NUMERICAL STUDY OF GAS-JET/LIQUID LAYER INTERACTION

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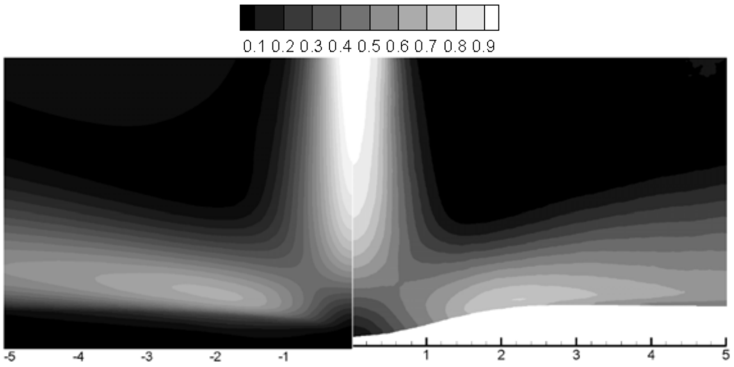
The phenomenon of a gas jet impinging normally onto a deformable liquid surface is present in a wide range of industrial and engineering applications. Understanding of the behaviour of the gas-jet/liquid surface interaction has become a very important issue to be able to control and to optimize those processes. The objective of the present research project is to simulate the fluid dynamics phenomena involved in this interaction and to compare with experimental data obtained in parallel by the Ph.D. student R. Berger. The investigation is performed adopting the CFD approach based on the use of the commercial code Star-CCM+. The VOF (Volume of Fluid) method is applied due to the existence of two different immiscible phases separated by just one interface.

A 2D simplified model of the experimental setup was chosen as the computational domain. The turbulence was modeled by the URANS realizable k-ε approach, performing simulations of 2 physical seconds for two different configurations belonging to the dimpling and splashing modes, respectively.

The numerical results were compared with experimental data from hot wire and PIV measurements for the air phase. In terms of velocity field, the numerical results reproduce the overall pattern accurately whereas for the turbulence intensity sensible differences appear but the tendency is well caught. The way to compute the velocity fluctuations in URANS was discussed, considering the contribution of the unsteadiness of the mean flow to the coherent turbulence creation.

The water deformation because of the impinging jet was compared with LeDaR measurements. The flapping of the jet was perceived and the frequency content was extracted. Cavity oscillations were noticed in streamwise and spanwise directions and its amplitude and frequency were computed. In addition, waves propagation was characterized. Approximate correlations were found between both cavity frequencies and the flapping motion of the jet. Finally, the coherent vortex structures of the air flow were analysed by means of vorticity field and Q and λ_2 criteria, identifying three different regions.



x/d

(a) Numerical results ***(b) PIV measurements***

Figure 1: Dimensionless mean velocity magnitude field, U_m/U_{jet}