2021 Fall - Image Second Report

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I. Intent of Image

The original intent of this photo was to observe the different ways that dye would expand depending on fluid density. Figure 1 shows the final result, which is a comparison over time for dye falling into three different types of fluid: water, wine, and oil. Thankfully, the images gathered provided an interesting visualization of boundaries between two types of fluid, answering my original intent.

Figure 1: *Final Photo Image, showing a drop of dye falling (L to R) into water, wine, and oil.*

II. Flow Description

The flow observed in this experiment comes from the dye being dropped into different densities of liquid. To explain the phenomenon, we must first define the densities of all fluids in the experiment:

$$\rho_{water} = 997 \frac{kg}{m^3}$$
$$\rho_{wine} = 985 \frac{kg}{m^3}$$
$$\rho_{oil} = 919 \frac{kg}{m^3}$$
$$\rho_{dye} \simeq 1000 \frac{kg}{m^3}$$
$$\rho_{air} = 1.225 \frac{kg}{m^3}$$

Besides the density of water, wine, and oil, we also define the density of the dye and air. To begin thinking about the experiment, we first notice that the density of water is the highest (heaviest), then wine, then oil. The density of air is significantly lower, and finally the density of the dye is assumed to be slightly higher than that of water, since it sinks in all three fluids.

Lastly, we must talk about polarity. Polarity is defined by the arrangement of charges in a molecule. If a molecule has a locational imbalance of charges, it will attract other molecules and is called polar. If a molecule is stable on its own, however, it will generally remain separate from other molecules. In this experiment, oil is nonpolar, while water and wine are both polar liquids.

Now, to explain the expansion of the dye. In the oil, we notice that the dye does not expand in the fluid at all. It remains bound by its own surface tension and the nonpolar oil molecules. In this case, the dye and oil do not interact at all. In the wine, we see more interaction between the two fluids. The dye disperses into the polar wine. It forms boundaries and flows through the fluid in streams, exploding when the molecule reaches the bottom of the glass. The dye flowing into the water does the same thing, but has a noticeably larger amount of streams and movement. This is because the density of the water is so close to the density of the wine. Because they are so compatible in density, the dye is able to expand and mix into the water more than it does in the wine.

III. Visualization Technique

Seeded boundaries are created by mixing the dye with the water. While there would be similar flow qualities by mixing a drop of water, the color of the dye allows us to visualize the flow. The dyes were all dropped at the same time from approximately 5 inches above the glasses. Multiple drops (two in this specific photo) were used to add to the amount of visual flow.

IV. Photographic Technique

In the same way as I set up my first photo, to create a good background for the photos, I created a light box using white paper available at my house, this helped reflect the lamp light and sunlight that was available during my experiment. Unfortunately the lighting was yellow instead of a cleaner white light. It helped to ensure there was minimal reflection on the fluid from direct light as well.

The photos were taken with a borrowed Canon EOS REBEL T3 [1]. The settings were optimized to take a clear photo from about 1 ft away. Below, the exact specifications can be seen.

Camera: Canon EOS REBEL T3
Field View: 29 x 29 cm
Distance from object: 1 ft
Size: 2695 x 11147
File Size: 4.8 MB
ISO: 3200
F: 4.5
SS: 1/250 s

After taking the photo, I completed some post processing, the original and edited photo can be seen in figure 2 [2]. The key changes that were made was increasing the brightness and changing the white point to decrease the yellow tint. I also lowered the saturation slightly to help make the photo more visually appealing.

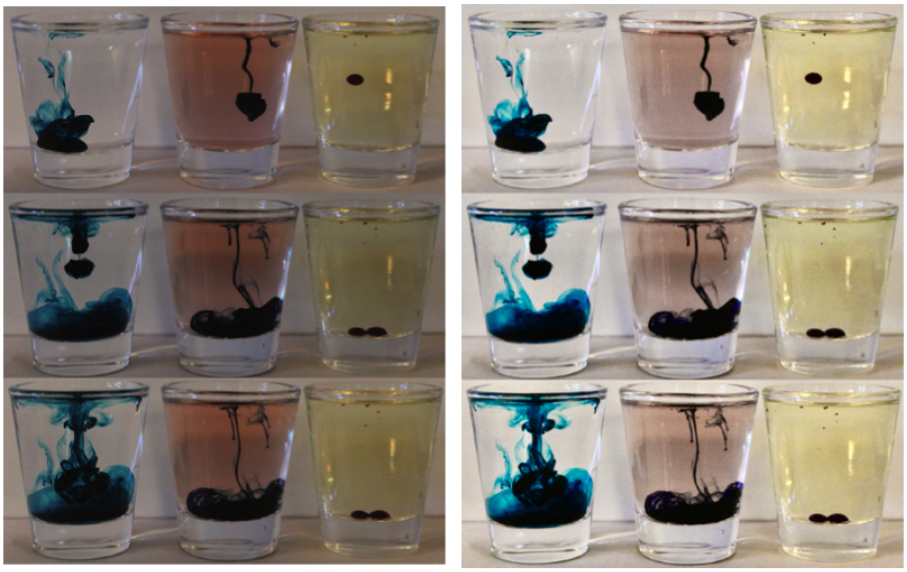

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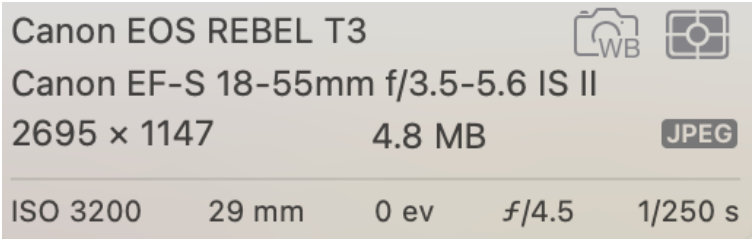
Figure 2: *Before and after postprocessing of the photo.*

V. Image Commentary

This image displayed really interesting flow visualization. It has an experimental look to it because it is comparing three different liquids at the same time. I like that about the photo. While another person could photograph only one frame of one liquid, comparing the three liquids over three time stamps makes it unique. I think it is a very interesting way to visualize fluid density and polarity. Coming into the experiment, I did not know what the outcome would be, so I learned about these things in the process of explaining these photos. The main thing that I would improve about this setup for the future is to use better lighting. Having a very clean white background would make the photos much more engaging and exciting.

VI. Appendix and References

1. Camera Specifications from final photo(s):



2. Post Processing Specifications: