A WIND TUNNEL TO ASSESS THE PERFORMANCE OF INERTIAL PARTICLE SEPARATORS FOR TURBO-PROP AND TURBO-SHAFT ENGINES

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ABSTRACT

Inertial Particle Separators (IPS) are used in the inlet of turbo-prop and turbo-shaft engines to remove a significant fraction of the particulate which would otherwise be ingested. Engine manufacturers need accurate experimental data of both local and global IPS performance to validate their designs. The development of a new facility currently in construction at the von Karman Institute (VKI) to assess the performance of Inertial Particle Separators (IPS) is here presented. The facility provides the unique capability of assessing both the aerodynamic performance of the IPS and the sand/dust separation efficiency, by using two separate channels in which filters are installed. Once put into operation, the facility will provide a unique tool to evaluate the goodness of IPS systems for gas turbine engines and powerplants.

INTRODUCTION

Inertial Particle Separators (IPS) are utilized in the inlet of turbo-prop and turbo-shaft propulsors, due to their lower weight and pressure losses compared to other engine-protection systems. The design of these components represents a compromise between several requirements, targeting in particular for: low pressure-losses, reduced space claim, and high-separation efficiency. An effective IPS design requires a good comprehension of the complex particle-laden phenomena occurring within these components, as well as experimental databases for model validation. With regard to these needs, however, there is a lack of experimental data in the freely-available literature (Jiang, 2012), particularly because most of the previous tests have been performed for component qualification, rather than to perform accurate measurements for model validation. Focusing this latter need, at VKI a new blow-down facility has been developed and is currently in construction to assess IPS performance. The design of this facility is presented in this paper: the test-bench has the peculiarity of allowing both three-dimensional component testing in terms of separation efficiency (i.e., the mass fraction of particles flowing in the scavenge/bypass channel with respect to the total mass at the inlet), as well as permitting local measurements of the paths of air and particles by using Particle Image Velocimetry (PIV) and Particle Tracking Velocimetry (PTV). Two separate filters are installed to collect the particles flowing towards the scavenge and main channel, respectively, and granulometry analyses are foreseen to assess the size distributions.

The design of this facility was based on different technical backgrounds, ranging from aero-engine testing to pneumatic conveying. The requirements for the particle injection system also involved a customized design with a counter-current jet to enhance the particle mixture. The facility assembly is currently occurring and, once in operation, it will provide a unique tool to enlarge the knowledge on IPS operation and design, thus providing a source of efficiency gain for the engines on which these components are installed.

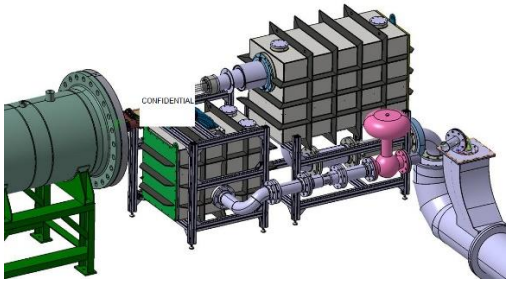

Figure 1. The wind tunnel for IPS performance assessment, with the two separate channels.

References

Jiang, L. Y. (2012). Assessment of scavenge efficiency for a helicopter particle separation system. *Journal of the American Helicopter Society* , 41-48.