IV 2 Report
Milk with food coloring

MCEN 4151: Flow Visualization

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I. The purpose of the image

The purpose of the image is to capture how the fluid flow forms when food coloring is added to it. In my experiment, I chose to play with milk by adding food coloring and a little bit of dish soap. The motivation behind this flow visualization experiment is to observe how the fluid mechanics work when the food coloring and dish soap are added to the milk. For the first attempt, I poured some milk into a plate and then I added some food coloring to it, I tried moving it with a Q tip, but I was not satisfied with the pattern I ended up with. For the second attempt, I did exactly like what I did in the first one except that I dipped the Q tib in dish soap and then pressed it in the plate that has the milk and the food coloring which led to witnessing an impressive phenomenon. The main focus of the image is to observe the turbulent flow of the milk mixed with food coloring.

II. Fluid Mechanics

The resulting flow of the milk mixed with food coloring turned out to be turbulent as expected. Elements used in the experiment like the milk and food coloring do have relatively low viscosities. As a result, their movement was smooth and fast, and they have a relatively low resistance to fluid motion. The Reynolds number equation [1] was used to prove that the fluid movement is turbulent. If the Reynolds number is higher than 2000, this indicates that the fluid flow is turbulent.

$$Re = \frac{\rho_{milk} * u_{milk} * L_{plate}}{\mu_{milk}} = \frac{\left(1030\ \frac{kg}{m^3}\right)^{[2]} * \left(0.1\ \frac{m}{s}\right) * (0.2032\ m)}{\left(0.000332\ \frac{Ns}{m^2}\right)}$$

$$= \ 63.04 * 10^3 \qquad [1]$$

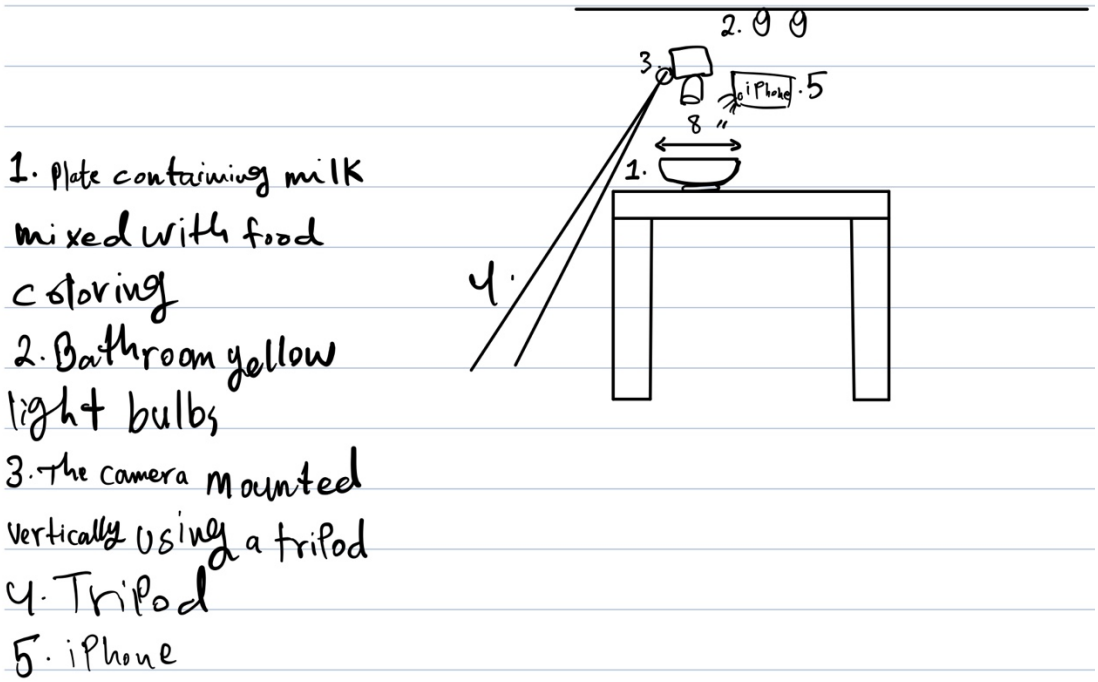
Where:

Rho: density of milk, u: flow speed of milk, L: characteristic length of the plate and mu: absolute viscosity of milk.

Reynolds number is more than 2000, this proves that the flow is turbulent.

