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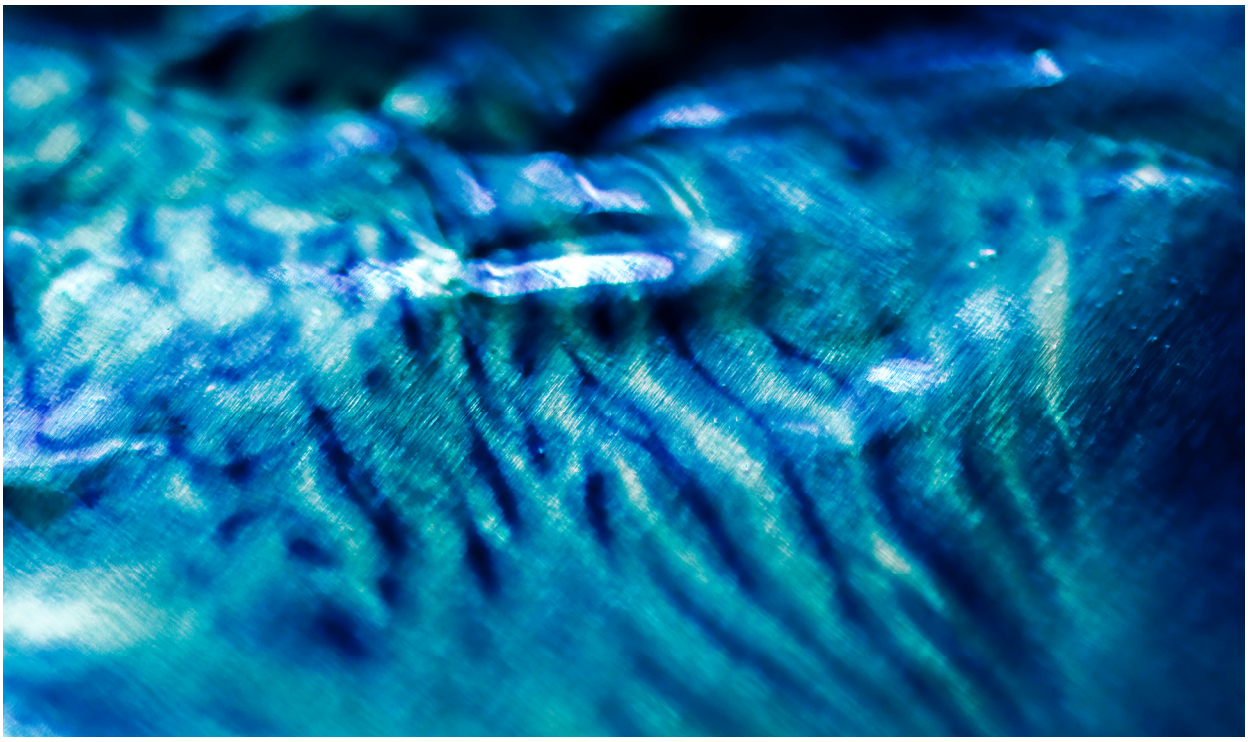
MCEN-4228-001

Flow Visualization: Group Project 01



Modified final image

The group focused on capturing the diffusion between two fluids with different densities. We mainly focused on the interaction between the interfaces of fluids. The first test was diffusion between distilled sink water and corn syrup at room temperature; however, the process took far too long. In an attempt to decrease the time it took to diffuse, other common household chemicals were used. These chemicals are 200-proof ethanol and 3% hydrogen peroxide. A ceramic plate was covered with Reynolds wrap aluminum foil to reflect light through the fluids. Then a drop of corn syrup was placed on top. After 30 seconds, the corn syrup would even out. Afterwards, well mixed dyed ethanol or peroxide was placed next to the corn syrup in hopes that for a quicker diffusion time. The Figures below is a list of the fluid properties and an estimated Reynolds number as the corn syrup diffused into the less dense fluids. The

diffusion can be modeled using Fisk's first and second laws of diffusivity. The first law relates the diffusive flux to the concentration field. His second law predicts how diffusion causes the concentration field to change with time. For the case of the Flow Visualization experiment, the first law:

$$n(x,t) = n(0)\,\mathrm{erfc}\left(\frac{x}{2\sqrt{Dt}}\right)$$

Calculates how far the density has propagated in the x-direction by diffusion in time t. Time t=15s, travel length D= 0.025m, and n(0) is the density of the corn syrup at time t= 0s. The equation provides a generalized differential equation of density as it moves through x distance with respect to time. At the interface between the two fluids, the of corn syrup density increases as it diffuses into the ethanol alcohol.

