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# CLASSIFYING STEADY FLOWS IN EMPTYING-FILLING BOXES

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The steady state flows possible within an enclosure ventilated through both high level and low level vents, and supplied with buoyancy from a maintained, point source located at floor level are examined. Previous, guiding research by Linden et al. (1990, Journal of Fluid Mechanics, Vol 212, pp 309-335) concluded that a stable two layer stratification exhibiting zero mixing is established within the enclosure at the steady state. However, an extensive programme of small-scale laboratory experiments conducted using fresh water and brine solutions shows that 3 distinct steady state flow patterns are possible. These flow patterns can depart significantly from that described by Linden et al., exhibiting varying degrees of interfacial mixing and in some cases even supporting an exchange flow through the high level vent previously dedicated solely to outgoing fluid.

A major contribution of this work is the classification of the steady state flows based on the degree of mixing at the interface and the direction of flow through the high level vent. The classification presents the transition between flow patterns in terms of two Froude numbers; the first Froude number based on conditions at the interface due to the low level vent and the second Froude number based on conditions at the high level vent.

Finally, the implications of this work to the natural ventilation of buildings are discussed. The type of flow established at the steady state greatly influences the comfort of occupants and so the emphasis is on achieving the optimum flow type.