GLOBAL RAINBOW THERMOMETRY APPLIED TO A FLASHING FREON JET

Maria Grazia De Giorgi, Italy
Supervisors: J.P.A.J. van Beeck & D. Yildiz

Main task of the project is the application of a non intrusive laser technique, the Global Rainbow Thermometry (GRT), to study a flashing freon jet. A further development of this technique is presented. It is based on the detection of the rainbow obtained from the scattered light coming out of the droplets illuminated by a laser beam. Experimental set-up has been improved with the application of a spatial filter, used to select a well-defined spray volume containing an amount of droplets. (FIG.1)

Firstly a study of a water flat fan spray has been performed. For this spray measurements have been carried out for different pressures at different positions along the centerline of the spray. Axial and radial droplet size and temperature profiles are measured and the results were compared with the Phase Doppler Anemometer measurements. The results obtained applying the Global Rainbow Thermometry show similar trends as the characteristic diameters obtained with PDA.

The technique seems to be able to reveal the relative number of non spherical droplets, present in the probe volume, so looking to the scattered intensity distribution a new parameter, called sphericity factor, has been introduced To investigate the influence of the presence of the non spherical droplets in the probe volume, numerical simulations have been performed using the droplet size distribution coming out from the PDA experiments, corrected according to the experimental sphericity factor. Using this simple model, it was showed that the presence of non spherical droplets gives an underestimation of the droplet diameter.

From both simulated and experimental results, droplet size has been found to increase along the radial position towards the spray envelope border. (FIG.2) Then, looking to the influence of the injection pressure, the mean diameter decreases if the injection pressure increases. It is also evident from the droplet-size distribution obtained by using PDA.

Data processing analysis has shown an accuracy of the GRT in term of temperature measurements of ±5 °C.

As another main task, the possibility to apply the technique to a flashing freon jet has been investigated. A first set of measurements was undertaken to assess the visibility of the rainbow on the screen. This initial difficulty was because in literature there were not data about the geometrical scattering angle.

Spray from Freon 134a was analyzed for drop size and temperature information. Centreline droplet size and temperature of a two phase freon jet have been carried out for two different flow rates.

The droplet axial profile reveals initially the presence of very small droplets, generated in the flashing region (by a shattering mechanism). Then an increasing in the droplets size appears.

For the temperature measurements, in the beginning a rapid increasing in temperature is measured due to air entrainment.

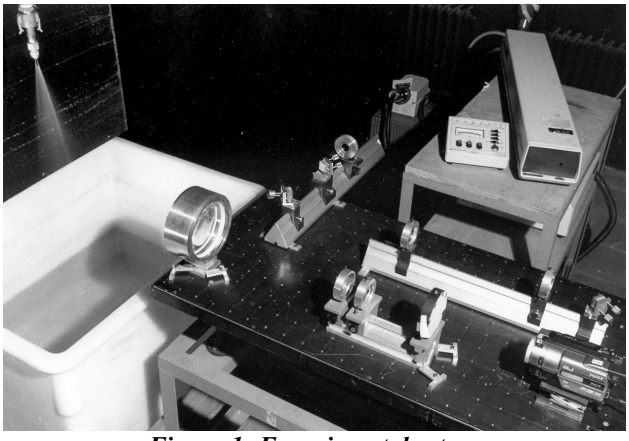

Figure 1: Experimental set-up

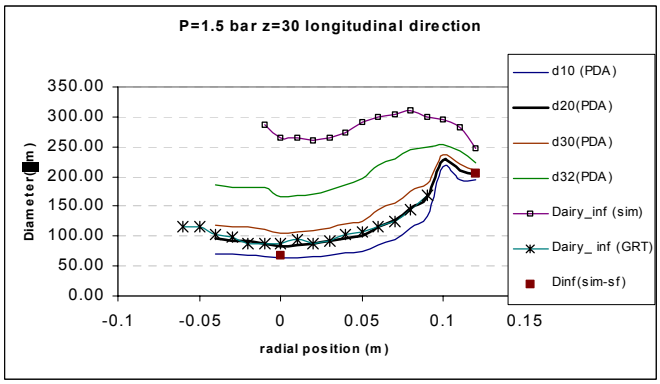

Figure 2: Droplet size profiles for p=1.4 bar and z=30 cm for a water flat fan spray