Team First Report

Ferrofluid

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Introduction

Experiments are fun, especially when there is a physics phenomenon that I have never seen in my life. My team and I were fortunate to have Dr. Hertzberg provide us with Ferro fluid to experiment amazing effects in the presence of magnetic field. Ferrofluid, is an amazing liquid that is "strongly magnetized in the presence of a magnetic field" [1]. To perform this experiment, Matthew, Abhishek, and Rob provided with India ink, office space, and glass vessel respectively. Also, Blake lend me his Camera to be able to take my final image. The reason for the India ink is to give the image colors since Ferrofluid is black. When we magnetized the Ferrofluid we saw an aesthetically looking spikes with bright India ink colors.

Experiment Setup

To make the experiment of Ferrofluid possible, a ferromagnetic fluid, Cylinder-shaped magnet, glass vessel, India ink, and office flashlight as shown in Figure 1. At first, Ferrofluid were poured to the glass vessel. Then, using a magnet as a stand made it possible for us to use the most of the flashlight through that angle, as well as, to deform Ferrofluid into spike shape effect. Lastly, few random India ink color were used to add colors to image since Ferrofluid is jet Black. Then team would change the position of the magnet so that the spike effect can mix with the India colors, creating an interesting effect to be captured.

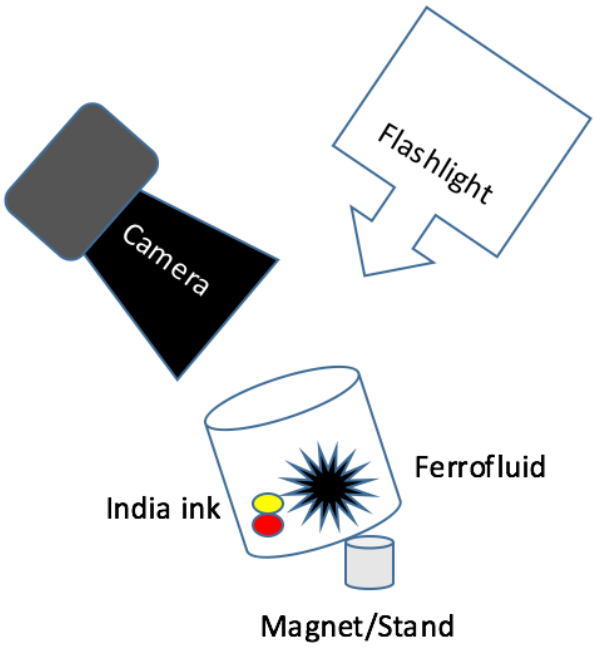

Figure 1: Experimental setup

Ferrofluid physics

Ferrofluid is an interesting fluid that we had a hands on experience to create multiple effect and observe how different method creates different visual effect. Using magnet below the container, the Ferrofluid becomes magnetized, forming spikes, in which magnetic field lines were clear. However, whenever the magnet is pushed away from Ferrofluid the spikes effect decrease until it returns to its natural form of liquid. Observing the spikes made the team recognize that these phenomena is the normal-field instability, in which ferromagnetic material always line up with the magnetic field. Certainly after adding India color, the Van Der Walls forces were shown in that the ink molecules were together and did not separate. However since there was a difference in density between Ferrofluid and India ink, they did not mix well with each other.

The history of Ferrofluid go back to early 20^{th} century, when NASA needed a liquid rocket fluid that could be drawn to a rocket pump in the absence of gravity. Fortunately, in 1963, Steve Papell invented the solution for that problem, which is a ferromagnetic material called Ferrofluid [1].

Photographic technique

To be able to create this beatifule capture a camera were borrowed from Blake Chin. The camera was a digital Canon PowerShot SX530 HS. The original image has a dimension of 640x480 pixels. The image was taken approximately 3 inches away from vessel and the field of view was approximately 5x5 inches. The camera setting for the final image was F5, 1/60 s, and 640 for aprature, shutter speed, and ISO respectively.

After the original image was captured, a post editing process was established using Photos. At first, the original image was cropped so that the glass vessel is not apparent in the image. Then, the color of the image was turned up to show the cell effect in close. The difference between the original image and final image are shown in figure 2.

a)

b)

Figure 2: Original image (a) Vs. Final image (b)

Conclusion

All in all, the experiment was fun to make, especially when adding different colors and observing how the cell effect form when being near a ferromagnetic material. The normal-line instability phenomena were also observed within the spikes of the Ferrofluid. Also, I would imagine that the cell effect can be seen as Grain structures in metals, in which the lines between the grains are grain boundaries. The outcome visual image of the experiment that I was indented has been accomplished successfully. However, for future improvements, I would consider not cropping a lot of the image as the quality noticeably reduced. Also, a larger vassel will allow the artist to zoom out and move in near to the image to show the highest possible magnifications.

Refrence:

[1] Ferrofluid. (2019). *En.wikipedia.org*. Retrieved, from https://en.wikipedia.org/wiki/Ferrofluid