Team Image #2 Report

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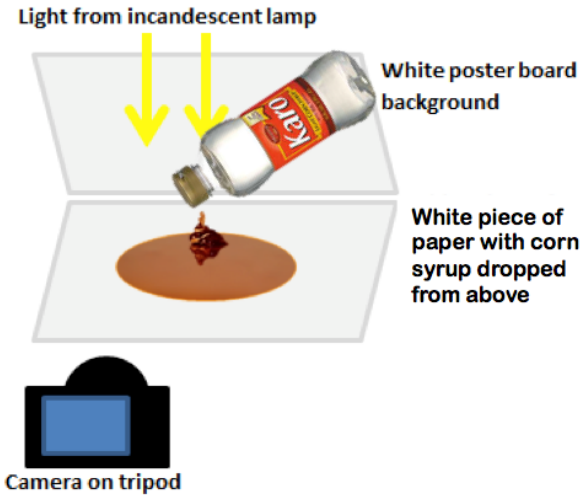
Liquid Rope Coiling

https://vimeo.com/90670470

The video I created titled “Liquid Rope Coiling” is a product of the second team image assignment for the Flow Visualization course at the University of Colorado at Boulder. This idea was inspired from an image I saw from a previous students’ work for the Get Wet assignment in 2011 that demonstrated the Liquid Rope Coiling effect with honey[1]. I worked with my assigned team members on this idea to photograph multiple images and videos of this effect with both honey and corn syrup. The intent was to photograph the phenomenon that can be created by releasing viscous fluid from a specified height so that it coils on top of itself into a cylinder. The video I created does not display this effect perfectly, but instead it displays the instability that is created by a dropping a viscous fluid from a higher specified height and how the liquid rope coiling affect comes into play.

The flow apparatus used in this video consisted of the corn syrup dropped from a height of about one foot, onto a flat sheet of paper with a white backdrop across from the camera on a tripod. This apparatus is illustrated in Figure 1, below. The flow itself was created using Karo Corn Syrup that was dyed purple, poured in a cup, and placed in the freezer for about 10 minutes to make it cooler and therefore, more viscous. Corn syrup was chosen because of its high viscosity and ability to fall in a steady stream with varying



[1] Phee, Matt. *Get Wet Spring 2011*. 2011. Flow Visualization: Get Wet 2011, Boulder, CO.

thicknesses. In this image, the corn syrup was poured out of a cup, so the stream of fluid falling was thin. The corn syrup remained in a thin stream until it hit the surface of the paper, at which point it curled and fell into different shapes, similar to how a rope would fall in real life, which is why this phenomenon can be described as the liquid rope coiling effect. Rope coiling, a phenomenon which is not quite fully understood by scientists, can be studied with the help of the Reynolds number, which is a ratio of inertial to viscous forces. This number, calculated by the equation below, helps scientists determine inertial versus viscous forces that are demonstrated over the flow.

$$Re = \frac{\rho V L}{\mu}$$

The variables in the equation represent common properties of the fluid: density (ρ), velocity (V), length (L) and dynamic viscosity (μ) of the fluid[2]. Density of corn syrup is 1380 kg/m^3 [3], the length of the flow is estimated to be 1 foot (0.305 m) and the dynamic viscosity is about 24 kg/s m[4]. Since the fluid was dropped about 0.3 meters up and took under 1 second to fall, I estimate the velocity to be bout 0.3 m/s. Using the equation, I obtained a result of 5.26:

$$Re = \frac{\rho V L}{\mu} = \frac{(1380\ \frac{kg}{m^3})(0.3\ \frac{m}{s})(0.305\ m)}{24\ \frac{kg}{m\ s}} = 5.26$$

Since this Reynolds number is low, it suggests that viscous forces dominate over the inertial forces, meaning that the flow is laminar. In addition to the Reynolds number, the flow in my video can also be described as the inertial regime of the

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[2] Decker, Terese. *Liquid Rope Coiling Effect: Assessing the Behavior of a Highly Viscous Fluid Jet*. Tech. Boulder: Flow Visualization, 2010. Print.

[3] Elert, Glenn. "Density." The Physics Hypertextbook. N.p., 2014. Web. 6 Apr. 2014. <http://physics.info/density/>.

[4] "Suspension Feeding." SMS 481: SBS, Design of Organisms for Momentum, Mass and Information Transfer. University of Maine, Fall 2010. Web. 10 Apr. 2014. <http://www.umaine.edu/marine/people/sites/pjumars/classes/SMS_481/SFLab.pdf>.

liquid coiling effect[5], which is created when a viscous fluid is dropped from a height of about 1 foot and inertial forces come into play over gravitational forces.

The visualization technique used in this image is through the use of a viscous fluid. The fluid, corn syrup, was obtained from the local grocery store, King Soopers. The lighting used in the room was from the natural lighting of the window as well as an incandescent lamp from up above. The camera used was a Nikon D5200 DSLR on the video setting. The distance from the object to the lens was about 6 inches. I edited the movie using iMovie on my MacBook Pro. With the help from a music composer, Alexander White, I was able to add an audio soundtrack to the final movie. Overall, the video reveals the fascinating phenomenon of liquid rope coiling that cannot be seen in every day life and I was satisfied with the final product. For future work, I would like to repeat this liquid rope coiling effect with varying heights and fluids so that I can demonstrate the different types of fluid flow that can be studied and demonstrated.

[5] *Amazing Honey Coiling High Speed Video! - Smarter Every Day 53*. Dir. Destin. Perf. Destin. Smarter Every Day, 2012. YouTube Video.