EXPERIMENTAL INVESTIGATION ON TURBULENCE MODIFICATION BY PARTICLES IN SHEAR LAYER FLOW USING L–6 TWIN–JET WIND TUNNEL

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An experimental investigation on turbulence modification by liquid droplets in a turbulent, plane, free mixing layer flow is presented. Flow visualization, Phase Doppler Anemometry /PDA/, Particle Image Velocimetry /PIV/, Particle Tracking Velocimetry and Sizing /PTVS/ techniques are used to obtain detailed data of the spatial evolution of the laden and unladen turbulent flow field in the plane mixing layer.

Firstly, the project involves a preliminary spray characterization study to obtain parameters as turbulent velocity field and size distribution of the spray, as well as volume ratio. Then the experimental apparatus is designed for the special two–phase flow configuration. The L–6 twin–jet shear layer wind tunnel is upgraded for the present study to be available for the two–phase flow configuration of a vertically downward twin–jet , and it has been supplemented with the spray generation device.

PIV is used to characterize the single gas phase flow field in the mixing layer for three velocity ratios. Four different streamwise positions downstream of the trailing edge of the splitter plate were investigated using Nd:Yag pulsed laser to obtain the mean and turbulent flow field parameters with the help of computational post–processing.

In case of the two–phase flow in the plane mixing layer, PDA is used to characterize the velocity field and size distribution of the liquid droplet phase discharging from an ultrasonic atomization type spray device. Furthermore, PTVS is supplemented with a size–discriminating routine to distinguish between the droplets and seeding particles, and then is applied to the images of droplet–gas two–phase flow to obtain the separate gas phase and liquid phase velocity flow field data.

Detailed photographic documentation of the re–designed experimental facility and flow visualizations in single–phase and two–phase flow using laser sheet technique is provided by the author (see e.g. the photograph below).

The results of droplet–air two–phase flow measurements are comparisons of turbulence modulation for the various configurations of velocity ratio and measurement positions with extracted profiles. The particle behaviour in the mixing layer is analyzed and summarized in the turbulence modulation maps and in graphs plotting the streamwise evolution of the time and length scale ratios for the measured droplet size range (see the proposed graph of $St_p=f(x,d_p)$ below). To determine the role in turbulence modification of the droplets having various Stokes number and size, the probability of droplet presence in the mixing layer is also calculated in function of x streamwise distance, for various St_p and d_p.

It is shown that the streamwise variation of the characteristic time and length scale ratio of the particulate and carrier phase plays a significant role in particle dispersion and in particle–turbulence interaction in the mixing layer.