88c Simultaneous Turbulent Velocity and Concentration Measurements in a Rectangular Reactor

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The study of mixing in canonical turbulent shear flows, such as jets and wakes, is of great importance in both advancing turbulence theory and in the development and validation computational fluid dynamics (CFD) models. In the present work, a combined particle image velocimetry (PIV) and planar laser-induced fluorescence (PLIF) system has been developed to study the turbulent mixing in a liquid-phase rectangular reactor. The passive scalar fluorescent dye Rhodamine 6G was used as the fluorescent dye for the PLIF measurements. A planar jet (at a Reynolds number of 50,000) and a plane wake (at a Reynolds number of 37,500) have been investigated using the combined PIV/PLIF technique. The velocity field and concentration field data were analyzed to yield pointwise statistical quantities, such as mean velocity, Reynolds stresses, turbulent kinetic energy, concentration mean and variance, turbulent fluxes, turbulent viscosity and diffusivity, and turbulent Schmidt number. In addition, characteristics of large-scale turbulent structures were also investigated by measuring spatial correlations of turbulent fluxes and concentration. Using these spatial correlations, conditional averages of velocity and concentration fields were calculated using a linear stochastic estimation technique based on a mixture fraction fluctuation. The experimental results have been used to validate CFD models for turbulent transport and mixing, including traditional RANS k-ε models, transported Lagrangian PDF models, and large-eddy simulations.