Three-color LIF thermometry applied to the mixing of two non-isothermal sprays

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An experimental study investigates the ability of the laser-induced fluorescence thermometry to measure properly the droplets temperature in the case of the mixing of two different sprays, both having two different droplet size distributions and injection temperatures. The two-color LIF (2cLIF) was tested and successfully validated in the case of combusting and evaporating single droplets [1-2]. The principle consists in inducing the fluorescence of a tracer previously seeded in the liquid of interest. Consequently, the three-color laser-induced fluorescence (3cLIF) was developed, where a third band of detection was introduced which allows calculating a second fluorescence ratio \( R_{12} \). In this work, the 3cLIF is also coupled with phase Doppler anemometry (PDA) in order to derive the droplet temperature per droplet size class [4] in the case of two mixed water sprays (Fig. 1). The water of the first spray is pre-heated whereas the water of the second one is kept at ambient temperature. The hot spray is operated at a flow rate of 20 ml/min and the effect of the flow rate of the cold spray on average local droplet temperature is investigated.

![Fig. 1 Sprays mixing facilities and optical devices for 3cLIF detection](image)

However, from these first measurements, it is difficult to determine if heat transfer occurs between both sprays. To verify it, further experiments have been performed by seeding only one spray by the fluorescent tracer. The results have clearly demonstrated that heat transfer due to hot and cold droplets coalescence remains marginal.

Fig. 2 Evolution of the droplet temperature as a function of the droplet diameter for both spray mixed at ambient temperature, for spray (1) heated, injected alone and for spray (1) heated and mixed with spray (2) at two flow rates: (a) at \( Z = 30 \text{ mm} \) and (b) at \( Z = 60 \text{ mm} \).

![Graphs showing droplet temperature evolution](image)