Design and Implementation of a Small UAV's Pod Equipped with a Solid Oxide Fuel Cell

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Abstract

Unmanned aerial vehicles (UAVs) have recently received great interest due to their great potential in both military and civil applications [1-4]. Testing and construction of UAVs is expensive and time consuming and a simulation approach can help to reduce cost for both design and tests. In this paper, the authors have used COMSOL Multiphysics software to design a UAV's pod equipped with a Solid Oxide Fuel Cell (SOFCs). The study was developed in the framework of the European project SUAV (Microtubular Solid Oxide Fuel Cell Power System development and integration into a Mini-UAV). The stack, with a maximum power of 200 W, is fed by propane. Thanks to his energy density, propane permits to store more energy than fuel cell fed by hydrogen. The aim of this study was to calculate the temperature distributions inside the pod, having information about the air intakes' size. A simplified experimental test was carried out to validate the simulation. The test's set up consists of a PVC tube where inside the SOFC stack is located, as showed in figure 1.

In front of PVC tube was located a mask with variable surface area (from 5% to 75% open). Experimental tests have permitted to evaluate the influence of outlet size on temperature distribution. The inlet air was controlled through a mass flow rate according to the internal temperature, and a pressure transmitters were used to measure the pressure drop along the tube.

In early study, COMSOL Multiphysics simulation will be validate through experimental data and will be used to evaluate new air intakes configuration (different position and size), as showed in fig.2.

In the following figure, the geometry implemented in COMSOL and preliminary fluid dynamic results are reported. A turbulent approach was used to solve the problem. Early results showed that pressure drop and velocity field are in accordance with experimental tests.

The next steps will be the implementation of model with "heat transfer in fluid" physic to know the distribution of temperature in the domain for a complete model validation.

Reference

[1] Frost&Sullivan, 2007, "Study Analysing the Current Activities in the Field of UAV," European Commission - Enterprise and Industry Directorate-General.

[2] Peng K, Dong M, Chen Ben M, Cai G, Lum KY, Lee TH. Design and implementation of an autonomous flight control law for a UAV helicopter. In: Proceedings of the 26th Chinese control conference, Zhangjiajie, Hunan, China, vol. 6, 2007. p. 662–7.

[3] S. Saripalli, J.F. Montgomery, G.S. Sukhatme Visually-guided landing of an unmanned aerial vehicle IEEE Trans Robot Automat, 19 (2003), pp. 371–381.

[4] Cox, T. H., Nagy, C. J., Skoog, M. A., Somers, I. A., and Warner, R., 2004, "A Report Overview of the Civil UAV Capability Assessment," NASA.

Figures used in the abstract

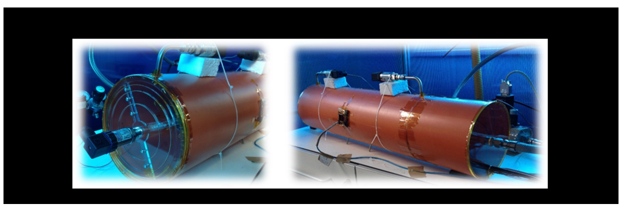

Figure 1: Front and rear view of PVC tube.

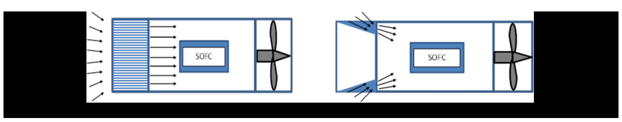

Figure 2: Uniform and localized air inlets.

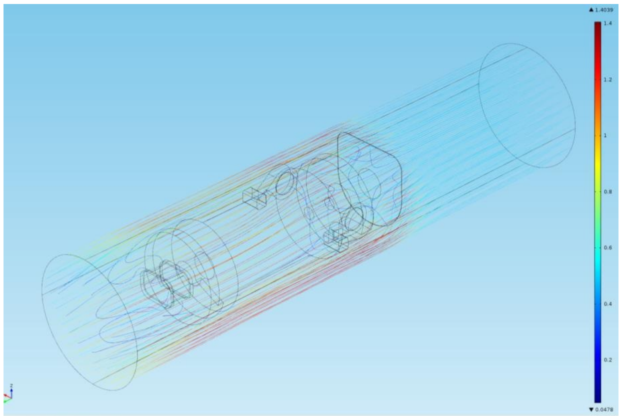

Figure 3: Geometry and preliminary results of study.

Figure 4