

Milk and Soap experiment



Figure 1 Final Image

The first assignment for my flow visualization was very open ended; the intent was to let us get to know our cameras and the difficulties in trying to photograph fluids. Fluids often pose difficult problems when trying to take a picture of them; like how they are often moving and hard to get a sharp focus on. For this assignment I chose a very simple phenomenon to photograph so that I could try to focus on the imaging part of the assignment. My image is showing the flow patterns of milk when soap is added to the surface. This is probably one of those experiments that you did in elementary school to show that science was fun; it is also a very intriguing phenomenon to look at in more detail. It was nice having a simple experiment because it meant that I could do it over and over until I got an image that I could work with. In all I ran the procedure five times taking twenty plus pictures of each run.

For my experiment I took a plate with a 10in. flat bottom and placed it on a table. With my camera on a tripod, I set it up with the lens about 12 in. away from the plate, looking down at an angle. Taking 1% milk I poured enough into the plate so as to cover the bottom. Using gel food coloring I mixed up a dark blue solution in another cup. Then taking a syringe I put 5-6 drops of the food coloring solution into the middle of the plate of milk. Then using a Q-tip with a drop of dish soap on the end of it I touched end of the Q-tip to the surface of the milk as close to the center as I could. The reaction is immediate, so with my camera in continuous shooting mode, I started taking pictures right away.

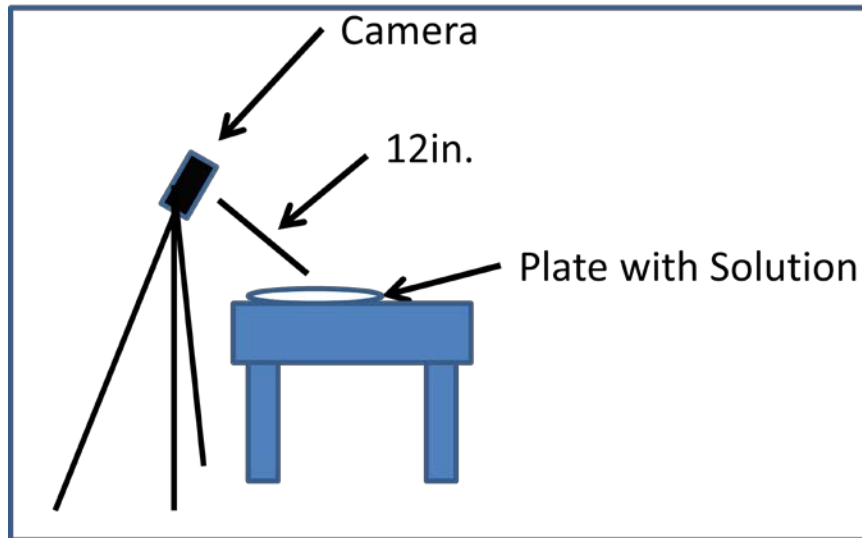


Figure 2: Apparatus Schematic

The forces that cause the dye to move around on the surface of the milk are from the reaction of the bipolar soap particles and the fat and proteins particles in the milk [1]. The soap weakens the bonds that usually hold the fat and protein particles in solution. With this weakened bond, the soap's polar end (hydrophilic) dissolves in the water and the non-polar end (hydrophobic) attaches to fat particles in the milk [1]. With the soap trying to bond in this manner, fat and protein particles are pushed and pulled across the surface causing the dye particles to move all around [1]. In my image it was interesting to see out the flow is almost directly out in four direction 90 degrees from one another. My guess for why this is happening is because the angle between the flows are as far away from each another as they can with the amount of soap that was added and the activity that was caused by this addition. Looking at other images that I got during my experiments, it was really dependent on the amount of soap that was added to the milk that caused the different flow patterns. It was really hard to estimate the velocity that the milk was moving at on the surface, because there is so much going on really fast. This picture was taken about two seconds after touching the Q-tip to the surface, and the farthest point of the star is about 4.5 in. from the center of the colored area, so that means that the fastest particles were had a velocity of 2.25 in/sec or .128 mph. From looking at the image I would say that the flow is still laminar, though with this experiment there is a lot happening on the surface that can mess with the direction and appearance of the flow.

