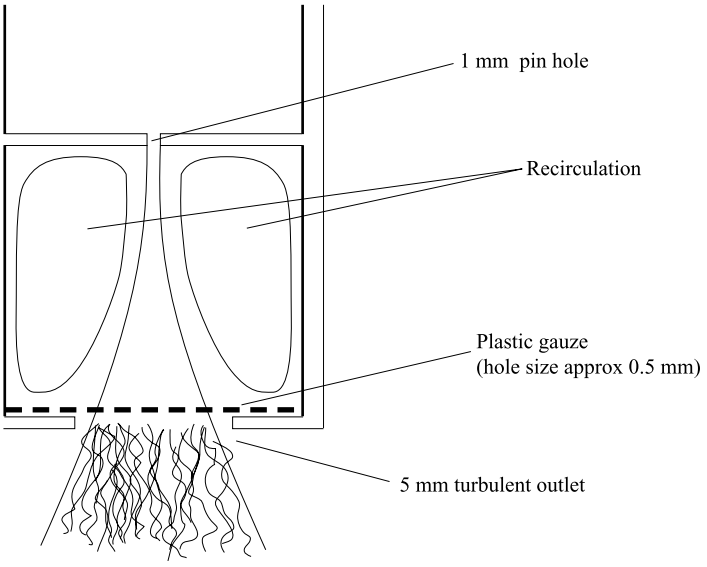

FIGURE 10. Schematic diagram of the Cooper plume nozzle used to produce a turbulent plume source.

4. Experiments

Sections 2 and 3 describe theoretical predictions for the merging height of co-flowing turbulent plumes, and the behaviour of the resulting plume in the far field. Experiments have been performed to test the validity of these models. The experiments were carried out using salt plumes in water. The density of the salt solution and the flow rate determined the buoyancy flux. These were chosen such that the plumes were close to ideal, i.e. with small initial volume and momentum fluxes. Corrections for the non-ideal nature of the sources were made by calculating the virtual origin z_v using the method described in Hunt & Kaye (2001). These corrections were typically of the order of 1 cm, which is considerably less that the typical coalescence heights measured of 10–30 cm. For the case of unequal plumes, the average of the two virtual origin corrections was used. The difference between the origin corrections for each separate plume was typically less than 0.5 cm, or 10% of the plume separation, making the use of the average correction a reasonable approximation.

Typical flow rates used in the experiments were between 0.5 and 2.5 $\mathrm{cm^3\,s^{-1}}$. The source buoyancy was varied between 30 and 150 $\mathrm{cm\,s^{-2}}$. The equal plume experiments were run using the dye attenuation technique in a glass tank approximately 60 cm square with a depth of 180 cm. The unequal plume experiments were run using a light-induced fluorescence (LIF) technique in a 64 cm square Perspex tank that was filled to a depth of 15–35 cm. In order to maintain a turbulent plume from the source, a special nozzle was constructed.† Figure 10 shows a schematic of the nozzle used. The nozzle allowed the creation of a turbulent outlet that would normally be laminar at the flow rates used. Figure 7 of Hunt & Linden (2001) shows the outflow from this nozzle compared to a standard cylindrical tube. The use of the Cooper nozzle meant that the plumes rapidly developed into their self-similar form. This can be more

† The initial nozzle was designed by Dr Paul Cooper, Department of Mechanical Engineering, University of Wollongong, NSW, Australia.