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Flow Visualization
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SAFFMAN-TAYLOR INSTABILITY
WITHIN THE HELE-SHAW CELL

INTRODUCTION

The purpose of this image was to clearly illustrate the Saffman Taylor instability. As well as illustrating this flow phenomenon a picture that is visually appealing was also desired. In order to do this a Hele-Shaw cell was used with 2 fluids that had different viscosities.

EXPERIMENTAL SETUP

The Hele-Shaw cell is basically two surfaces placed close enough together in which the fluid in between is touching both surfaces. The bottom surface was white plastic, and the upper surface was glass, so the phenomenon could be observed. The distance between the two surfaces was not measured; however the glass was just sitting directly on top of the plastic. A 60W light bulb illuminated the white plastic from below about 1ft away.

To create the phenomenon first purple hand soap was placed on the white plastic around the small hole. Then the glass was placed on top of the white plastic, spreading the soap in a circular manner. Due to the reduction in thickness the purple hand soap appeared clear. Then water with red food coloring was injected into the hand soap. This created the instability. Left over yellow dye was also on the board.

FLOW PHENOMENA

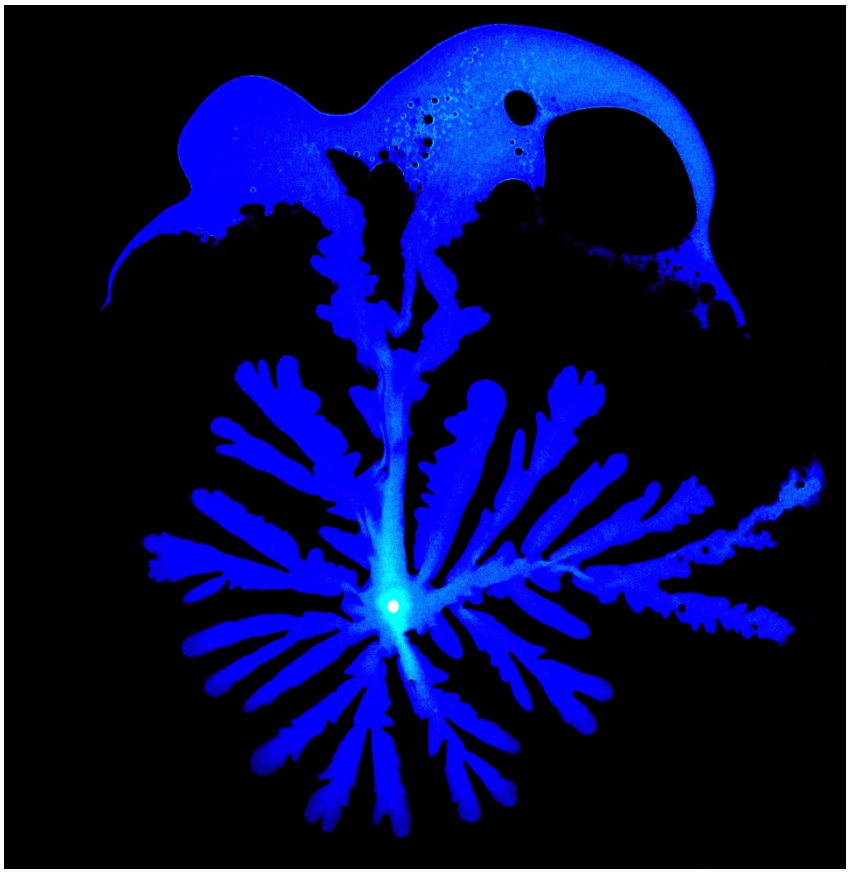
The flow phenomenon observed is the Saffman Taylor instability. This is also sometimes described as the fingering effect. This occurs when a fluid with lower viscosity is injected into a fluid with a higher viscosity. This instability is dependent on many factors such as fluid viscosities, distance between the two surfaces, and injection rate. These, as well as other variables determine the shapes formed. In this particular picture you can also observe where the lower viscosity fluid penetrated the higher viscosity fluid then took the route of least resistance and gather in the upper portion of the image.

PHOTOGRAPHY AND POSTPROCESSING

As previously mentioned a 60W light bulb was used to illuminate the white plastic from below. The field of view was about 6 inches by 6 inches and the camera was about 1 ft away. The camera used was a Canon PowerShot SD1200 IS. The shutter speed was 1/125s, F-Stop of f/2.8, aperture of f/2.8, ISO of 80, and focal length of 6.2mm. The original image dimensions are 3648x2736 pixels.

For post processing the image was cropped, then rotated, and the color was inverted in order to increase the dramatic effect and contrast between the two liquids. A few distracting non essential elements are also removed. The changes can be observed on the following page.

Original Photo



Final Photo

REFERENCES

- http://m.njit.edu/~kondic/capstone/2002/a/capstone.html
- http://journals.cambridge.org/action/displayFulltext?type=1&fid=392853&jid=FLM&volumeId=177&issueId=-1&aid=392852