Paper ID: 101766
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IAF MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Interactive Presentations - IAF MATERIALS AND STRUCTURES SYMPOSIUM (IP)

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DESIGN, SIMULATION, AND TESTING OF A SUPERSONIC WIND TUNNEL FOR AERODYNAMIC CHARACTERIZATION

Abstract

The study of supersonic aerodynamics is essential for the development of high-speed aerospace vehicles. This research focuses on the complete process of designing, modeling, simulating, constructing, instrumenting, and testing a supersonic wind tunnel to analyze aerodynamic properties under controlled conditions. The tunnel is designed to achieve stable supersonic flows, allowing the study of shock waves, boundary layer interactions, and thermal effects on test models.

A key aspect of this study is the evaluation of different air intake systems, including vacuum fan-based intakes, to optimize airflow and pressure regulation. Computational Fluid Dynamics (CFD) simulations are employed to validate the theoretical design and optimize the tunnel's geometry. The structure is equipped with pressure, temperature, and velocity sensors for real-time data acquisition, ensuring precise characterization of aerodynamic behavior.

This research aims to provide an innovative approach to supersonic wind tunnel design using alternative intake mechanisms, contributing to more cost-effective and accessible testing facilities. The results will be valuable for the aerospace industry, particularly in the validation of spacecraft, airfoils, and propulsion components in supersonic conditions.

Keywords: supersonic wind tunnel, aerodynamic testing, space structures, computational fluid dynamics, aerospace engineering.