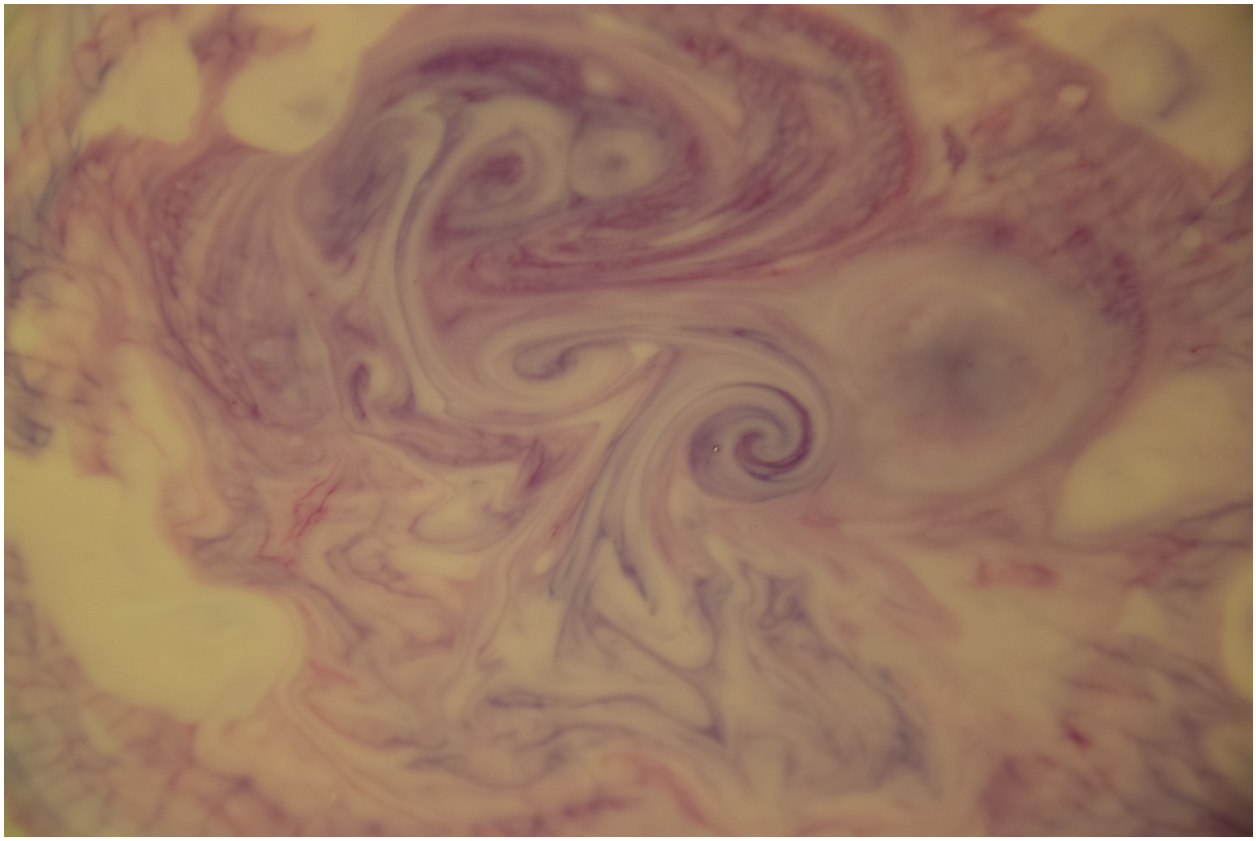
III. Flow Visualization Technique

A plate was used to contain the whole milk, “Watkins” assorted food coloring was used to make the flow pattern in this experiment. A Q tip was dipped in dish soap, then the head of the Q tip was pressed into the plate containing the fluid to make the colors form as a pattern. This experiment was conducted indoors at a room temperature of 22C. The lighting source was the bathroom bulb lights, and an iPhone X flash. The iPhone X flash was directed vertically to best avoid any possible reflections.

