NORMALIZATION OF TRAJECTORY AND CENTRELINE CONCENTRATION OF A BUOYANT JET IN A COUNTERFLOW

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Discharge of pollutants into the atmosphere or receiving water bodies is usually in form of a turbulent jet or plume. The dilution of the pollutant is greatly enhanced by the presence of ambient fluid. The characteristic of mixing and dilution are dependent on ambient flow stream in a significant manner (Wood 1993). The object of this paper is a buoyant jet discharging horizontally into an ambient fluid which has opposite direction against the jet discharge. This counterflow situation is found in wastewater outfalls, especially in the design is of a rosette jet group, that is multiple jets arranged around a central riser (Lee et al. 2000).

We investigated the trajectory and spreading of a buoyant jet into a counter-flowing ambient flow stream in the laboratory with the laser-induced fluorescence (LIF) technique. The jet behaviors are found to depend on two flow parameters. The densimetric Froude number Fr represents the relative importance of buoyancy and momentum. The jet-to-current velocity ratio R compares the initial jet exit velocity to the speed of the counterflow. Experiments are carried out at a number of flow cases at Froude number with values between 2.5 and 11 and velocity ratio between 2.5 and 18. The relative counterflow situation was produced by towing the jet nozzle with a calibrated motor in the same direction as the jet exit. Time-averaged patterns of the jet are revealed by the mean LIF concentration field of jet effluent. The trajectory of the jet and the increase in jet width are investigated by digital image processing of the mean LIF images. The detail experimental data have been reported previously. In this paper, the result of normalization of the trajectory and centerline concentration is reported.

The trajectory data are also normalized by length scale and compared with equations obtained from dimensional analysis. The trajectory data after penetration point eventually changes to BDFF. Fig.1 shows the normalization of trajectory by length scales after penetration point. As x direction is in opposite direction of the initial jet exit after penetration point, the x coordinate of trajectory is then subtracted by x_p. The x direction is divided by counterflow momentum length scale $l_{M_e U_0}$ and y direction is divided by counterflow buoyancy length scale l_{BU_0}. An asymptote in BDFF is drawn. The data is quite close to the equation prediction.

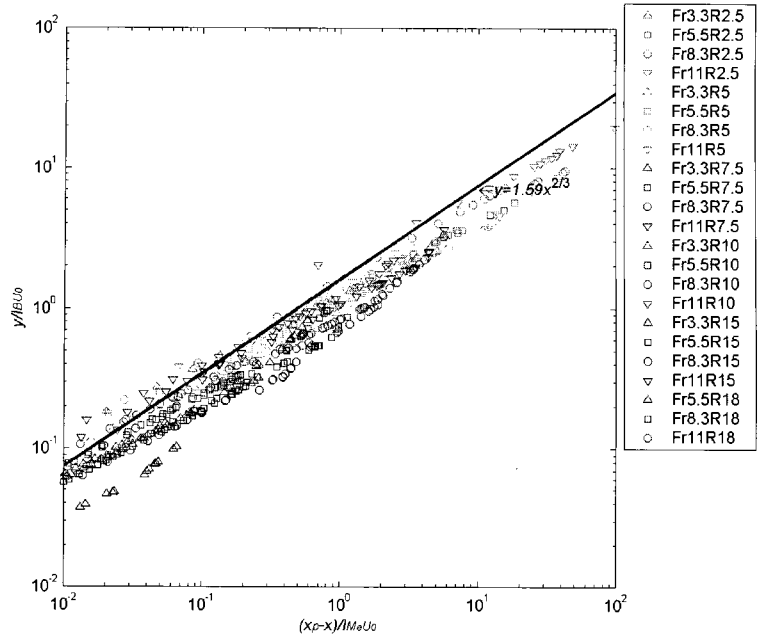

Fig. 1 Normalization of the trajectory by length scales after the penetration point

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