

DESIGN AND OPERATION OF AN OPEN JET WIND TUNNEL AT PURDUE UNIVERSITY

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ABSTRACT

This paper presents the design methodology and operation of a new open jet blow down wind tunnel that was commissioned at Purdue University. The first section discusses the design and integration of the open jet module with the existing Wind Tunnel (PT-1) at the Purdue Experimental Turbine Aerothermal Laboratory (PETAL). The exit diameter was sized to be 80 mm, with the primary objective of calibrating multiple aerodynamic probes and thermocouples with low turbulence dry air up to transonic conditions for blowdown periods above 30 minutes depending on the Mach and Reynolds numbers. The aerodynamic performance of the open jet was examined in detail after its fabrication. The size of the potential core was measured at three different axial positions downstream the exit plane at low and transonic speeds and characterized by a turbulence level of about 0.3%. Additionally, a five-hole probe rake was calibrated at yaw and pitch angle increments of 4 degrees ranging between -24 degrees to 24 degrees at five different Mach numbers between 0.25 and 1.00; similarly, the sensitivity of a Kiel probe rake to incidence was also investigated. Experiments can be carried out at a pressure of up to 5.5 bar and temperatures of up to 400 K. This allows to operate the jet in under-expanded mode and the characteristics of the jet in this regime were studied using a Schlieren optical setup at different pressure ratios.

INTRODUCTION

The calibration of aerodynamic probes at exact Mach number conditions is a critical aspect in obtaining accurate measurements during test campaigns such as transonic cascade testing. At transonic conditions, calibrating probes in a linear closed wind tunnel can be challenging or unfeasible due to the blockage effect induced by the probe and probe holder and a very large or perforated wind tunnel and miniature probes are required [1]. Thus, an open jet wind tunnel is customary implemented for calibrations at transonic conditions.

RESULTS AND DISCUSSION

The potential core size was investigated using a Kiel Probe Rake at three different axial positions (50mm, 200mm, 400mm) downstream the jet exit plane. Figure 1 shows contour plots and line plots taken at Mach = 1.00 of the pressure measurements non dimensionalized by a reference total pressure probe in the settling chamber.

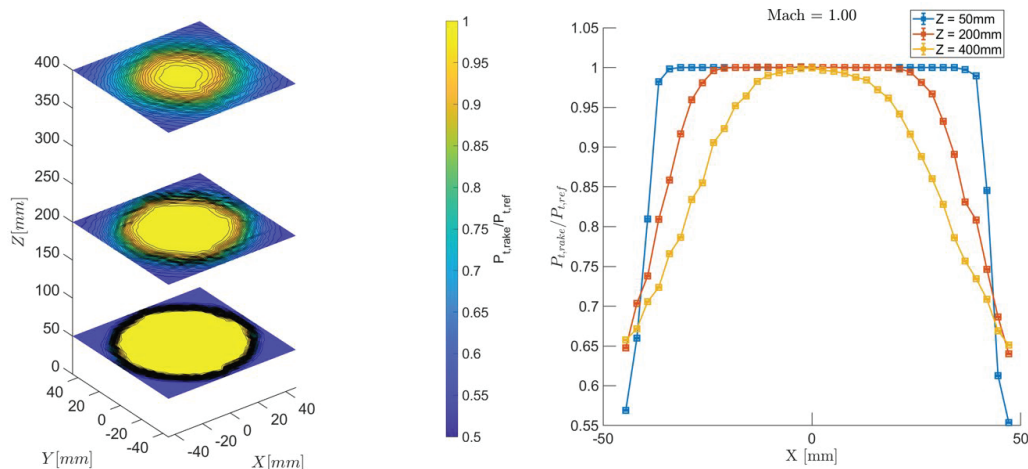


Figure 1. Potential Core Size Analysis at three different axial positions at Mach = 1.00

REFERENCES

- [1] C. Sieverding, "Design and calibration of four probes for use in the transonic turbine cascade testing," in *MTT037A11*, 1974.