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3rd team report

This was 3rd team assignment; the purpose of this assignment was to capture the images of the fluids mixing under a black light. Mainly, the mixing of the two fluids were manifested by creating a tornado effect in one fluid then a second fluid was slowly added at a steady rate. Based on experimental setup, a couple assumptions were made prior to the experiment. The tornado effect will cause the separation of the fluids with different particle size or densities. Where heavier particles will tend to travel outside of the vortex and this phenomenon could be more visible under a black light condition.

Why do certain materials glow under a "Black Light"? A black light is also referred to as ultraviolet light and short for UV light. An ultraviolet light has a higher photon energy (*e*) this is due to short wavelength. A mathematical expression of photon energy and the wavelength can be seen in Eq.1. Where the speed of light ($2.99 * 10^8\ meters/sec$) and Plank's constant ($6.626 * 10^{-34} Joules * sec$) are denoted by 'c' and 'h'.

$$e = c * \frac{h}{\lambda} \qquad \text{Equation 1}$$

A black light gives off highly energetic ultraviolet light. Any materials with fluorescent substances (or lower wavelength) absorb the ultraviolet light and then re-emit it instantaneously. During this process the emitted light has a longer wavelength than the absorbed radiation, which makes this light visible and causes the material to appear to glow. For the purposes of this assignment variety of fluids were researched to make sure it can actually glow under black light condition. Ultimately it was determined that tonic water (with quinine) and highlighter fluid was chosen for the experiment.

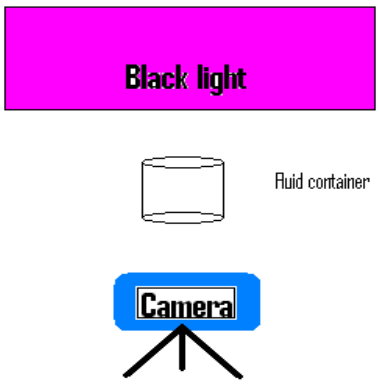

Figure 1. Front view-Experimental layout

As shown in figure 1, the experimental layout was set up such that the fluid container and the black light was place on tabletop. The black light was placed directly above the fluid container to avoid any reflection and the camera was place in front of the experimental setup with tripod. The fluid container had OD of 3 inches and a height of 12 inches. The space between the fluid container and the black light was about 6 inches. A small pancake (handheld) mixer was used to create the tornado effect in the container. During practice runs it was very obvious that turbulent flow is related to the position/angle of the bitter relative the container center. As shown in figure 2, the most of turbulent behavior was formed behind the stem of the

bitter. The behavior of such flow can be analyzed using Reynolds number (*Re*) [1]. The Reynolds number is defined as $Re = Q/\nu$, where $Q = W_0 * A/h$ is the volume of the fluid per unit thickness into the converging area, A is the area of the boundary through outward flow velocity $W_0$is specified, *h* is the thickness of the convergent area, and ν is the dynamic viscosity of the fluid. No quantitative analysis was performed at this point since the turbulent behavior was discovered during practice runs.

Figure 2. Turbulent flow generated during practice runs

My final image can be seen below in figure 3. In order to capture the tornado effect of two different fluids mixing I had to take multiple pictures with a higher shutter speed. The detail procedure of the experiment are as follows: first, pour tonic water into an empty container, place the container underneath the black light such that minimized the reflection off the container surface from the light, set up camera and adjust focus, submerge the mixer in the container and turn on the mixer, pull out mixer out of the container quickly and steadily pour in the highlighter fluid at a steady rate. It was very interesting to observe the two fluids mixing under vortex created by the mixer. As you may notice in figure 3, the vortex is pushing and pulling the highlighter fluid (about two-thirds way down the photo) however it is interesting to recognize that there isn't much interaction in the bottom of the container. Also shear force produced to the fluid from pulling out the mixer can be observed as well. Mainly the tornado formation is maintained on top of the container and the most streaks produced from mixing the two fluids seem that they are not quite a turbulent flow but rather a transitional flow.

