Nicole Nageli

Professor Hertzberg

Flow Visualization Fall 2023

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Teams First: Saffman–Taylor Instability with Jess, Cameron, and Maddie

The intent of the image was to capture the ‘fingers’ of the phenomena known as the Saffman–Taylor Instability. The scientific intent of the image was to demonstrate the Saffman–Taylor Instability and how liquid of two different viscosities is displaced. In addition to the science, the artistic intent was to showcase the finger-like patterns that result from this fluid phenomena.

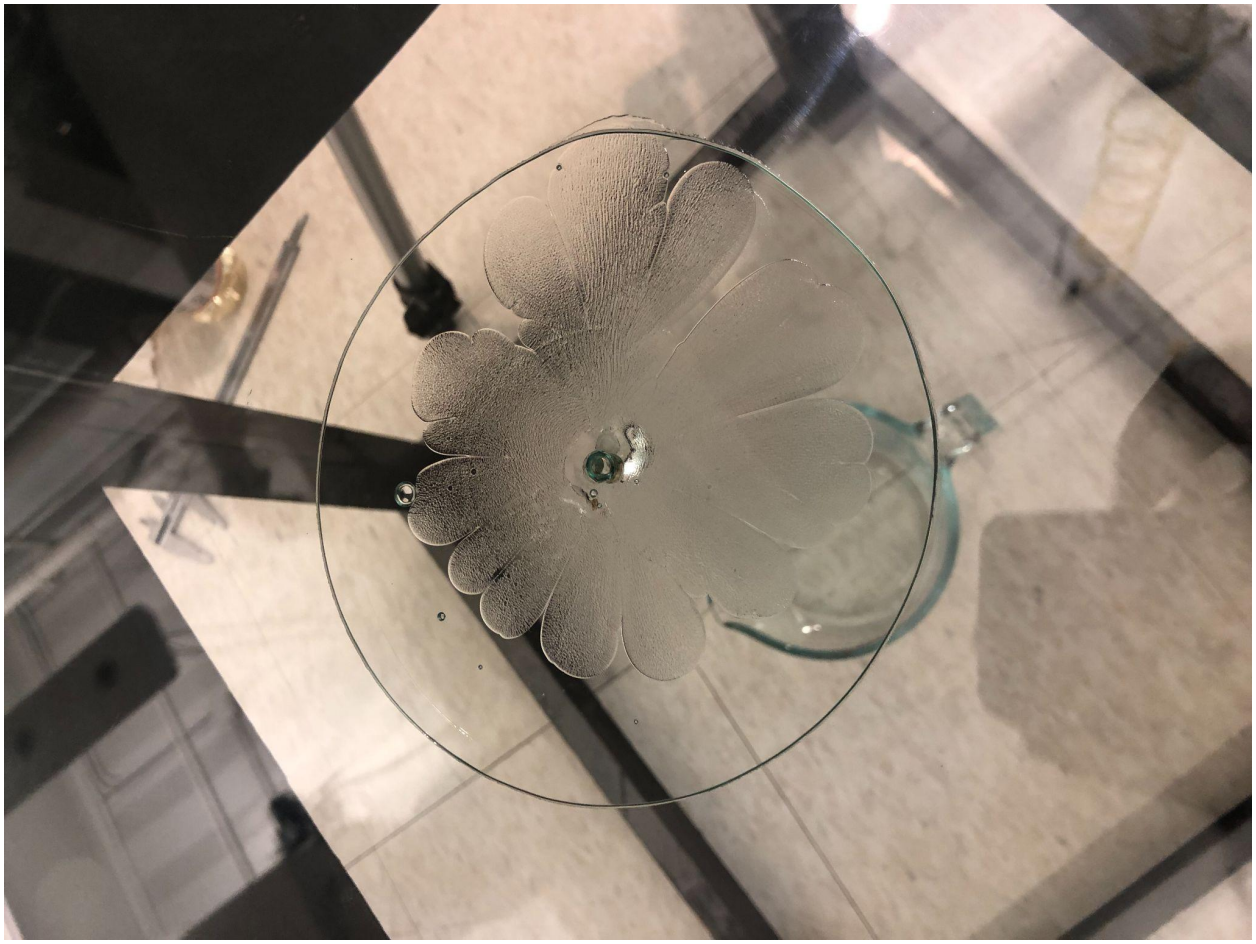
FLUID PHENOMENA:

The Saffman–Taylor instability happens when a more viscous fluid is displaced by a fluid with lesser viscosity or when the less viscous fluid gets displaced by the more viscous fluid (New Jersey Institute of Technology, n.d.). This setup used a radial configuration of the instability; we were focused on what would happen as the fluid disperses outwards from a point. This results in finger patterns as, over time, the unevenness and curves in the liquids spread out more. The less viscous fluid spreads out faster than the other and the surface tension keeps these fingers in place, creating lines and patterns inside each finger. In this case, as water pushes in, films of glycerin and water occur at the top and bottom of the surface with tiny air bubbles trapped in between.

