"Get Wet"

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The first flow visualization project entitled "Get Wet" is supposed to show any type of fluid flow. The intent of the image was to observe a wake and mixing in a sheer thickening fluid (cornstarch) and to try to capture the exciting science in an aesthetically pleasing photograph.

The flow apparatus is shown in figure 1 below. The lighting was created by cutting a slit in a box and holding it about three feet above the bowl containing the fluid. The camera was held as close to directly over the bowl as possible to avoid shadows or obscure lighting. A seven-inch diameter bowl was used to hold the cornstarch. Next drops of green food coloring were put in three lines (picture 1). Finally the wake was created by lightly dragging a spoon through the cornstarch (connecting the food coloring drops) as shown in picture 2. To further explore the sheer thickening fluid, drops of red food coloring were put into the cornstarch (picture 3). Picture 4 shows the two food colorings and the cornstarch mixed together. Cornstarch is a viscous enough fluid that once the wake was placed, it stayed for as long as was necessary to take the picture. Cornstarch is a shear thickening fluid because the apparent viscosity increases as the shear rate increases. This means that the harder the cornstarch is stirred, the more it resists. When using the spoon to create a wake and stir the cornstarch it was necessary to go slow and not push to hard or the fluid would act like a solid. A shear thickening fluid also means that it is a non-Newtonian fluid because a plot of shear stress versus shear rate at a given temperature would not be a straight line. Examples of Newtonian fluids are water, air and ethanol. Another shear thickening fluid is quick sand. Shear thinning fluids are the opposite of shear thickening fluids. When a shear thinning fluid's shear rate increases, the viscosity decreases. An example of such a fluid is ketchup.
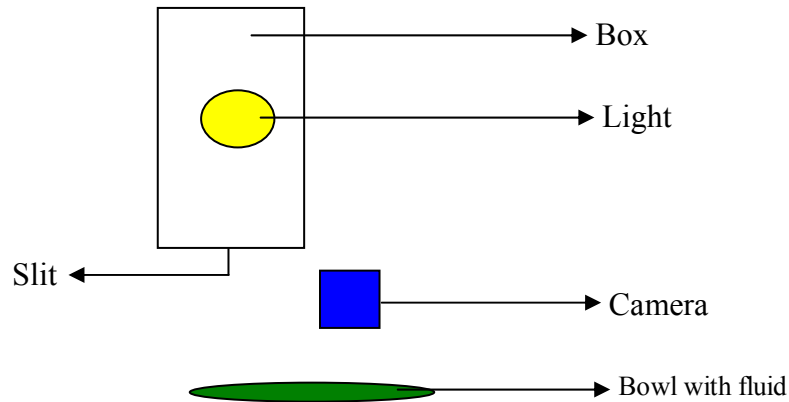
Figure 1: Picture setup

The food coloring was used as a visualization technique so the wake and the mixing could be easily captured in a picture. The lighting apparatus, a 60-watt bulb in a box with a slit eliminates the need for the flash.

Inside the bowl, the size of the field of view was six inches and the distance from the object to the lens was about two feet. The camera used was a digital Canon PowerShot G2 and the pictures were taken with its auto setting. The camera has 4.1 megapixels resolution, 3 times optical zoom, 11 times digital zoom, an aperture of f/2.0 to f/2.5, a focal length of 7-21 mm and a shutter speed range from 1/1000 to 15 seconds. Photoshop was used only to crop the picture and to change the resolution.

The string of images tells an artistic story whereas the wake picture (picture 2) and the mixture picture (picture 4) examine the science behind a shear thickening fluid. The cornstarch freezes what happens when a wake is created and I love how that is captured in picture 2. This also demonstrates the viscosity of the fluid. I also like the artistic strangeness of picture 3. In the image, it appears that Christmas trees are bleeding. I tried to get the pictures to look sharper and less grainy but found that the pictures on the auto setting looked the best. I hope to improve my picture taking skills. These pictures could have turned out better if I completely understood all of the settings on the camera. However, the intent of the project was to fool around with fluids and "get wet" and that is precisely what I did. I would say that it was a success and the future could hold cornstarch on a larger scale in a glass bowl to look at buoyancy.

References:

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3. Munson, Young, Okiishi. Fundamentals of Fluid Mechanics. John Wiley & Sons, New York. 1990.