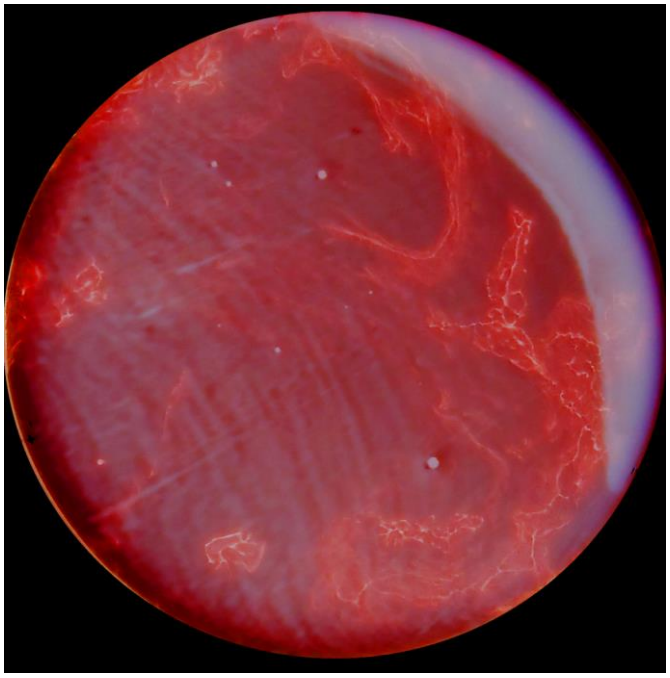
Brent Bauer, Team First Report
MCEN 4151 Flow Visualization
3/4/18

Blue Curacao Dropped in Milk



The image I created was a shot glass filled with Blue Curacao and then dropped in a circular motion into a glass of soy milk. The first thing I needed to do was get a glass that was large enough to be able to observe the flow phenomena, but still flat and vertical enough that it wasn't just a thin pool of liquid on the bottom. I ended up going with an old candle jar than bad been cleaned out and stripped of its stickers. The flow within the image depicts the diffusion of the blue alcohol droplets within the soy milk. The phenomena observed would be a combination of surface tension and intermolecular resistance. The intent of the image was to create a scene where two "working" colors mixed together in what was intended to be an appealing fashion.

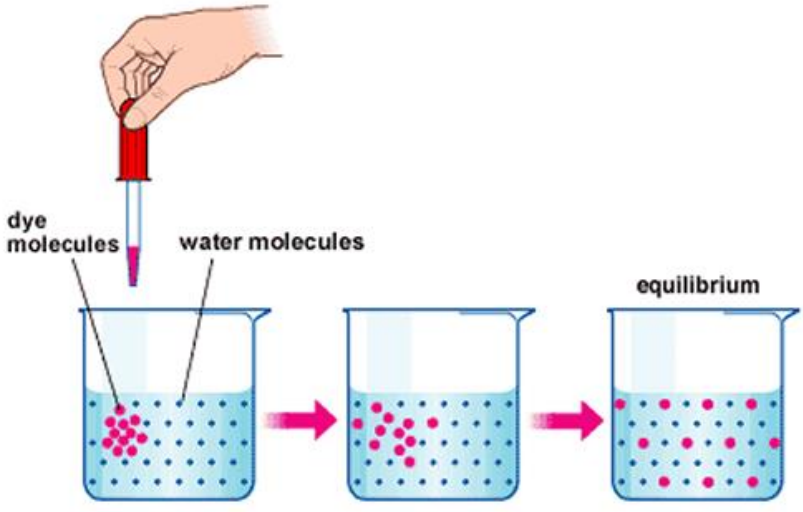
The flow within this image would be best described as a diffusion flow. Diffusion occurs when a substance of a high concentration comes into a substance with a low concentration relative to the first substance. This causes an imbalance in the mixture which drives a flow towards balance. This flow is substance one spreading out into the mixture with substance two until the entire mixture has an evenly spread amount of both substances throughout. In this case it was the dispersion of the alcohol molecules into the larger body of milk molecules. Diffusion can be described mathematically via Fick's laws of diffusion which state; 1. The molar flux due to diffusion is proportional to the concentration gradient, and 2. The rate of change of concentration at a point in space is proportional to the second derivative of concentration with space. [1] The equations for these laws can be depicted below.

Fick's first: $N_i = -D_i \nabla c_i$

Fick's second: $\frac{\partial c_i}{\partial t} = D_i \nabla^2 c_i$

Where i is the species, N is the molar flux, D is the diffusion coefficient and c is the concentration.

The flow of diffusion is best depicted as follows [2]



The Image I created takes place in step 2 from above, the Blue Curacao is beginning to diffuse, but it was not fully diffused into the milk at that time. The image depicted on page 1 has a total size of about 4" x 4" and approximately 2" tall and was taken from 8" above the glass and 10" from the top of the mixture. Since the liquid was moving so slow, no special resolution or shutter times needed to be used.

For this image, the photographing technique was quite simple. I had an extra light as well as a ceiling light from above to help reduce shadows or reflections in the glass, and then I put the camera on full zoom and leaned inwards until the image was both in focus and filled the sensor. The extra light was a flashlight from an IPhone 7 and was held approximately 24" above the glass. After taking several images of this liquid, I decided on this one because it not only showed the most interesting shapes, but it also had the best clarity in presenting the mixing of the Blue Curacao into the milk.

This image was taken using a Cannon model DS 126311 with a standard 18-55mm lens and a shutter speed of approximately 1/60. In terms of post processing I used Photoshop to crop out the class, enhance the contrast, and complete the color inversion which helped put focus on the liquid and give it the cosmic look. I also increased the brightness just slightly to further help the colors pop.

As aforementioned this image depicts the diffusion of Blue Curacao in soy milk. The Curacao was poured in, in a swirling pattern to try an incite a more appealing image. Overall I am really pleased with how the image turned out. I am quite the novice when it comes to photography and image processing, so being able to produce something that I consider to be "quality art" is a real moment of pride for me. Since the mixture is moving so slow, and all forces are intermolecular the physics cannot be seen directly within the image, but are more inferred. I would say though, that my intent for the photo was fulfilled and if I had to do it again I would try repeating it with different swirl techniques, different liquid temps, and possibly even different types of milk to see how the different fat percentages change the diffusion rate.

Source links:

1. https://www.comsol.com/multiphysics/diffusion-equation
2. https://socratic.org/questions/how-would-you-compare-diffusion-with-effusion