METHOD

The setup for this experiment was done twice. A Hele-Shaw cell was used to show fluid flow. It uses two glass plates and a gap in between with a syringe tube at the center to inject fluid. In this setup we used a radial configuration, where the less viscous fluid is injected at the center of the cell.

(a picture of our first setup: the camera was set above the hele-shaw cell and captured the instability)

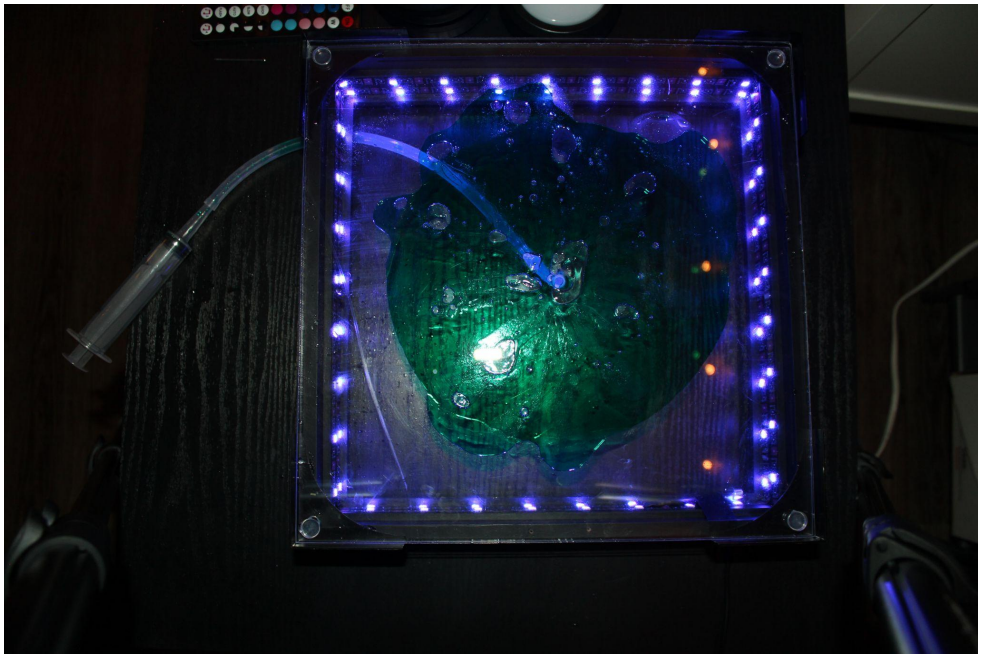


(a picture of the instability from the first set up, without any food dye or coloring)

Having the first set up taught us what we wanted to capture, both artistically and scientifically. We decided to use food dye for each of the liquids to better show the phenomenon.

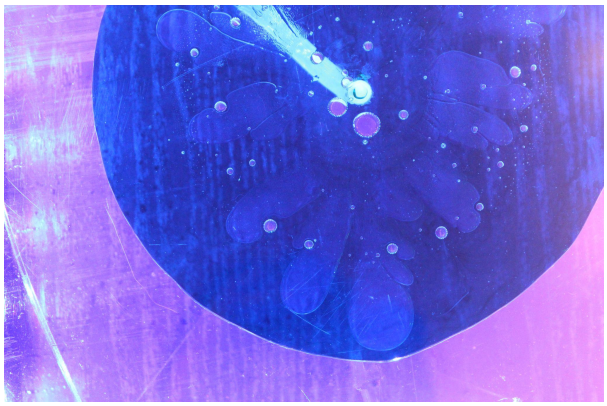
For the final image, Jess created the setup. She recreated a smaller version of the Hele-Shaw cell with two plates of glass and a syringe tube in the center. Around the cell, she used led lights to surround and light up the area. She dyed the liquids green. The camera was placed above. She also used glycerin and water for the fluids instead of our original attempt of