In the following section the detail description of the photographic technique used to create final image (figure 3). Canon EOS Rebel T2i Digital Single Lens Reflex (DSLR) camera with EF 100mm macro lens were used. The approximate distance from object to lens was 1.2 Ft. Aperture, shutter speed, and ISO setting was set to f/5.0, 0.5 second, and 3200. The pixel dimension was set to 4081 x 6130. Lastly camera was set to aperture priority (AV). The final image was generated and edited using Photoshop. I used a merge function in Photoshop to combine 4 photos into one image to bring out tornado effect. All 4 photos were taken in continuous-focus mode about 0.5 seconds apart.

I am pretty happy with how my final image turned out. I really like how well focused and clear the fluid is on the bottom of container and it still has a great dynamics of two fluids trying to mix in upper part of the container. Although working under black light condition was a

bit challenging but it was a good learning experience to understand how to modify camera settings in order to compensate for low light condition. I also found it to be very hard to edit images with high ISO in Photoshop. If I have a chance to try this setup again I would love to explorer various containers with different shapes and sizes.

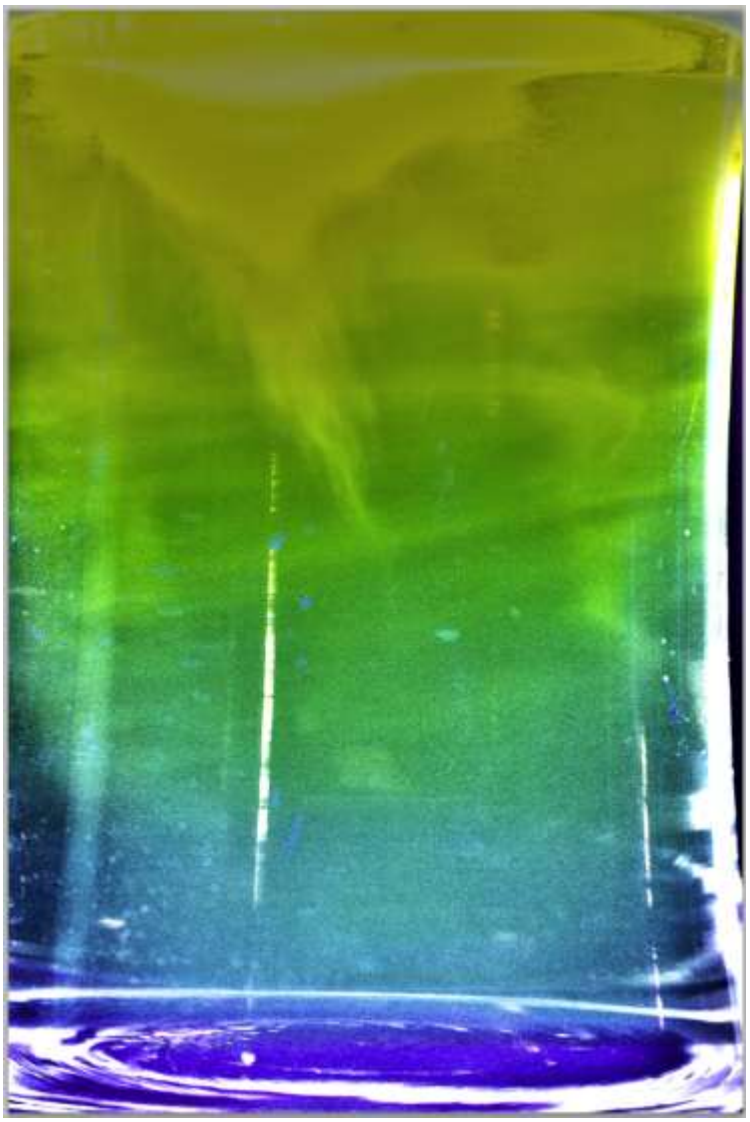

Figure 3. Final image