Mixing of a stratified fluid by a turbulent jet

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Abstract

We study the mixing of a stratified fluid by a turbulent jet, extending the seminal work of Baines [1] and Kumagai [2]. Experiments are performed in a tank filled with a layer of salty water at the bottom and fresh water at the top. A region of imposed height with a linear density profile connects continuously the two layers. A constant downward flow is imposed by a nozzle at the top of the tank causing the formation of a turbulent jet. The evolution of the density profile and of the velocity field is observed by colorimetry and Particle Image Velocimetry, respectively. Our study is motivated by nuclear safety problems: the experimental setup reproduces the emergency procedure adopted in the event of an hydrogen leak in a reactor core, where mixing by turbulent jet of the stratified atmosphere is expected to dilute hydrogen in the ambiant air and to maintain the ratio hydrogen / oxygen below the critical level for explosion.

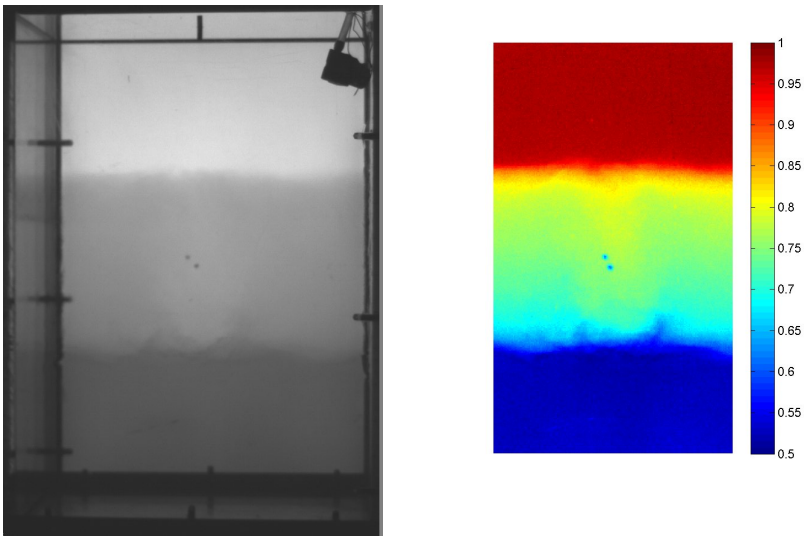

Fig. 1: On the left, an image of the experimental tank taken by the camera, where the salty water is dyed. On the right, a map of the rescaled luminosity for the central portion of the same image, where blue correponds to salty water and red to fresh water.

Experiments show the existence of two different time scales, related to the erosion of the bottom layer and the increasing density of the upper layer, respectively. We performed several experiments, changing the imposed flow rate, the density difference between fresh and salty water, and the height of the intermediate linearly stratified region. We analyze our results in the view of the recent model by Shrinivas and Hunt [3] developped for the limit case of an interfacial density jump.

References

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[3] Shrinivas AB and Hunt GR *J. Fluid Mech.* **757**:573-598, 2014.

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