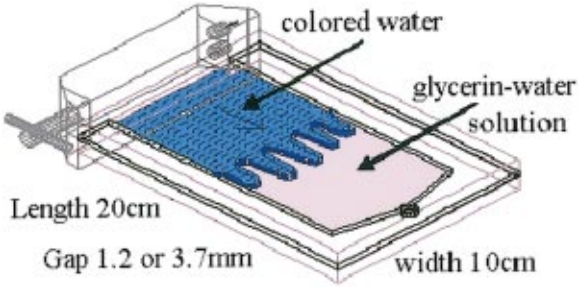

FIG. 1. Hele–Shaw cell and the cavity dimensions.

FIG. 2. Parabolic maneuver of the airbus A300 Zero-G.

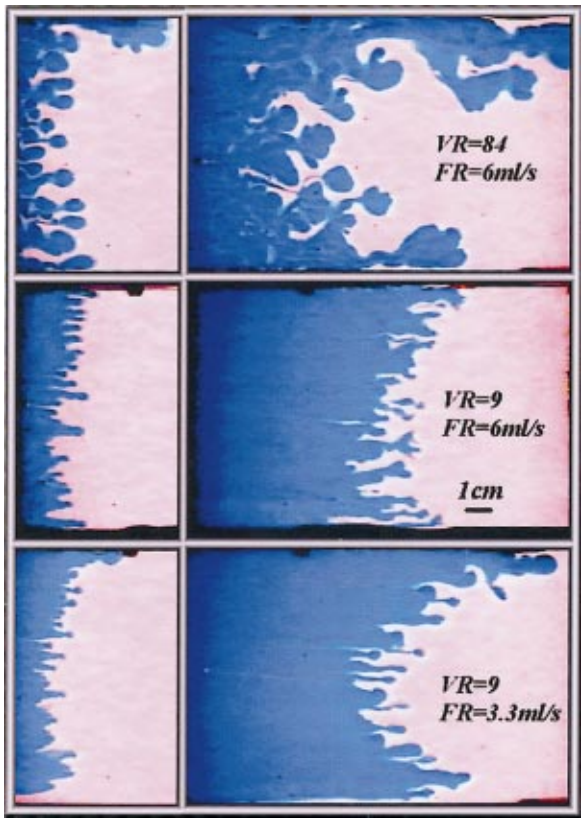

FIG. 3. Fingering in microgravity (water injection). VR–viscosity ratio, FR–flow rate.

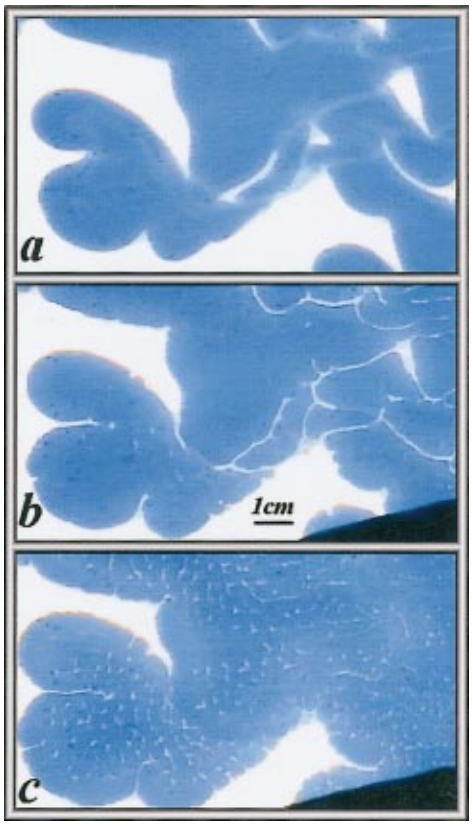

FIG. 4. Interpenetration of layers during gravity change from (a) ±0.01 to (c) +1.8 g. No injection.

Viscous Fingering in Miscible Liquids under Microgravity Conditions

Submitted by
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Viscous fingering was observed by injecting colored water into a Hele–Shaw cell (Fig. 1) preliminarily filled with a glycerin–water solution. We varied the viscosity ratio, the flow rate, the gap width, and the density ratio. The Péclet number was higher than 10^5. Part of the experiments was performed in microgravity conditions (parabolic flights) in order to eliminate the gravity influence on pattern formation. Figure 3 shows peculiarities of fingering in microgravity conditions for a gap width of 1.2 mm. The initial stages are in the left and the developed patterns in the right column.

Behind the front, the liquids formed a three-layer ''sandwich'' with the injected liquid in the middle of the gap. During and after transition from micro- to normal gravity, such a system has a tendency to form a two-layer system. The typical stages are shown in Fig. 4, where the gravity vector was perpendicular to the image plane. Here we have: (a) initial state; (b) formation of first holes and long channels in the thinned regions of the low viscosity layer; and (c) multiple hole formation far from the periphery of the water layer and squeezing of the channels. The time interval between images (a) and (c) in Fig. 4 was 2.5 s, the density ratio of the liquids before mixing was 1.22, the gap width was 3.7 mm. Finally (not shown), the holes also squeezed, the layers uniformly spread over the entire plane of view and gradually mixed within the gap by diffusion.

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