7 Buoyant Plumes, Thermals, etc.

7.1 Jets, plumes, forced plumes, thermals, etc. Stable and unstable atmospheres.

7.2 The Boussinesq approximation and the conditions for its applicability.

7.3 Integral equations for a steady, vertical plume or jet in a still ambient fluid. The entrainment approximation. The effect of the ambient atmosphere on thermal plumes and the physical significance of the atmospheric stratifications parameter S.

The "top−hat" model and its relationship to Gaussian distribution parameters. The boundary conditions at x=0. Non−thermal buoyancy (e.g. bubbles in water).

7.4 Example: far−field solution for a non−buoyant jet ($S=0,\ F_o\approx 0,\ Q_o\approx 0,\ J_o>0$). Comparison with experiment.

7.5 Far−field solution for a thermal plume in a neutrally stable atmosphere ($S=0,\ F_o>0,\ Q_o\approx 0, J_o\approx 0$). Comparison with experiment.

7.6 Far−field solution for a thermal plume in a stably stratified atmosphere ($S>0,\ F_o>0,\ Q_o\approx 0,\ J_o\approx 0$). Comparison with Experiment.

7.7 Transient thermals rising in a still atmosphere: integral equations and solutions.

7.8 Plumes in a crosswind.

References

Morton, Taylor, & Turner. *Proc. Roy. Soc. A*, **234** (1956):1−23.

Turner. *Buoyancy Effects in Fluids.* Cambridge: 165−173 & 194−200, 1973.

Chen & Rodi.″A Review of Experimental Data.″ *Vertical Turbulent Buoyant Jets.* Pergamon Press, 1980.

Fay, "Buoyant Plumes and Wakes." *Ann. Rev. Fluid Mech.* Vol. 5. 1973

List. "Turbulent Jets and Plumes." *Ann. Rev. Fluid Mech.* Vol.14. 1982.

Rodi. *Turbulent Buoyant Jets & Plumes.* Pergamon Press, 1982.