Team First Report

By: Greg Kornguth

Flow Visualization Fall 2023 Section 001
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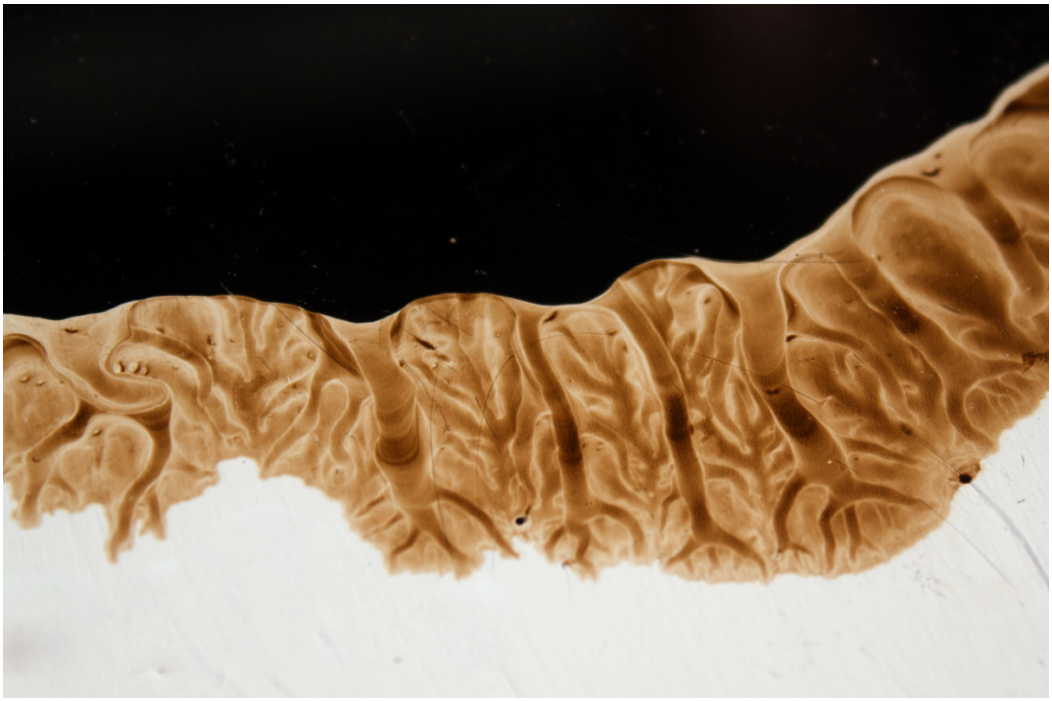


