

## Sticky Fingers

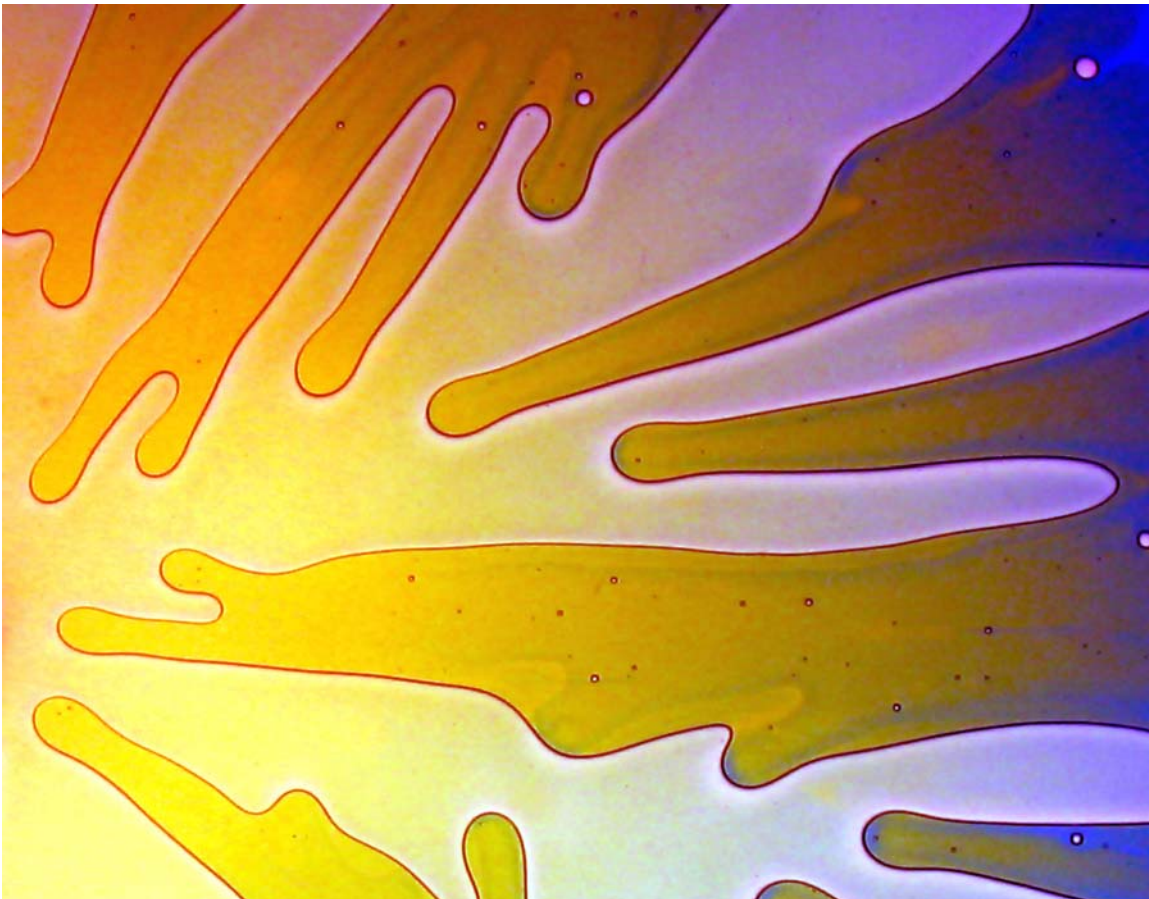


Figure 1. Saffman-Taylor instability created using air injected into corn syrup

### Context

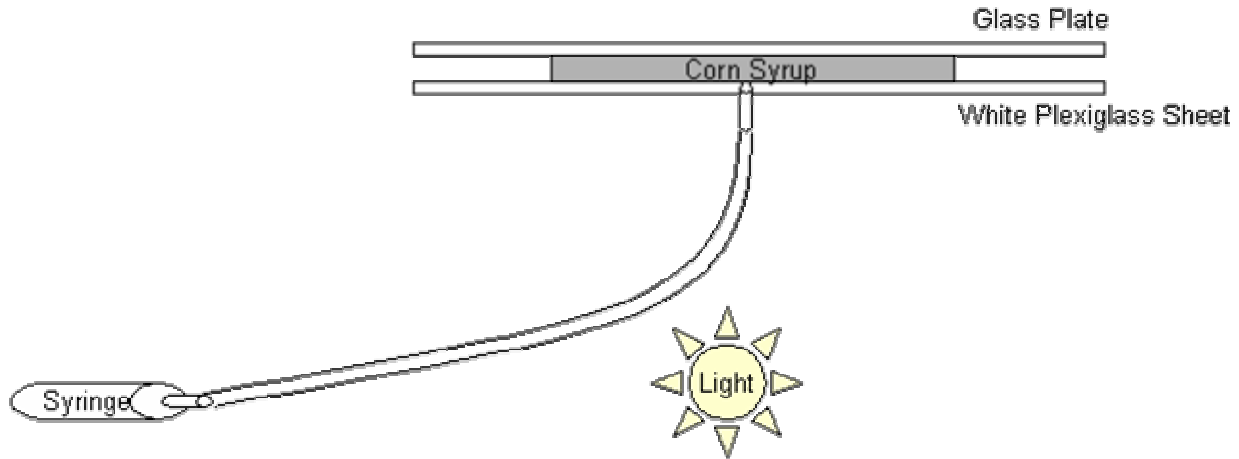
This image was created for group project 1. The original intent of the image was to use concentric rings of colored fluid to show contours in an image of the Saffman-Taylor instability. The rings were pushed completely aside by the injected air, and so no contours were visible, so for this image, I wanted capture an interesting and colorful image of the Saffman-Taylor instability.

### Materials and Equipment

The image was created using the Hele-Shaw cell/Saffman-Taylor apparatus. The apparatus has a flat sheet of white acrylic and a sheet of glass that is lowered onto the acrylic, sandwiching a viscous liquid between the layers. A needle inserted through a

small hole in the center of the acrylic plate allows a less viscous liquid to be injected between the layers using a syringe. The low-viscosity liquid creates “fingers” in the more viscous liquid. A light was placed directly under the apparatus to provide backlighting. A diagram of the apparatus is shown below in figure 2.

In this image, the viscous liquid used was generic brand corn syrup. Cargill Sweeteners gives the viscosity of their Clearsweet 63/43 Corn Syrup as 25,000 cP at 80°F [1]. The less viscous liquid was air, with a viscosity of .018 cP [2].



**Figure 2.** Diagram of Hele-Shaw cell/Saffman-Taylor apparatus

### **Visualization Technique**

The boundary between the air and corn syrup provides sufficient contrast for visualizing the Saffman-Taylor instability. However, the corn syrup was colored with food coloring (glycerol, water, and dye) to increase the visual appeal of the image. The syrup closer to the air injection port is dyed yellow, while the syrup is dyed blue beginning about 1.5 to 2 inches from the port. Lighting was provided by one of the large shop lamps available for checkout in the ITLL. The lamp was placed directly under the Hele-Shaw cell to provide backlighting.

