Flow Visualization: Team Image #2 Report

The image above is a submission for the spring semester of Flow Visualization's second team based image assignment. Similar to the first team image project, this image and setup was created independent of a group. This image captures the fluid experiment involving food color dye in milk with dish soap. The food coloring dropped into the milk remains relatively motionless at first, but once a bit of dish soap comes into contact with the milk, the dye begins to rapidly travel about the milk.

The image apparatus setup was simple. Whole milk bought from a local grocery store was poured into a ceramic plate. Once this thin layer of milk on the bottom of the plate settled, neon food coloring dye (McCormick ®) was dropped onto the surface of the milk. In the case of this particular image, four drops of each neon purple, green, pink, and blue were placed in a four separate regions in the plate. The four regions and plate can be seen below.

Figure 1 - Setup with plate and milk

After the food coloring was dropped in place, a cotton swap with a very small amount of Palmolive® dish soap was dabbed into the center of the milk layer on the plate. To recreate the image, however, any brand dish soap and food coloring should be as effective.

The phenomena itself revolves around the properties of dish soap and how it interacts with the milk in the plate. Dish soap has strong ability to break down and dissolve chemical bonds in order to effectively separate food and liquids from respective pots and pans. This is due to the soap's bipolar

properties of having hydrophilic and hydrophobic ends. The soap breaks down the fat inside the milk and destroys the surface tension where it comes into contact. Then, the surface tension elsewhere in the plate of milk pulls everything away from the dissolved area. In the case of this image, the center of the plate came into contact with the dish soap and immediately after, the surface – and food coloring – begins to pull away from the center. This causes the swirls and photographic elements. This mechanism where the area of liquid with higher surface tension pulling fluid from areas of low surface tension relates to a situation called the Marangoni effect, in which mass moves due to a surface tension gradient. This food coloring effect may also possibly be seen in water due to its polar bonding. However, milk provides a white backdrop and better color mixing.

For future recreation of the submitted image, the same setup can be used. Any plate or bowl can be used. Any milk can be used as well. However, milk with larger amounts of fat seems to be more effective for images. This is most likely due to the areas unaffected by the dish soap to have stronger surface tension from the larger amount of fat. Recreation may not produce identical results due to the chaotic nature of the food coloring, but similar results should be easy to attain.

The original image spans approximately one foot wide by three quarters foot high. The camera flash capability was not used and a combination of other default and custom camera settings were used. The camera, a Sony SLT-A55V DSLR, was located approximately 12 inches from the plate. A focal length of 85 mm was selected at first. Alongside the focal length, an F-number of 5.6, an exposure time of $1/80^{th}$ of a second, and an ISO of 1600 were selected for the best combination of clarity and lighting, at least in the camera's LCD screen. However, when the edited image (which introduces cropping and slight color adjustments from Adobe Photoshop) is placed on a projector screen, the. The original, unedited image can be seen below. Its resolution is 4912 x 3264. The final image, however, is cropped down and ultimately has a field of view of 3.5 inches wide by 2 inches high.

Several other photos were taken after taking advice to increase the depth of view further. However, no matter what combination of settings, there seemed to be a level of out of focus once the

image was zoomed in upon. When the image size is reduced and on screen, there is no obvious blur, but on a projector, focus issues become apparent.

Ultimately, the fluid phenomenon was captured effectively and the setup apparatus was simple. Many different trials allow for several different variations of color mixes and patterns. The largest issues related to the submitted image were photo capture related. Many different combinations of ISO, aperture, and shutter speed were attempted in order to capture an image with less "out of focus" feel when enlarged with the projector. The issue seemed to ultimately stem from possible lighting issues. With better lighting, more settings could have been used effectively and an effective combination may have been found.

Works Cited.

"Tie-Dyed Milk." *Cool Science*. Web. 31 Mar. 2012. <http://www.coolscience.org/CoolScience/KidScientists/tiedyemilk.htm

"Color Changing Milk." *Steve Spangler Science*. Web. 31 Mar. 2012. <http://www.stevespanglerscience.com/experiment/milk-color-explosion>.