COMMENTS

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Comments on "Rayleigh–Taylor instability of thin viscous layers"

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In a paper by Craik,[1] frequent references are made to our paper[2] which we believe are incorrect. It may also be pointed out that quite unusual circumstances would be required to provide a physical basis for Craik's analysis; the experiments described in his paper are not appropriately explained by his analysis.

As we state in our paper, our approximate solutions are not valid as $h - 0$. Our results, however, are valid for $kh \approx 1$ which means that our approximations provide reasonably accurate descriptions of situations in which the wavelength is greater than the layer thickness by roughly an order of magnitude. For smaller depths it is likely that molecular diffusion will provide the dominant mechanism for fluid transport as Craik correctly states in his introduction. No consideration of diffusion, however, is included in his computations.

As already remarked, few physical situations would be described by Craik's analysis. His condition that $kh \ll 1$ is sufficient to imply very slow growth of Rayleigh–Taylor type instabilities unless the applied acceleration is truly enormous. It follows when $kh \ll 1$ that sufficient time will be available for diffusion of a surface layer to a deeper "effective depth." Under this circumstance, "effective depth" may be used with good accuracy in our analysis provided a new upper layer density is computed. This is the case for the observations reported by Craik. As he states, diffusion creates a mixed layer with a thickness of approximately 0.1 cm. With this thickness, one finds that $kh > 1$, so that the situation is beyond the validity of his analysis.

We wish to point out that we did not give $kh \approx 1$ as a general result for the "preferred" wavelength for any instability. The preferred wavelength will vary with acceleration, with density difference, with viscosity as well as with upper layer thickness. Finally, we may remark that diffusion is an insignificant effect for the experimental cases we described.

[1] A. D. D. Craik, Phys. Fluids **19**, 479 (1976).
[2] M. S. Plesset and C. G. Whipple, Phys. Fluids **17**, 1 (1974).