PROBE INTERFERENCE EFFECTS IN A TRANSONIC WIND TUNNEL

Mehmet Kaya, Turkey
Supervisors: Prof. G. Paniagua & L. Villafãne

The evolution towards high thrust/weight ratio designs require the development of advanced cooling and lubricating systems. Thus, thermal management of the lubrication is vital for a continued successful operation. In order to dissipate high thermal loads, heat exchangers must be incorporated into the engines. VKI is involved in the research development of an air cooled oil cooling (ACOC) surface heat exchanger. The ACOC heat exchanger will be located within the inner shroud of the by-pass flow duct of the turbofan engine, close to the separator nose. A test model is developed where the real flow conditions of the engine are duplicated. An aerodynamic investigation is being performed in this test model to study the interaction of the flow with the heat exchanger. In the test section, the flow is governed by transonic conditions.

Within the content of this research activity, the disturbance that the 5 hole probe rake create on the test section is analyzed. The geometric blockage introduced by the probe is about 1.5%. The effects of the 5 hole probe is investigated in the most critical measurement plane.

In order to model the external flow over the probe, capabilities of OpenFoam and Numeca software are investigated. OpenFoam is found to be inadequate for the implementation of steady-state, transonic problems. In order to meet the objectives of the project, Numeca/Fine software is used, which is known to be working properly for this particular problem. Simplifications on the real five hole probe rake is performed to be able to create a structured mesh over the probe. Based on that, the 5 hole rake inserted test section geometry has been meshed with approximately 32 million cells. The flow is driven by a pressure difference between inlet and outlet sections. Turbulence is modeled with one equation model Spalart-Allmaras. Steady state calculations have been performed for the cases, without any instrumentation at the test section and with the 5 hole probe rake inserted test section geometry.

Based on this study, it is observed that five hole probe has a notable influence both on the local and global flow field. The blockage introduced by the probe is resulting in a reduced mass flow rate in the channel. This study allows to adjust P_{tot} and T_{tot} measurements. The highest deficit of total pressure and total temperature is observed for the lower probe head.

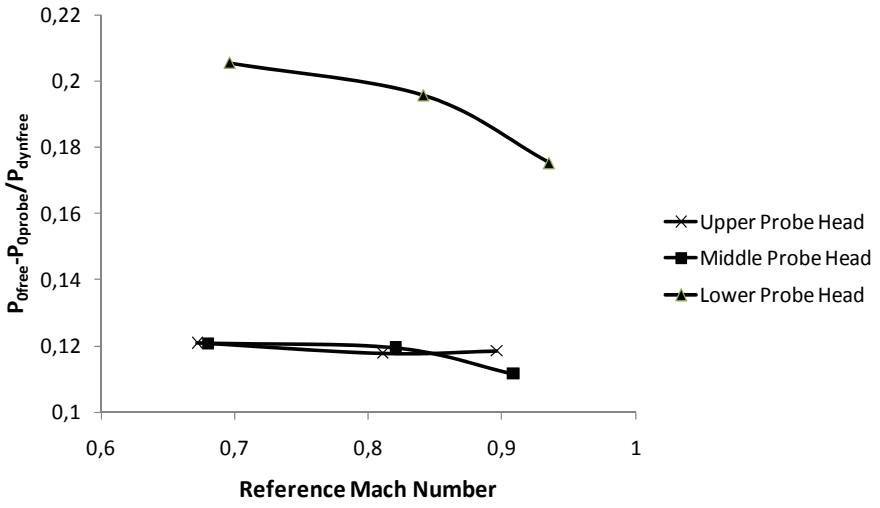

Figure 1: Total pressure deficit as a function of Mach number