Shane Fagan
471-865
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Get Wet 1

The purpose for creating this image was to investigate several fluid flows and to create a quality picture of one for the Get Wet Project 1. I intended to make an image that demonstrated how several properties, including density and viscosity, would affect fluid flow. Initially, I planned on involving smoke in the image, but it was very difficult to create a clear image with the interaction between the smoke and the liquids photographed at the right instant. The final image attempts to show how food-coloring droplets behave differently in surrounding fluids of differing densities and viscosities.

To create the image, all that was required was a standard clear pint glass, six ounces of room temperature water dyed with three drops of green food coloring, eight ounces of room temperature vegetable oil, and additional green food coloring to drop into the oil. The dyed water was placed in the glass, then the vegetable oil was carefully poured on top so as not to disturb the boundary layer or create bubbles. The dropper of green food coloring was held 10cm above the glass, and droplets were released over the surface of the oil. The objective was to observe that the dye, which contains propylene glycol as a solvent, would dissolve in water but not in oil. The density of the water is 0.997 g/mL, greater than that of the vegetable oil, which has a density of 0.894 g/mL. This difference in density is why the oil floats on top of the water. When dropped into the oil, the food coloring remains in spherical beads, but falls through at approximately 0.5cm/sec because of its higher density of 1.036 g/mL. The surface tension of the beads keeps them in this form to reduce surface area. The most fascinating part of the process was when the beads fall through the boundary layer between the oil and the water. The beads immediately burst open because of their water solubility, and the dye forms a stream that visibly falls faster and begins to pool at the bottom of the glass (the dye's density is also greater than that of the water). The dye falls faster once in the water because water's kinematic viscosity is significantly lower than that of vegetable oil: 0.91cS vs. 64 cS (calculated from absolute viscosity and density values).[1] The water is not as resistant to the more dense dye flowing through it.

The visualization technique used was aqueous food dye as a means to clearly illustrate the boundary between the oil and the water, as well as undiluted food dye drops to illustrate the path that a dense fluid will take. Ambient light in the room was used along with the camera's flash.

A white backdrop was created for the image using white cloth. The entire image accounts for a field of view of 25cm by 12cm, with the camera's lens 45cm away from the glass. A Fujifilm A900 digital camera was used, with a shutter speed of 1/70 sec, an aperture of 2.9, and a virtual film speed ISO of 400. The focal length of the lens was 8.8mm. Some minor adjustments were made in Photoshop, including adjusting the color balance, removing some writing on the glass, and blurring the background to make shadows and other impurities less distracting.

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[1] http://hypertextbook.com/physics/matter/viscosity/

The image was effective at displaying the differing densities of the water and oil, as well as how the soluble dye flows to the bottom of the glass because of its relative high density. My favorite part of the image is the evidence of this pooling effect at the bottom of the glass, while my least favorite aspect is that it is difficult to see the dye spheres in the oil. Overall I would say that fluid physics are displayed fairly well, and my intent was fulfilled. I would like to improve the clarity of the image, and could expand on the idea by adding a third, even less dense layer on top of the oil or by having a buoyant substance rise through the layers rather than a dense one falling through.