Evaporation of droplets of pure and complex fluids trapped in an acoustic field with PIV and rainbow diffractometry techniques

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HIGHLIGHTS

- An evaporation chamber is developed to study the drying of droplets of pure or complex fluids
- A light scattering model allows accounting for droplets non-sphericity
- Rainbow diffractometry allows retrieval of the size and temperature of non-spherical droplets

ABSTRACT

This communication reports on the work in progress to develop an evaporation chamber and optical diagnostics allowing to study the drying of a single droplet that is trapped in an acoustic field. A classical particle image system (PIV) is used to analyze the flow structures (see Fig. 1) generated by the acoustic field around the droplet, while a rainbow diffractometer (RD) allows retrieval of the key parameters of the droplet: size, aspect ratio and refractive index (i.e. composition or temperature). A shadowgraph is also used for comparison purpose.

[Fig. 1 Left: velocity and vorticity fields of the surrounding gas in the plan of symmetry of a 1 mm water droplet (hidden by a PIV mask); Right: light scattering calculations showing the influence of the droplet aspect ratios \( \xi \) on the estimated diameter (Nominal: principal diameter of an elliptical droplet, Recovered: spherical particle assumption).

It is shown that the acoustic trap (from tec5 AG) generates a strong acoustic streaming (vortices) acting as a disruptive effect of the droplet shape, position and evaporation rate. To solve this problem, a new acoustic reflector has been designed. The latter allows generating a dry to wet steam jet preventing the formation of these vortices as well as to better control the parameter of the drying process (flat velocity profile, constant humidity and temperature). The scattering patterns recorded with the RD system exhibits trends that are characteristic of spheroids: elliptical curvature of the primary fringes and the occurrence of a second caustic [1]. By analyzing this inter-caustic region with the newly introduced VCRM [2], it is shown that droplets aspect ratio and temperature can be obtained with a good accuracy. However, a numerical analysis shows that the response of the RD system is highly sensitive to any tilt angle of the droplet principal plane regarding to the conventional scattering plane.