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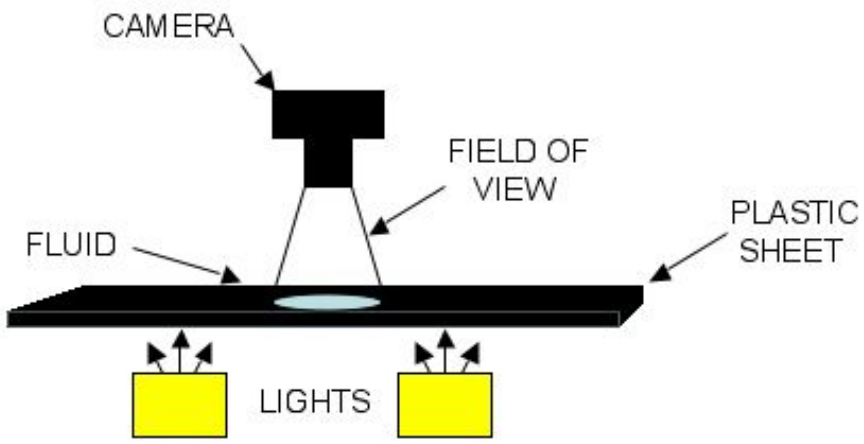
MCEN 4228
Group Project 1

The purpose for creating this image was to show the effects of several fluid properties on fluid interaction. Also intended was to display Saffman-Taylor instability in the displacement of a fluid by a less viscous one. This was initially planned to be done in a Hele-Shaw cell to restrict the motion of the fluids, but the desired effect could not be achieved. The final image attempts to show how surface tension, density, and viscosity affect the interaction of several fluids.

To create the flow, the Hele-Shaw setup was used without the glass plate on top. The semi-transparent plastic sheet was backlight so the light diffused evenly, eliminating glare. Approximately 3 fluid ounces of Corn syrup was poured onto the plastic, being careful to keep it level so the syrup would stay in a relatively round shape. Then aqueous solutions of red and blue food coloring were alternately injected into the center of the syrup from above. The setup is shown below:



After one color was injected, time was allowed for this color to move through the syrup toward its outer edge. This usually took around five seconds, and then the other color was injected with a needle just under the surface of the syrup at its center. Initially, some fingering was seen as the red coloring approached the syrup's edge. This is an indication of Saffman-Taylor instability, as the viscous syrup (~35 cP) is displaced by the less viscous color solution (~2-3 cP).[1] As the blue dye was injected, it followed the path of the red dye, producing similar fingering. After more injections, the dye stopped behaving that way, and instead started to form concentric circles in the center of the syrup. The surface tension at the boundary layers and the different densities of the oil and colors prevented them from mixing, creating the effect seen in the final image.

To create the flow seen, standard corn syrup was used, along with aqueous solutions of red and blue food coloring in 5% concentration. No flash was used so glare would be eliminated. The plastic sheet was backlit with two standard lights from the ITLL media shack.

The field of view is approximately five cm, with a distance from the lens to the fluid of five cm. The lens used was a 50 mm macro lens on a Canon EOS Digital SLR Rebel camera. The exposure was created with f10, a shutter speed of 1/60 sec, and an ISO of 400. In Photoshop, dust specs from the lens were removed, colors were enhanced, and a small bubble in the fluid was removed.

I think this image is quite effective at displaying the interaction between different fluids. I like the contrast between the blue and red colors, which is

[1] http://www.engineeringtoolbox.com/dynamic-absolute-kinematic-viscosity-d_412.html

displayed well because of the clean boundary layer between the concentric circles. My favorite part is the coloring at the outer edge, which appears to look like flames. I would have liked to capture a clearer picture of the fingering associated with Saffman-Taylor instability, while still having time to inject further dye circles into the syrup. I would like to further investigate these flows by actually using a Hele-Shaw cell.