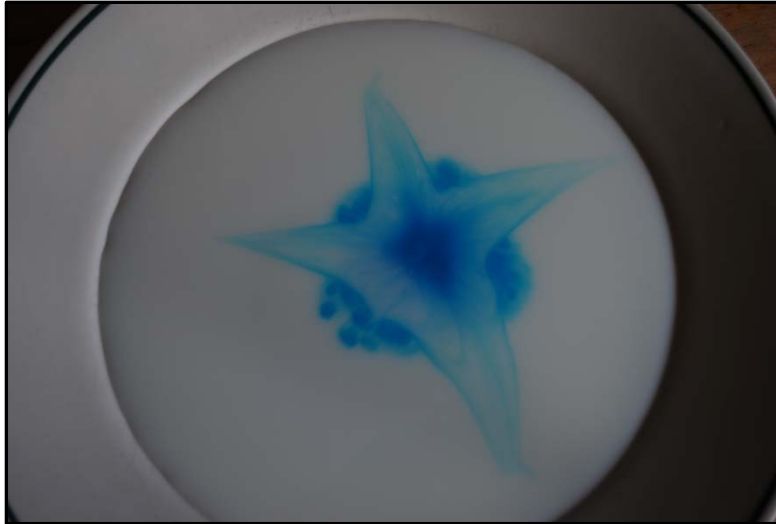


Figure 3: Original Image

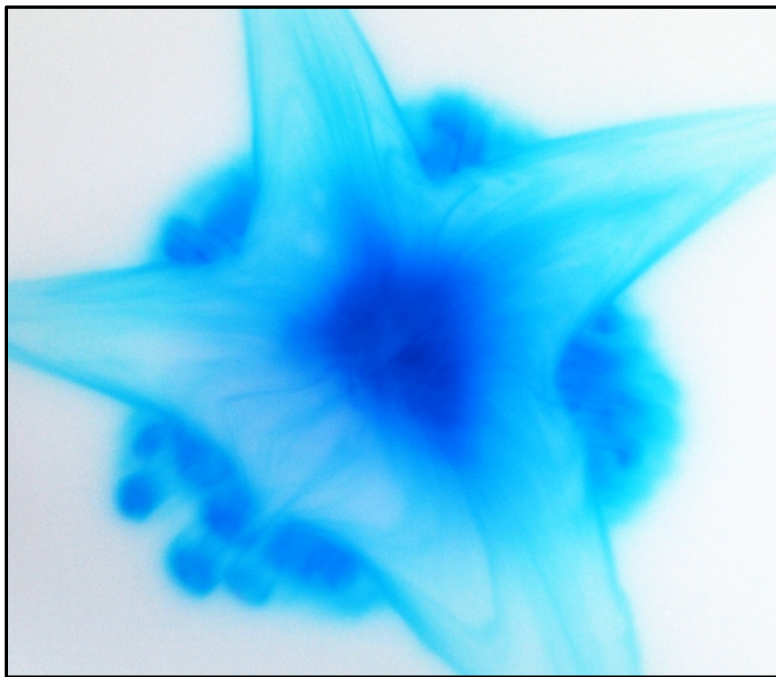


Figure 4: Final Image

This experiment can be done with just milk and soap but to be able to see all the interesting flow patterns some sort of tracking additive must be added to the milk so that you can see how the milk particles that were in the center move quickly outward. For this experiment I use food coloring to track the movement of the milk during the reaction. This image was taken in natural light from a window, though if I was to do it again I would have put more direct lighting onto it so that there is not that shadow on the dish in the original image.

This photo was taken from about 12 inches away from the surface of the milk with a Nikon D40. I used my AK-S Nikkor 18-55 mm lens for this photo, though when the photo was taken the focal length

was set at 30mm, I used this focal length because this is where I could achieve my most crisp focus of the surface. It would have been nice to have a macro lens though, then I would have been able to pick up more detail in the flow pattern, but I did not have one available. The aperture was set to an F-stop of 4.8 with a shutter speed of 1/30sec and ISO set to 100. I was in manual mode and messed around with a couple of different settings, but this gave me the clearest images. The original image was 3872 x 2592 megapixels, after processing the image with PhotoShop the image was 1462 x 1260 megapixels. I used PhotoShop to crop the picture down to the important part; I chose to cut the points of the star off to add a sense of the dye flowing off somewhere. I also messed with the color curve of the image to make the milk whiter and the blue stick out a little more, this also brightened the image some from the original photo.

I really liked how my image turned out, though it was not what I had expected or had seen before when doing this experiment. First off I was using a different kind of food coloring than I have used before; usually people use the water based food coloring and can put the drops into the milk in a really concentrated form, where as my dye solution was already diluted from mixing it with milk. I think this is one of the reasons my image came out the way it did. The reason that I chose this image of all that I took was the distinct four pointed star that was formed. I wish I could have got the image a sharper and more detailed in the flow, to get this change I needed more light and a macro lens for my camera. I could not get the focus on the surface of the milk as sharp as I wanted it with the lens that I used. Plus with a macro lens I bet you would be able to see the individual dye particles in the milk. Even the way that I took this image you can see how the color bunched in darker lines where the milk is still undisturbed in between the four points. Over all though as my first image for the course I am pleased with what I came out with. I feel the flow of the dye is very prevalent in my image, though more detail would have been nice.

Sources:

[1] Spangler, Steven. "Color Changing Milk." *Steve Spangler Science*. Steve Spangler, INC., n.d. Web. 3 Feb. 2013. <<http://www.stevespanglerscience.com/experiment/milk-color-explosion>>.