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Title
UAV icing testing facility for H24 services

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Abstract
In the recent years, the field of unmanned aircraft vehicles (UAVs) has shown great technological progresses and many new applications have born. To assess the potential of this technology and to improve the availability and reliability of the rising services it is critical to overcome operational limitations. One key operational hazard is atmospheric in-flight icing, resulting in large aerodynamic penalties, unbalances and other detrimental phenomena that sometimes can lead to catastrophic consequences.

In this paper, a new ice tunnel developed in the large hypobaric and climatic chamber of the terraXcube facility of Eurac will be presented. The chamber has already been used for testing UAVs performances in extremely different climatic conditions: low pressure (up to the equivalent 9000 m), freezing conditions (down to -40°C) to experimentally evaluate the capability of such emerging technology to operate in flight conditions that are out the standard flight envelope [1]. The terraXcube facility has been improved to extent the experimental capability and provide further reliable experimental data to better understand how to model these challenging flight conditions for whom there is currently a lack of data in the open literature.

EASA CS-29 appendix C (certification specification large rotorcraft) has been identified as the reference for the ice accretion tests. Both continuous maximum and intermittent maximum icing conditions have been recreated in the terraXcube controlled and repeatable way.

The ice tunnel has been built inside the large hypobaric climatic chamber (12 m long, 6 m wide, 5 m high) in which it is possible to control temperature, pressure and humidity. Starting from a first simple test set [2] and following subsequent further improvements, a complete system was developed. The developed open loop ice tunnel is about 20 m long with a diameter of 1 m. It is powered by an axial fan (operating range 0 – 30 m s-1) at the inlet followed by a honeycomb, after which the section where the supercooled droplets are produced is placed. The section is composed by a matrix of 24 heated nozzles [3]. Each nozzle can be controlled independently from both the water and the air side, which allows to simulate many different operative conditions. At the end of the tunnel different outlets, at various heights, could be installed depending on UAV and testing purposes. The tunnel allows to do ice accretion tests with a fine control on the subcooled droplet dimensions and liquid water content of the stream.

A shadowgraph-based imaging system [4] has been used for measurement of the median volume diameter MVD and liquid water content LWC.

A specific procedure was developed to ensure standardized approach while testing UAV with this system. This paper will present results from the calibration and first test performed in this facility. Some of the methods proposed in SAE ARP 5905 were used for a first calibration of the system. Then, many other conditions were tested to evaluate the entire system inside and outside of the icing envelope, as required by EASA rules.

References

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