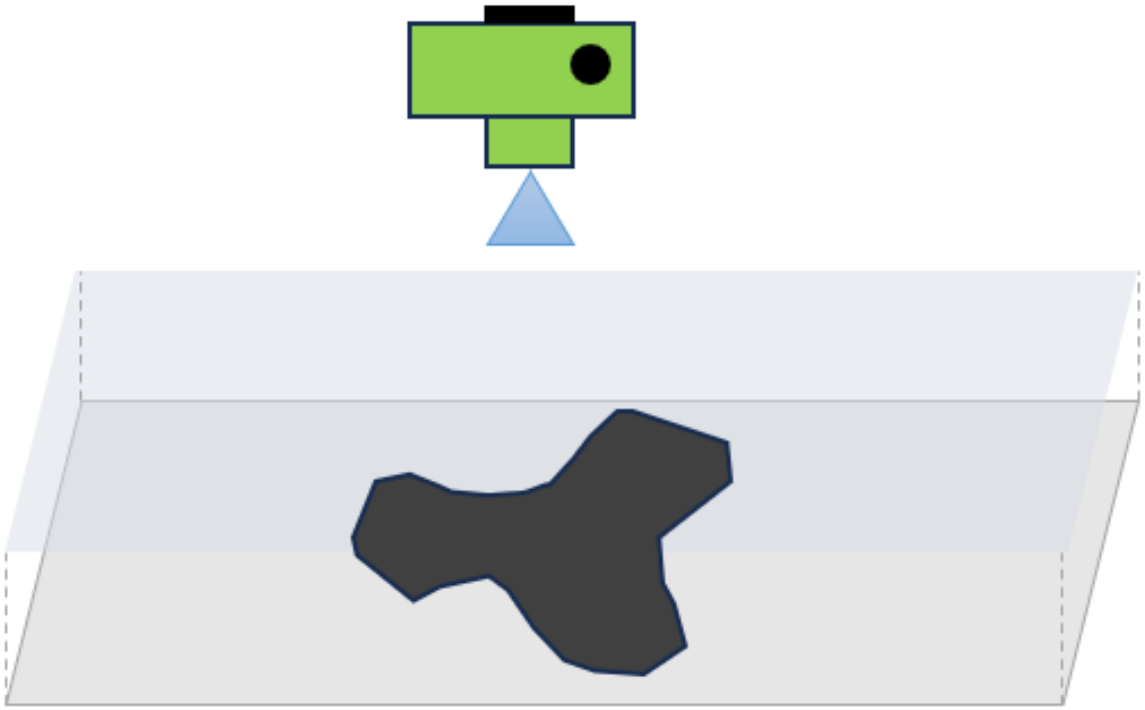
Context and Purpose

Our team wanted to do something a little more nonconventional than usual. We decided that a ferrofluid setup would be interesting to observe so we obtained some ferrofluid and started messing around with it. Our results from the ferrofluid were not quite what we had hoped, but we tried many different setups and got some interesting results. We attempted to use magnets to get some cool "spiky" fluid interactions, but the magnets that we had were not strong enough to produce these results. Although our setup did not come out as planned, we achieved our goal of working as a team to achieve a more complex setup than we could have alone.

Flow Description

We set out to capture interesting interactions between ferrofluid and magnetic fields, but this original plan did not work as we had hoped. The goal was to use magnets to cause the ferrofluid to flow in interesting ways around the magnetic fields, and to capture those flows to help understand what is going on. Due to our lack of magnets strong enough to cause anything to happen in the ferrofluid, I decided to move away from magnetic interactions and toward

interactions that occurred in the process of our setup attempts. The interaction that I decided to use occurred after sandwiching the ferrofluid between two flat surfaces and lifting one surface straight up. As shown in the drawing shown below, the camera was directly above the fluid, and the glass pane had just been lifted off the fluid. Because the fluid at the time of the photo is static, there is no Reynolds number since Reynolds number is a function of velocity. The patterns in the fluid after the glass is removed are due to the surface tension of the ferrofluid and the pressure differences within the fluid when the glass is removed. The fluid tends to stick to the surfaces it touches, so when the glass is lifted, some of the fluid sticks to the glass and then releases once the two surfaces are far apart. The size of the whole pool of ferrofluid that I photographed was around eight inches in diameter, but the section that I photographed was only about four inches across.



Visualization Technique

To set up the photo all I really needed to do was make sure that the lighting was ideal, and that the fluid was in focus. The fluid was on a whiteboard that we scavenged from a trash heap and the clear surface that was originally on top of the fluid was a pane of acrylic that we also found in the trash. The ferrofluid was borrowed from Professor Hertzberg. Having a white surface to put the ferrofluid on was very helpful to make the patterns really stand out and catch the eye. Since the ferrofluid was almost completely black, it was necessary to have a light background so that the thinner parts of the fluid were easier to see and notice. I did not have to

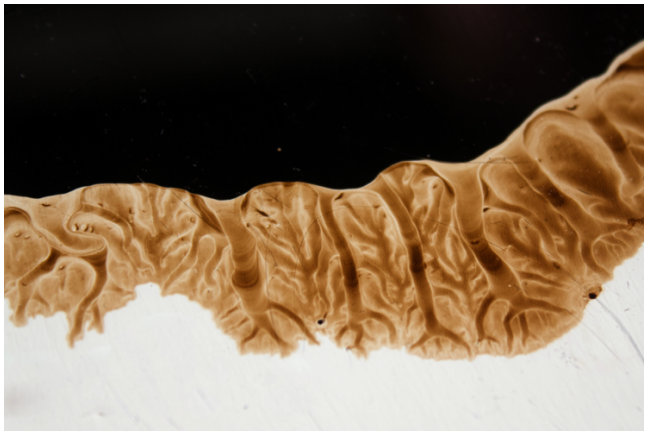
use any artificial lighting for my image because the sun was high and illuminated the setup very well.

Photographic Technique

I thought that the best way to capture the fluid was to get as close of a shot as I could. The field of view of my image was about four inches across, and the surface of the fluid was about a foot and a half away from my camera. I used a Canon EOS Rebel T2i with an 18-55 mm lens. The focal length of my camera was 55 mm, the aperture was f/5.6, the shutter speed was 1/800 s, and the ISO was 320. I did not mess with the image too much in post editing, but I did turn the black levels up a little bit, and the highlights down a little bit. I also used a spot tool to get rid of a couple of imperfections on the surface of the whiteboard and cropped the image to fit within the required dimensions.

Before

After



Reflection

I believe that this image captures the ways that fluids move due to surface tension very well. It's easy to see the areas that stuck to the acrylic pane the longest and it is also very striking. I am happy with the way my image turned out considering all the challenges we faced and shortcomings we experienced while trying to achieve our initial goals. It is very cool to see how the tendrils of ferrofluid almost look like roots from a tree diving down into the dirt. My intent was to work with my team to get a striking and interesting photo, and I would say that I achieved this goal. Next time, our group is going to do more research into interesting ways that we could set up our fluid interactions, but I think things going away from our plan was a good thing for team building and experience.

References

1. Ferro Tec. (2015, November 4). *Ferrofluid Safety Data Sheet*. Educational Innovations, Inc. https://www.teachersource.com/downloads/msds/FF-310SDS.pdf