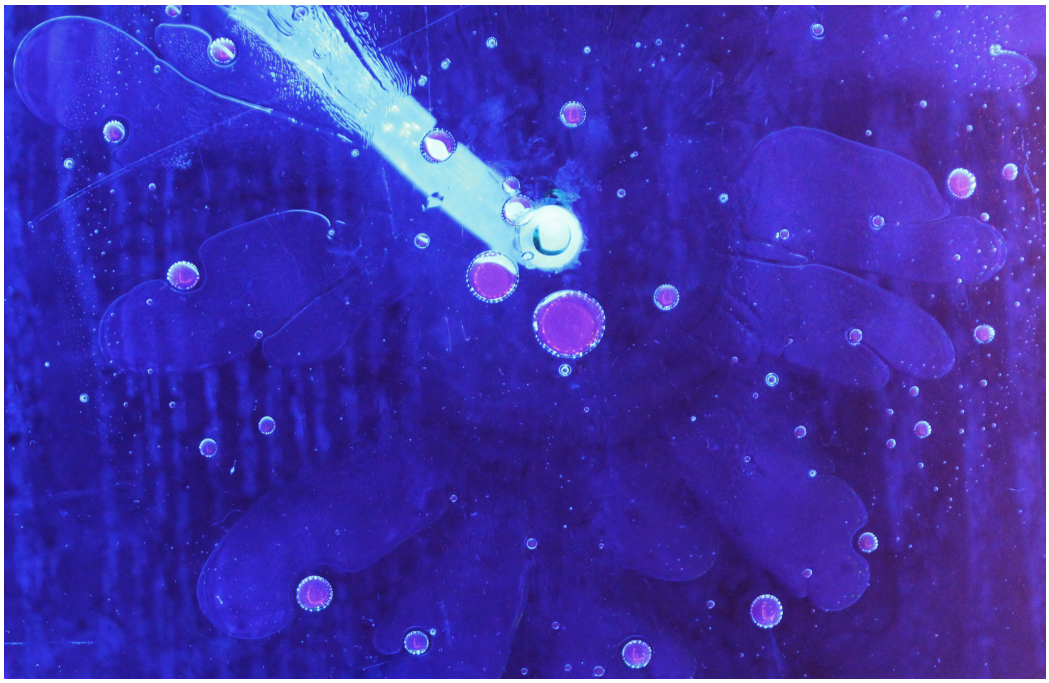
corn syrup and water. The viscosity of glycerin is 954 cP (Glycerine, 2023) while water's viscosity is 0.8 cP (Engineers Edge, 2023).



(a picture of Jess's setup)

EDITING





(Pictures of the raw file vs final edited image)

The image was taken with the Canon EOS REBEL T3i. Its exposure time was ⅛ sec, which means it demonstrated how far the fluids traveled in that amount of time. It had an f-stop of f/5.6, ISO-3200, focal length of 55mm, and was taken about a foot away from the camera with lighting provided by blue LED lights

The editing was done in Photoshop. The contrast was brought to its maximum and brightness reduced to focus on the instability patterns and enhance the gradient created by the

green and blue colors.Saturation was reduced and red and yellow midtones increased to create a purple gradient. The image was cropped to highlight the instability patterns and create a visually pleasing composition. The dimensions of the image changed from 5184px x 3456px to 3409px x 2203px.

The goal of the photograph was to show the distinctive fingers that result from the Saffman-Taylor Instability. Scientifically speaking, the intent of the picture was realized because it showed the displacement of different viscosities of liquids.The photograph also did a good job of artistically highlighting the complex finger-like patterns in a visually pleasing way.

Works Cited

Edge, Engineers. “Water - Density Viscosity Specific Weight.” Engineers Edge - Engineering, Design and Manufacturing Solutions, www.engineersedge.com/physics/water__density_viscosity_specific_weight_13146.htm#:~:text=The%20dynamic%20viscosity%20of%20water,centipoise%20at%2020%20%C2%B0C. Accessed 6 Oct. 2023.

Glycerine, www.microkat.gr/msdspd90-99/Glycerine.html. Accessed 6 Oct. 2023.

New Jersey Institute of Technology. Saffman-Taylor - New Jersey Institute of Technology, web.njit.edu/~kondic/capstone/2015/saffman-taylor.pdf. Accessed 6 Oct. 2023.