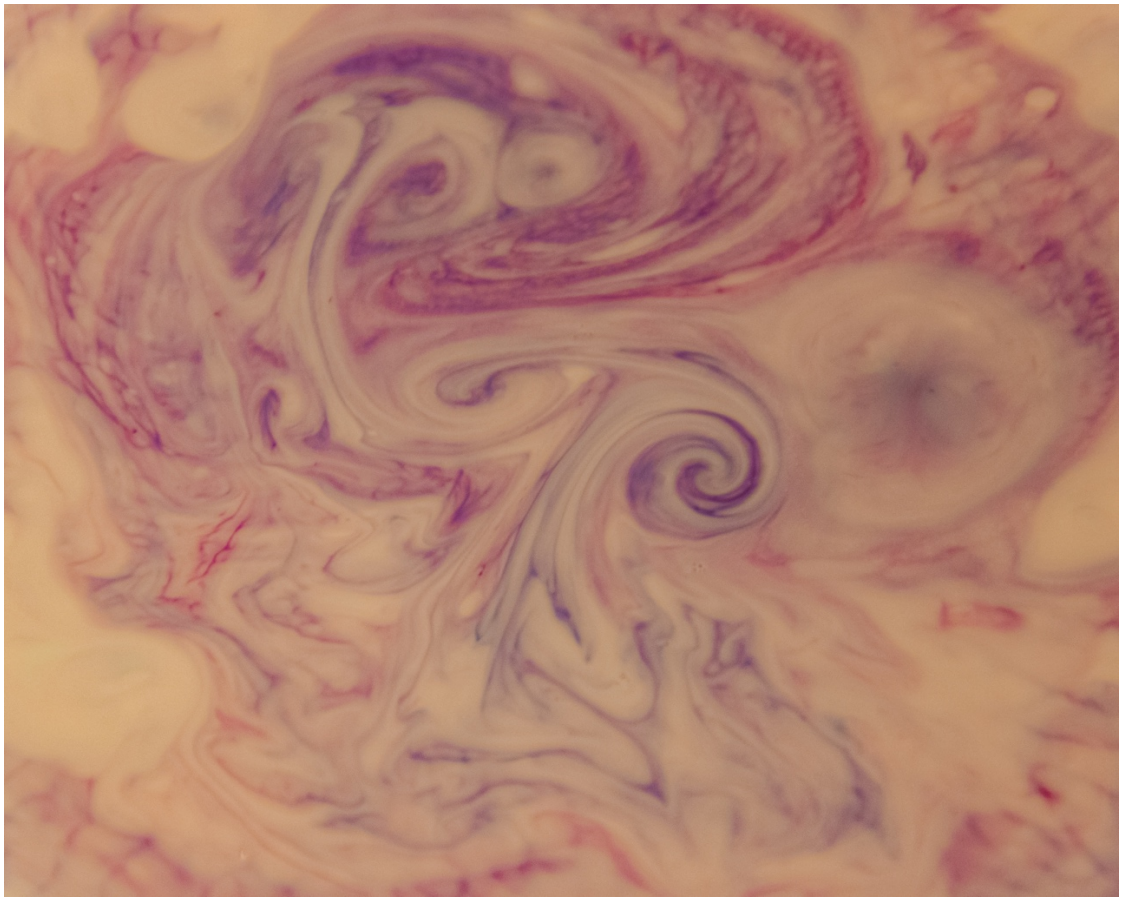


IV. Photographic Technique

A Nikon D7100 DSLR camera with a lens of 18-105 mm was used to capture the flow phenomenon. The camera was mounted using a tripod 20 cm away from the object, it is mounted vertically to capture the flow in an upper view. For the camera settings, the image was captured with an ISO of 800, a zoom of 105 mm, f/5.6 aperture, and a shutter speed of 1/30 secs. Lightroom software was used to perform post-processing to the image. Exposure was increased to give the image more lighting, the contrast was increased as well to make the colors pop up, whites were increased to make the milk color pop up. Besides, the final image was cropped by a scale of 4x5, however, the original image dimensions are 6000×4000 pixels.



Original Image



Final Image

V. Image Reveals

The image shows milk mixed with food coloring forming a fluid mixture. I like the image colors; both pink and purple show a great contrast. What I do not like about the image is that the milk color is kind of yellowish. Fluid physics was demonstrated, the fluid has a low viscosity and is turbulent. What I would like to improve about this image in the future is to capture the flow under white lighting instead of yellow. Overall, I am satisfied with the results, I feel like the intent of the project was fulfilled and the final result is relatively good.

VI. References

[1] *Reynolds number*. Engineering ToolBox. (n.d.). Retrieved October 12, 2021, from https://www.engineeringtoolbox.com/reynolds-number-d_237.html.

[2] Physical Properties of Milk. (n.d.). Retrieved October 12, 2021, from https://www.uoguelph.ca/foodscience/book/export/html/1988.