SLAG ACCUMULATION IN A STAGNANT AREA

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Solid propellant motors with submerged nozzle have to face, during combustion, the formation of a cavity around the internal part of the nozzle lips. Droplets of liquid alumina, a product of the combustion, are interacting – as shown in Fig. 1– on one hand with the vortices generated by the inhibitors, and on the other hand with the nozzle, creating a liquid puddle in the cavity, called slag.

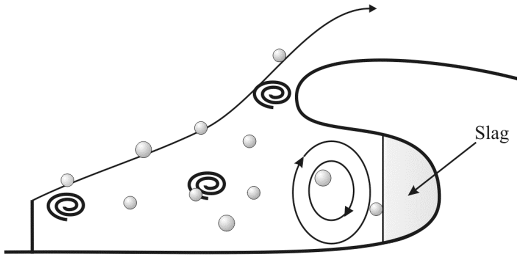

Figure 1 : Physical process of slag accumulation

The objective of the project is to investigate the slag accumulation with cold gases simulations (the gas-phase is modelled by air and the models of the alumina droplets are water droplets) on a simplified model. To achieve this goal, the interaction of the droplets with the vortices of the flow will be studied with PIV and the droplets entrapment process investigated using LeDaR, a new optical measurement technique allowing the detection of liquid free surfaces. It was planned to use this technique to measure the slag surface, and thus the volume of liquid droplets entrapped in the cavity

A new setup has been designed to model a submerged nozzle. The cavity is independent from the vertical wind tunnel, and is supported by a balance. The latter allows one to measure the mass (thus the volume) of liquid in the cavity. It was also used to carry out an (unsuccessful) validation of the LeDaR technique.

A parametric study involving various sizes of obstacles, distances from liquid surface to obstacle, wind velocity, sprays and test-section-to-cavity area ratios, was then carried out with the balance. A typical evolution of the mass flow entering the cavity, as a function of the non-dimensional ratio between the distance from the nozzle tip to the inhibitor and the size of the latter (called O2NR), was highlighted (Fig 2).

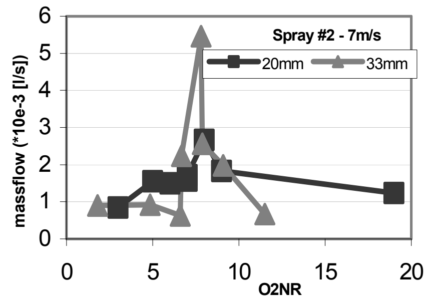

Figure 2: Mass increase in the cavity, function of the O2NR

PIV measurements (Fig 3) were realized and analysed using the wavelet technique both in the surroundings of the nozzle tip, and inside the cavity. In the present configuration, the stagnation point is located at the nozzle tip. In single phase, the vortices mostly escape through the free stream after impinging on the nozzle. A recirculation zone occupies most of the volume of the tank, and perturbs the development of the recirculation zones downstream the inhibitor, especially when the latter is very close to the tank opening. The coherent structures lose most of their energy on the nozzle.

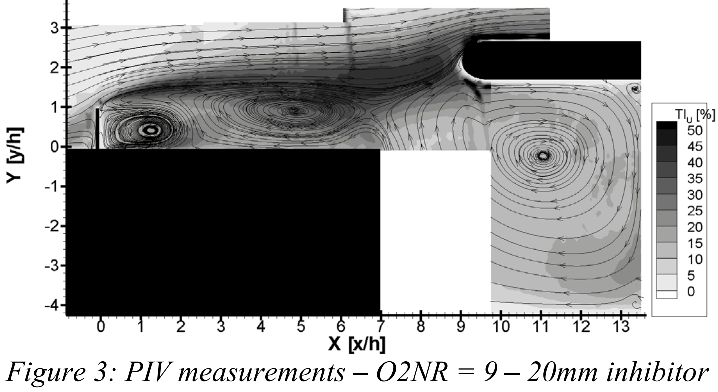

Figure 3: PIV measurements – O2NR = 9 – 20mm inhibitor