STUDY OF WATER ENTRAINMENT BY TURBULENT AIR FLOW IN A SIMPLIFIED CAR DASHBOARD COWL

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Preliminary step of a Three years work on the VOF interface tracking method and turbulence coupling, the goals of the DC project is to reproduce accurately the air flow in a cowl-box model. The dedicated facility is shown in figure 1.

To reach the objective, two different approaches are followed. The first one is an experimental approach. It deals with the visualization of the phenomena in an air-water situation and the measurement of the air velocity field in several locations of the cowl box with PIV technique.

The second approach is numerical. Two numerical methods are used. The first one is based on RANS turbulence models in order to determine the general behaviour of the air flow in the model and allow a reduction of the computational domain for the second method based on LES turbulent model. The LES method is planned to be used for interface tracking so we need to reproduce as well as possible the flow field with a reasonable calculation power.

The visualisation of the interaction between the air flow and the water interface in the facility highlights two main phenomena, appearing with different levels of water. At low water level (~1cm), a droplet tearing off phenomenon is visible while with deep water layer (~8cm), some big amplitude waves that overflow the extraction duct of the facility are observed.

Numerically, it is shown that the flow in the facility is highly complex and fully three dimensional. By comparison with PIV data it is noticed that RANS model reproduces satisfactorily the velocity fields but that the description of the turbulence is limited. The good general reproduction of the flow allows using RANS based profiles to reduce the calculation domain of LES simulation.

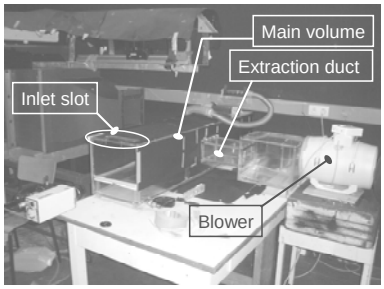

Figure 1: View of the cowl-box setup

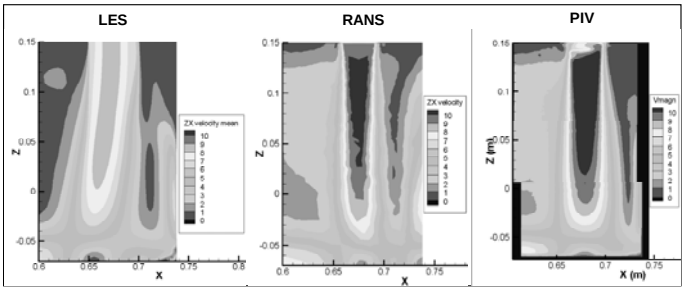

Figure 2: Comparison of PIV and CFD results at one inlet slot

The LES results show a difference between experimental and LES prediction as depicted in figure 2. This discrepancy results from a deficiency in the setting of the boundary conditions mainly caused by a simplification of the numerical domain. The turbulent condition at the inlet for the LES simulation is too low to reproduce properly the downstream part of the flow. However, qualitative analysis of the instantaneous flow field points out the generation of large coherent vortical structures at the bottom wall due to flapping of the impinging jets. The advection of these structures in the cowl-box generates large oscillations of wall shear stress and pressure distributions, which are thought to be actuators of water-air interface deformation and therefore of great importance for further two-phase flow simulations.