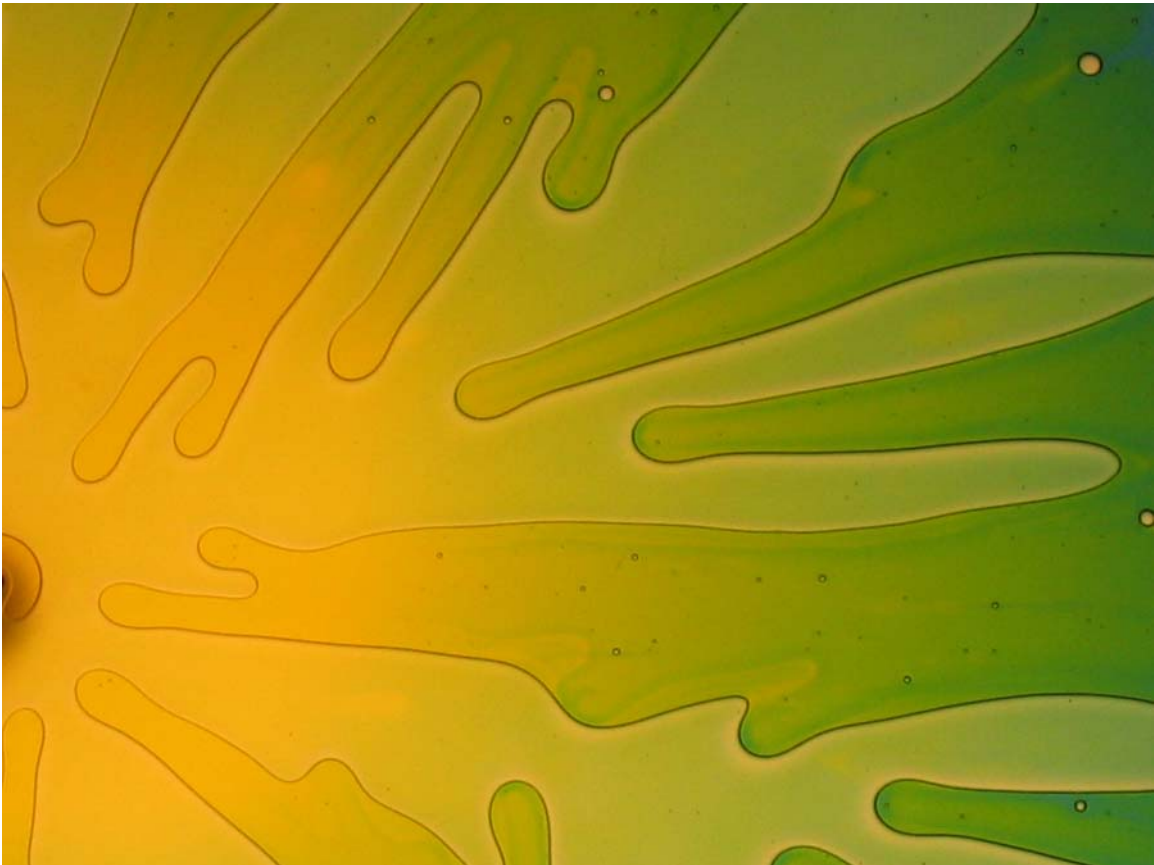
### **Photographic Technique**

The image was taken from 15 inches above the Hele-Shaw cell. The field of view was approximately 2.5 by 3 inches. The camera used was a Canon A70 digital camera. The focal length used was 16.2mm, with a 3X optical zoom. The A70 also allows further digital zoom to 12X magnification. This image was taken with a 4.8X zoom. The aperture was set to F4.0 and auto focusing and shutter speed features were used. The image was processed in photoshop using the auto levels and color balance filter. In the color balance filter, the red/cyan level was set to +100 (more red, less cyan), green/magenta level was set to -45 (more magenta, less green), and blue/yellow level was set to +100 (more blue, less yellow). The image was further processed using the smart blur effect to reduce graininess. Spots were removed from the air “fingers,” however, it was impossible to distinguish between spots in the syrup “fingers” created by smudges on the glass or acrylic and spots created by air bubbles in the syrup, so spots in

the fingers were left unaltered. The image was cropped to 1971 by 1536 pixels in order to remove the shadow created by the air injection needle, which was a distracting element. Finally, the brightness and contrast were increased slightly (+10 and +5, respectively).

### **Image Critique**

The image reveals the fingering caused by the Saffman-Taylor instability. I like the colors seen in the final image. Although the original image's color and contrast were not as intense, I like that the original image seems smoother. I would like to improve the timing of the image. Although I saw many beautiful fingering patterns while I was experimenting with the apparatus, it seemed that the photographs I took never captured the most complex of the images. If I were to continue working with this technique, I would like to try to improve the coloring of the images. I think that the colored corn syrup can be used to show the movement of the syrup, but I would need finer lines such as a candystriped pattern alternated with undyed syrup instead of the large circles of dyed syrup that I used to create this image.



**Figure 3.** Unaltered image

1. <http://www.cargillfoods.com/pdfs/sweeteners.pdf/ca209.pdf>
2. <http://xtronics.com/reference/viscosity.htm>