the JetCat P300-PRO will be purchased, and the afterburner sent for manufacturing.



Results

The data retrieved from the engine will help modify the design and provide empirical proof of the success on noise reduction and improved heat flow of the afterburner to reduce the heat signature. The variable nozzle and alternative fuels provide greater parameter space to extend any improvements along the way.

Introduction

Afterburners have been a subject of constant research and innovation in the aerospace industry. By aiming to improve the quality of the afterburner in terms of heat flow, cooling, and noise reduction, we hope to provide insight into creating approaches to outstanding issues such as takeoff noise production for aircraft. The increase of even 10 db of noise is a large increase in perceived noise and leads to lasting damaging effects. Focusing on heat flow could allow for significantly longer lifespans of engines, especially when regular use of the afterburner is employed, such as the constant training takeoff performed on aircraft carriers. Potential for reduced heat signatures is also a promising area of interest when looking at heat flow.

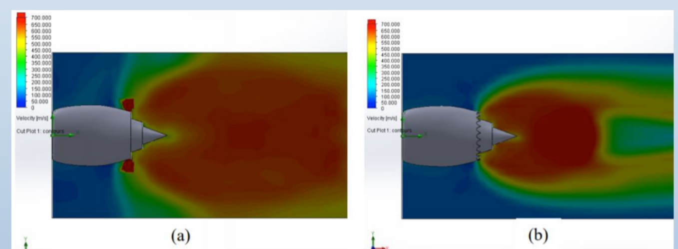


Figure 4. Velocity plot during take-off (m/s) (a) Round nozzle (b) Chevron nozzle.

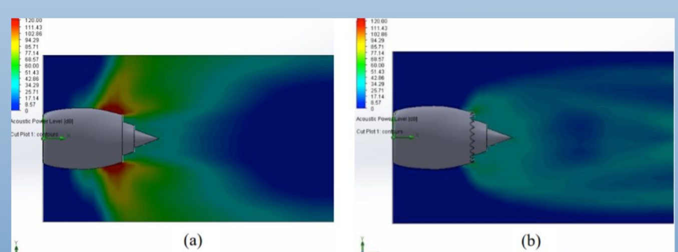


Figure 5. Acoustic power level plot during take-off (dB) (a) Round nozzle (b) Chevron nozzle

Materials & Methods:

The project will first design an afterburner to fit the JetCat P300-PRO. The design will be verified through mathematical models and CFD simulation before being sent for manufacturing. Physical testing and verification of the attached afterburner will allow for new low bypass regions to be designed to slightly alter properties such as pressure, density, and mixing of the low bypass region into the main jet stream to understand how these variables play into both noise reduction and cooling of the afterburner region.

Water will be pumped through coils of tubing around the exterior of the afterburner to promote heat transfer away from the system and cool the walls. This will be an open system with inflow from the JetCat nozzle and outflow exhausted into the environment. The heated water will be exhausted as well, forming fluidic chevrons that surround the gaseous exhaust and reduce noise. A variable nozzle will be added at the outlet of the afterburner to maximize thrust. Solid chevrons can be manufactured here as well to augment the reduction of noise.

Once greater understanding is achieved, optimization of the low bypass region will take place to maximize noise reduction while keeping acceptable temperatures for a long lifetime of the turbine and afterburner. The JetCat engine and afterburner will be controlled with the RaspberryPi. The Raspberry Pi will also be integrated in a way to gather critical data from the afterburner engine combination to maximize the design parameters for optimal results. The jet engine and afterburner will be tested in the test cell that is currently being used by Experimental Jet Engine Propulsion on campus by mounting the afterburner on the engine and going through static thrust stand testing. Different fuels can be tested aside from kerosene to test performance.

Reference

[1] Naval Research Advisory Committee, "Jet Engine Noise Reduction." 2009
[2] Guamieril, Jason and Cizmas, Paul, "A Method for Reducing Jet Engine Thermal Signature." International Journal of Turbo and Jet Engines. March 2008. DOI: 10.1515/TJJ.2008.25.1.1