An Experimental and Numerical Study to Analyse Mixed Convection Regime in a Fuselage Crown Compartment

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Abstract

The possibility, in the near future, to achieve a right-first-time design approach in the aeronautical industry, relies mostly in the capability to obtain an in depth knowledge of several interactive factors relative to structural, aerodynamic and thermodynamic issues.
The heat transfer in aeroplane compartments (wing boxes, leading edge compartments, fuselage confined compartments) is often modelled considering general hypothesis, i.e. average values of the heat transfer coefficient. Even if this is a valid approach, the introduction of composite materials and their non-homogeneous thermal behaviour, the presence of dissipating elements inside the compartments and the presence of obstructions, can limit the validity of such hypothesis. In this scenario, analyses that are more detailed are needed.
In this paper, the confined compartment located between the cabin roof and the fuselage, defined as crown compartment, is studied. The crown compartment is characterised by a differential temperature boundary condition between the fuselage and the cabin roof. The fuselage, exposed to the solar load can reach temperatures of 105˚C while the cabin roof instead can be kept at the same temperature of 25˚C by the air condition system. The crown is also characterised by the presence of an airflow that enters the compartment along the cabin roof and exits at the side of the crown compartment itself. This flow interacts with the buoyancy driven flow which develops along the hot surface (fuselage) generating flow features characteristic of such configuration as shown in Fig. 1.

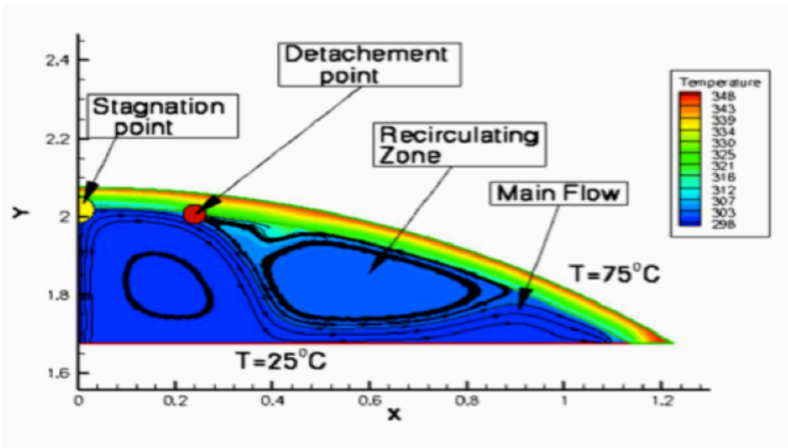

Figure 1:Flow features inside a crown compartment.

Due to a lack of literature for such configuration, both an experimental and a numerical approach have been utilised. The numerical and experimental campaign carried out, will allow to achieve a better insight in the flow-dynamic and heat transfer inside the crown compartment under different boundary conditions, and to generate a benchmark for validating numerical simulations of this configuration. A detailed knowledge of the flow field and heat transfer inside the compartment could also be useful in a future analysis of the displacement, inside the compartment, of thermally sensitive equipment and or obstacles.

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