

Team Image 3
Flow Visualization



Gamal Elbially
12/15/2015

Purpose

This project is for the “Team Image Three” assignment in the Flow Visualization Class with Professor Jean Hertzberg at the University of Colorado Boulder. Amazing fluid flow phenomenon occurs around us every day; however, most go unnoticed. This experiment is focused on Ferro fluid and its behavior under different circumstances. This flow was captured in collaboration with Chris O’Brien, Ian Macfarlane, and William Olson.

Safety:

The Ferro fluid used is EFH1, made by FerroTec. According to the Ferro fluid’s MSDS, Ferro fluid has minimal toxicity; however, if ingested a doctor must be consulted. Repeated contact may cause some minor irritation, and therefore the team used gloves and goggles avoid unwanted contact from accidental splashes. If contact occurred, the area was washed with soap and water immediately

Flow Apparatus:

The Ferro fluid was placed in a ceramic bowl, this is to avoid any unwanted staining on any other materials. Additionally, it is extremely difficult to remove the Ferro fluid if it comes in contact with magnets.

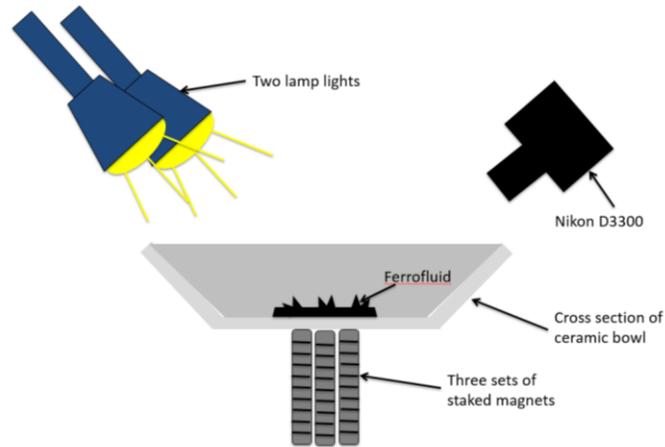


Figure 1: Experiment schematic

The image above shows the apparatus used for our experiment. Once the Ferro fluid was placed in the bowl, the bowl was placed under two bright light lamps. The lamps were adjusted to acquire desired reflection and lighting. The angle at which the magnets touched the bowl was also adjusted to acquire desired magnetic fields.

The lamps were 60 Watt lamps each, and the bowl was approximately 5 inches in diameter.

Visualization technique:

For this experiment, I decided to place 3 magnets under the bowl. The magnets were placed such that similar poles were on the same side. Below is my interpretation of the magnetic field induced from such orientation.

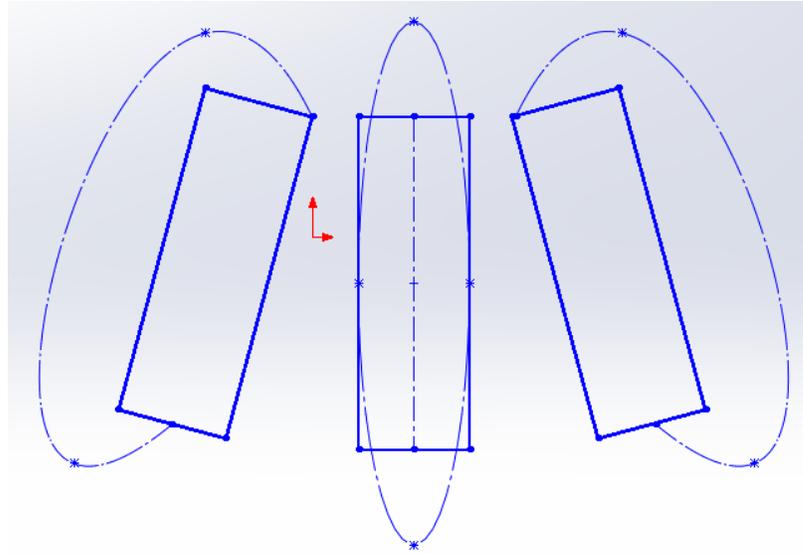


Figure 2: Magnetic field

Because similar poles were placed together, the magnetic fields were opposing each other. This is why the magnets on of the left and right in the above illustration have slightly skewed fields. This interpretation aligns with the resulting behavior of the Ferro fluid shown in the Photographic technique section below.

Photographic technique:

The image was taken using a Nikon DSLR D3300 Camera. Because the image was taken in a dark area, an ISO of 1800 was used. Aperture and shutter speed were set to f/5.6 and 1/125 sec. respectively. The original image had dimensions of 6000 x 4000 pixels. The combination of these settings lead to the following image:



Figure 3: Original image.

The image was then modified using Photoshop. First, the image was cropped to 3520 x 3320 pixels. The levels were then auto adjusted, this helped remove the layer of grey color that can be seen in the original image. This is likely due to the ISO and effects of the lighting used. Additionally, contrast was modified to help bring out more detail in the image. This resulted in the image below.



Figure 4: Final image.

Summary:

The image was interesting to take because Ferro fluid behavior is easily manipulated with the changing magnetic fields. It would have been interesting to try and use a speaker to move the Ferro fluid using the magnetic fields induced by the voice coil within the speaker. The magnetic field can be adjusted by playing songs and watching the fluid behave accordingly. Ideally, this would then be captured as a video.

Sources:

<http://www.colorado.edu/MCEN/flowvis/course/Ferrofluidfhmsds.pdf>

<http://www.colorado.edu/MCEN/flowvis/course/FerrofluidTechData.pdf>

<https://www.ferrotec.com/technology/ferrofluid/>

<http://scienceline.ucsb.edu/getkey.php?key=1821>