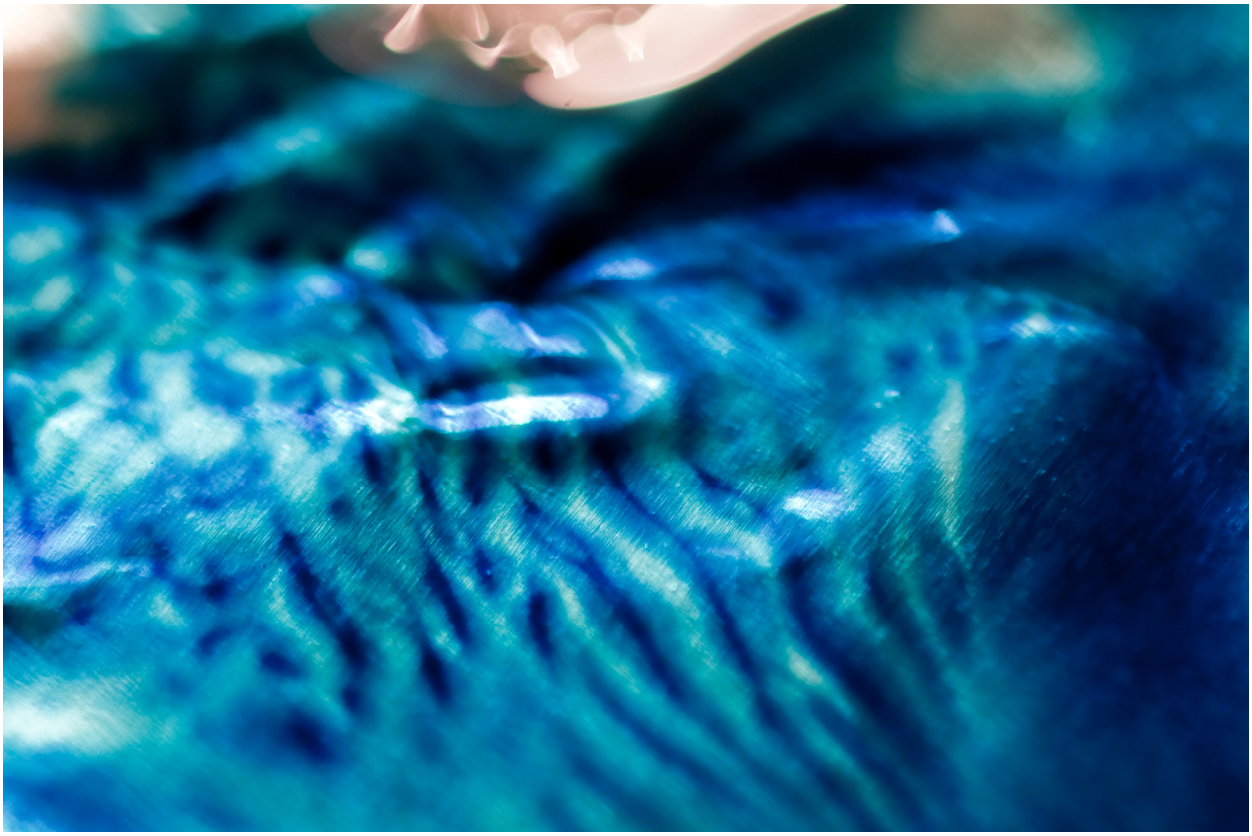
Table of fluid properties

	Corn Syrup [1]	Hydrogen Peroxide [2]	Ethanol [3]
Density :	1360 Kg/(m^3)	1004 Kg/(m^3)	789 Kg/(m^3)
Dynamic Viscosity:	24 Kg/(m*s)	1.04*10^-3 Kg/(m*s)	1.2*10^-3 Kg/(m*s)

Estimation of Reynolds Number

Density:	1360	Kg/(m^3)
Velocity (estimated):	0.00125	m/s
Length:	0.025	m
Viscosity:	0.00104	Kg/(m*s)
Re =	40.86538462	

The final image displays the diffusion of denser corn syrup into a lesser dense blue dyed ethanol mixture. Time lapse is much quicker than water; the photograph was taken 15 seconds after the two fluids had been mixed. The low Reynolds number indicates very laminar and stable flow throughout the concentration gradient. Photoshop was used to enhance the flow and display, in detail, the concentration gradients. A high pass filter was overlayed on top of the original image, and set to 23.3 pixels. Afterwards, picture cropping brought the raw image down to a manageable size. The original image size is 4288 x 2848 pixels down to 3859 x 2278 pixels. Other than the high pass filter and picture cropping, no other photo enhancements were done in Adobe Photoshop.



Unmodified final image

References

[1]http://www.umaine.edu/marine/people/sites/pjumars/classes/SMS_481/SFLab.pdf

[2] http://en.wikipedia.org/wiki/Hydrogen_peroxide
http://www.h2o2.com/intro/properties/physical.html

[3] http://en.wikipedia.org/wiki/Ethanol