

Abstract

Airborne turbocharger noise is becoming a topic of major concern for automotive manufacturers. Particularly, a broadband noise named as *whoosh* is detected during some engine conditions (full load, tip-in and tip-out maneuvers). This thesis aims to contribute to the understanding of turbocharger compressor flow-induced acoustics by means of 3-dimensional CFD.

A methodology to compare CFD and experimental spectra is developed so as to solve the issue of the different location of pressure probes. Pressure decomposition and different types of monitors are required by the model in order to provide meaningful spectra. A tip clearance sensitivity analysis is performed, concluding that tip clearance has an impact on compressor global variables but not on noise generation. CAD tip clearance profile is therefore safely used throughout the thesis. Most important set-up parameters such as grid spacing, solver type or time-step size are evaluated. The model is defined so that noise prediction accuracy is guaranteed in the whole hearing range. In any case, the time-step increment sensitivity analysis reflects that a significant save in computational effort could be made but retaining the right prediction of main spectra features.

Finally, three operating conditions are studied at same compressor speed; from best efficiency point to a working point close to surge. All the points present backflows (flow moving from the passage outlet towards the inlet) near the shroud, although their thickness increase when reducing the mass flow. This recirculation zone increase the meridional velocity and improve incidence angle, thus extending the stability margin. Noise emission also is more intense as flow is reduced, particularly at low frequency range. At best efficiency point, a periodic flow separation is observed on the blades suction side. Stalled cells are transported towards the exducer producing a pulsating jet-wake structure that may increase the broadband noise slightly below the main blade passing frequency.

In the two points with less mass flow, inducer and diffuser rotating stall can be noticed, causing the so-called whoosh noise. Actually, the point closest to surge presents an increase in the low frequency content found which masks whoosh noise. In this working point, a tornado-like structure is identified in the mixing region between the incoming and recirculating flows, increasing secondary flows and causing large pressure oscillations at the inducer. It is

considered that this phenomenon is responsible for the low frequency noise content rise.