Rayleigh-Taylor instability creates provocative images in painting

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Citation: Physics of Fluids (1994-present) **26**, 091102 (2014); doi: 10.1063/1.4894196
View online: http://dx.doi.org/10.1063/1.4894196
View Table of Contents: http://scitation.aip.org/content/aip/journal/pof2/26/9?ver=pdfcov
Published by the AIP Publishing

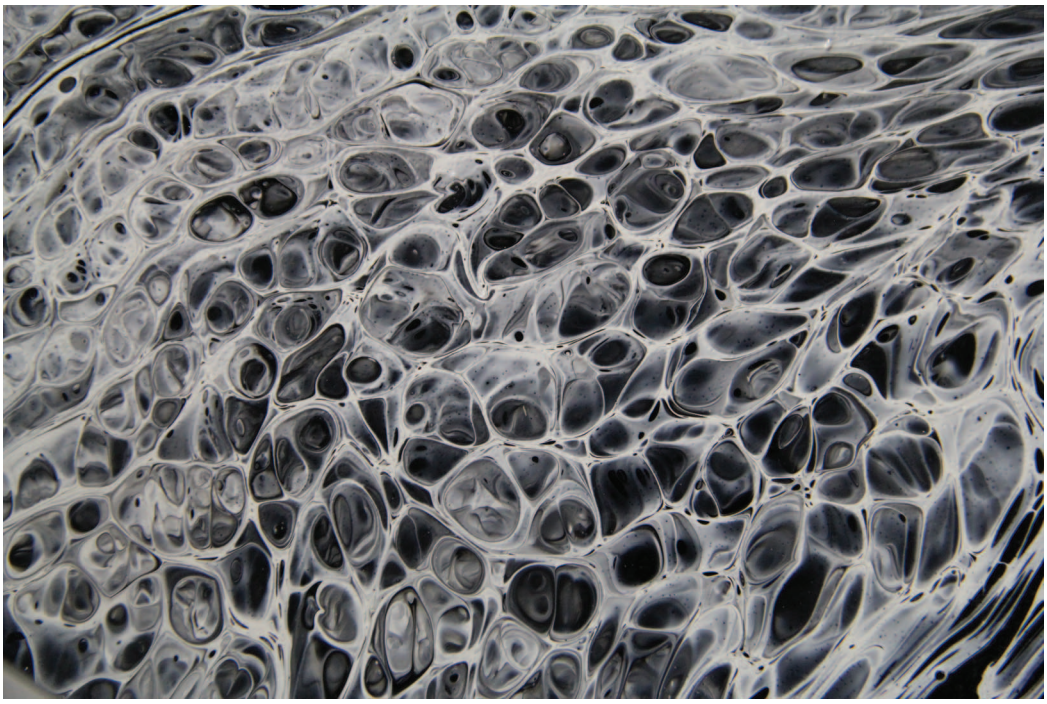

FIG. 1. Pattern created using then "accidental painting" technique developed by Siqueiros in the 1930s. It is the result of a Rayleigh-Taylor instability of a viscous layer. Two layers of paints are poured on top of each other onto a horizontal surface. For the image show here, we used white on top of black paints. Since the white paint is denser than the black one, the layer becomes unstable. Blobs of black emerge from the bottom as the white paint sinks to the base. The image size is approximately 10×6.7 cm^2. For this particular case Reynolds and Atwood numbers are $\mathrm{Re} = 2.1 \times 10^{-6}$ and $\mathrm{At} = 0.05$, respectively. After the instability appears, a matter of minutes, the paint begins to dry, "freezing" the pattern as shown in the image.

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(Received 8 August 2014; published online 19 September 2014)

Artists, in particular painters, have a deep empirical knowledge about the way fluids behave. Through practice, they can manipulate the way in which the paints and dyes are deposited on a substrate to create textures of aesthetic value. Painters can either change the fluid behavior by controlling the rate at which the paint is applied (changing the shear rate) or by changing the fluid physical properties by using thinning solvents (changing the viscosity.)

We have found that hydrodynamic instabilities can also be used to create interesting patterns. In particular, we have studied in detail some paintings by David Alfaro Siqueiros,[1] who is a well-known

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Mexican muralist. He invented a technique called "accidental painting" during an experimental painting workshop in New York in 1936.[2] The technique consists of pouring two, or more, layers of paint of different color on top of each another on a horizontal surface. When the correct color combination is used a spotted pattern emerges on the surface of top layer. Siquieros said that the painting technique produced "the most magical fantasies and forms that the human mind can imagine."

To understand the physics of this painting technique, we reproduced the original Siquieros' experiments in a controlled manner.[3] Figure 1 shows a typical example of the patterns created with this technique. For the image shown in the figure, we used white paint on top of a black paint layer. Since the density of the white liquid is higher than that of the black one (by about 5%), the viscous layer becomes unstable. This particular hydrodynamic instability has been widely studied. The Rayleigh-Taylor instability[4,5] appears when two fluids of different densities are accelerated into each other.

We found that the configuration is always unstable if the top layer is denser that the lower one. We also showed that the size of the blobs is in good agreement with a linear instability analysis of the thin dual viscous layer. A detailed account of this study can be found in Ref. 3. We will continue studying this and other instabilities used by painters to create artful images.

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