Flow Visualization

Team Project #2

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MCEN 4151: Flow Visualization

The purpose of this image was to observe the fingering effect of a Hele-Shaw cell. This effect is known as a Saffman-Taylor instability. The image was created with the help of teammate Travis Bildahl. The image was created for a course at the University of Colorado at Boulder titled Flow Visualization. This course aims to explore the art and physics of fluid flow.

To create this image we used a Hele-Shaw cell developed by previous Flow Visualization students. This apparatus consists of two panes of glass, mounted on a wooden structure. The lower pane of glass has a small hole through the glass. The purpose of the hole is to connect a tube and syringe in order to inject fluids between the panes of glass. The panes are separated by a 4 small screws. The plane separation is on the order of 1-2 mm. To produce the flow, corn syrup was poured on the lower plane and a few drops of food dye were dropped on the syrup. Then the top plane was placed on the corn syrup and screws. Then dyed water was injected into the corn syrup to produce a fingering effect. A diagram of the Hele-Shaw cell is shown below.

Figure 1: The Hele-Shaw cell used[1]

A necessary condition to create the Saffman-Taylor instability is a less viscous fluid being injected into a more viscous fluid. The less viscous fluid in this case is water, with a dynamic viscosity[2] of about 1E-3 Pa*s. The more viscous fluid is corn syrup with a dynamic viscosity[3] of about 1.31 Pa*s. Creating a dynamic viscosity ratio of 1310:1.

Figure 2: The original photograph

The original photo is picture above. The photograph was taken outside, on an overcast afternoon. The following specifications and techniques were used:

Size of field of view: about 12 cm x 6 cm

Distance from object to lens: 15 cm

Lens: EF 100 mm Macro USM

Make and model of camera: Canon EOS 7D

Aperture: f/5.6

Shutter speed: 1/400 sec

ISO setting: 1250

Original image dimensions: 3456 x 5284

Edited image dimensions: 5135 x 3059

Very minimal post processing was done using Adobe Photoshop. The image was simply cropped and rotated. Then the contrasted was adjusted slightly to bring out the colors more. I think the image is very fun and has the feel of a psychedelic wave. I considered removing the air bubbles that formed but decided they add more depth to the photo.

Works Cited:

1. Nguyen, Vien. *Group Project 2 Report*. Rep. University of Colorado, n.d. Web. <http://www.colorado.edu/MCEN/flowvis/galleries/2010/Team-2/Reports/Nguyen_Vien.pdf>.
2. "Water - Dynamic and Kinematic Viscosity." *Water - Dynamic and Kinematic Viscosity*. Engineering Toolbox, n.d. Web. 09 Apr. 2014. <http://www.engineeringtoolbox.com/water-dynamic-kinematic-viscosity-d_596.html>.
3. "Viscosity." *Wikipedia*. Wikimedia Foundation, 04 Sept. 2014. Web. 11 Apr. 2014. <http://en.wikipedia.org/wiki/Viscosity>.