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Self-similarity of Boussinesq Miscible Thermals: an Experimental Study BING ZHAO, NTU, ADRIAN LAI, SMART, ADRIAN LAW, NTU, ERIC ADAMS, MIT — The gross characteristics of fully-developed round miscible thermals have been well studied and reported to be self-similar (e.g. Scorer, 1957). However, there have been very few studies (Bond & Johari, 2005; Hart, 2008) concerning the internal structures of the thermal. Many important questions related to the interior fluid dynamics inside the thermal, including the self-similarity of the internal velocity and scalar distributions, remain outstanding. In the present study, detailed PIV and PLIF measurements were conducted in the axisymmetric plane (i.e. side view) of a negatively buoyant Boussinesq thermal to reveal the detailed internal structures, with CCD cameras that synchronized with a unique release mechanism that minimized the initial variations. Synchronized simultaneous flow visualization (with spotlights and a video camera) were also made to monitor the developmental shape of the thermal through a bottom view. The simultaneous information enabled an objective assessment of the experimental quality. The results showed that the maximum radius of the miscible thermal grows linearly with travel distance, which agrees with previous studies using dimensional analysis with self-similarity. The radius of the vortex ring is found to be expanding linearly, but surprising at a smaller growth rate that the overall thermal size. This raises a critical question whether the self-similarity with thermals truly exists or not. The results will be presented at the meeting.

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