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FREELY PROPAGATING AND CONFINED BUOYANT FLOWS

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This thesis uses experimental techniques to examine flows commonly occurring in geophysical and industrial contexts in the laboratory.

Laboratory techniques employed include Particle Image Velocimetry (PIV), temperature measurements using thermocouples and light-induced fluorescence visualisation and these are applied to each of the flows of interest to provide reliable turbulent statistics of the stationary flows.

The first part of the work focuses on turbulent buoyant plumes and their key physical properties. Data presented elucidates both mean and turbulent quantities of the plume including how the radius, velocity, volume momentum and buoyancy fluxes evolve with height. These results are compared to the classic plume theory of Morton, Taylor & Turner (1956). Four different experimental cases were considered, each of differing momentum-buoyancy balances.

Attention is paid to the near-source plume development region, which changes according to the Reynolds number of the flow. Analysis of the profiles of mean and fluctuating quantities allows an estimate of the vertical extent of this initial region. Away from this zone, the data is used to investigate the turbulent entrainment coefficient.

Next, the impinging plume is investigated using identical experimental techniques. The evolution of the flow as it is forced outwards by the horizontal boundary is of interest. In this section we investigate the head loss as the flow is forced around the corner, the cross-stream profiles of velocity and buoyancy in the radial outflow and some turbulent statistics. The mean quantities are compared to a bulk model similar to that suggested by Alpert (1975).