

Team Third Report - Ferrofluid

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Figure 1: Final Image

1 Introduction

The image shown in figure 1 was taken for the third team assignment in the MCEN-5151 Flow Visualization course at CU Boulder. For this assignment, our group chose to experiment with ferrofluid, magnets, and dyes to create a unique fluid flow.

2 Flow Apparatus Setup and Visualization Technique

The preliminary setup of this experiment is shown in figure 2 which contained a piece of acrylic, quarter-inch bolt and wing nut, hot glue, and a bar magnet (not shown). The bolt and wing nut was placed on the acrylic with a square wall of hot glue around it to act as a basin to contain the food dye. Additionally, a bar magnet was placed in alignment with the square basin underneath the acrylic to magnetize the nut and bolt.



Figure 2: Setup

Ferrofluids contain “colloidal dispersions of nano-sized particles” in a liquid that possesses magnetic properties, typically involving ferrimagnetic materials [1]. The flow from this experiment focuses on ferrofluids and is described by the following actions. First, the basin was filled with a mixture of water and five droplets of food dye to add color to the image. Second, ferrofluid was inserted into the apparatus by dropping small amounts on the wing nut and letting it drip downward on the nut and bolt. As a result of the weak seal between the glue and acrylic, some of the food dye dripped out which actually turned out to enhance the quality of the final image.

3 Photographic Technique



Figure 3: Original Image

A digital Nikon D3400 DSLR with a 18-55mm lens was used to capture a 6000 by 4000 pixel image in RAW format, figure 3. The photographic technique involved focusing on the bolt as the main object and dripping ferrofluid down the wing nut to observe the flow. The settings used for the camera are shown in the table

1. The ISO value was set to 3200 in order to enhance the colors and not make the photo have too high of a grain. The aperture of 7.1 was used with a shutter speed of 1/30 to quickly capture the still shot and maintain a balance for lighting. The lighting used in the setup was directly from a nearby window. The photo was edited to be the same size with some color enhancements. These color enhancements were made to increase the level of blues in the photo to make them more prominent and also remove the tint from the photo to make the whites stand out more.

ISO	3200
Focal Length	38mm
EV	1
Aperture	7.1
Shutter Speed	1/30 s
Mode	Manual

Table 1: Nikon D3400 Camera Settings

4 Image Revelation

This image is most appealing from the blues that stand out in the photo. Two flows are captured in this photo with the first being the ferrofluid on the nut and bolt, and the second one which captures the leakage of blue water from the basin due to the poor seal. The main focus of this image draws attention to the nut, bolt and ferrofluid, while additionally drawing some attention to the slightly out of focus stream of blue water. Additionally, the hot glue was not put on perfectly which adds texture to the photo since it is slightly off balance. Overall, the photo does a good job at framing the shot and capturing the fluid flow of ferrofluids.

References

- [1] S. Odenbach. *Ferrofluids: Magnetically Controllable Fluids and Their Applications*. Lecture Notes in Physics. Springer Berlin Heidelberg, 2002. ISBN: 9783540439783. URL: <https://books.google.com/books?id=xmMRYN4dWzEC>.