EXPLORING CHEMILUMINENSCENCE FLUID INTERACTIONS IN WATER

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ABSTRACT

The Flow Visualization class for the Fall semester of 2016 at the University of Colorado at Boulder engaged students to create artistic images of fluid flow. The effect of chemiluminescence for artistic images was explored, and the fluid used included contents from glow sticks submersed in water. The following paper details the assignment and results.

INTRODUCTION

Set-Up

On September 11, 2016, J. Julian and K. Gresh met to explore the effect of submersed chemiluminescence fluids in water. The project took place for an assignment for the Fall 2016 Flow Visualization course at the University of Colorado at Boulder. Several items were obtained which included glow sticks (orange, pink, blue, purple, yellow, and green), oil, black poster board, glass jars, scissors, and water. The set-up took place at the University of Colorado at Boulder and the image used a black backdrop and low lighting conditions to highlight the chemiluminescence effect. The camera used included a Canon Rebel SLR with standard lens. The glass jars were filled with tap water and glow sticks were activated and opened to pour into the jars. During several iterations of capturing images, it was determined that the optimal ISO for the set-up was 6400 and the optimal aperture was 5.6 for the clearest focused images in which the glow stick droplets had crisp, sharp edges. During the iterations of image taking, it was also discovered that the pours had to be extremely slow to capture a crisp image in low light. The faster pours resulted in the glow stick fluid forming droplets along the bottom of the glass jar, but then losing form. Oil was added to the water in an attempt to slow the drops of glow stick fluid, and it was very effective. Other challenges included focusing in extremely low light conditions since the depth of field was shallow and the focus was on droplets within different depths of field planes. The images taken were from the front of the jars on the same level as the base, or from above (Fig 1).

Flow Phenomena

It is approximated that the viscosity is 0.002 due to similarly flowing like milk with greater viscosity than water, but less than oil [Ref 3].

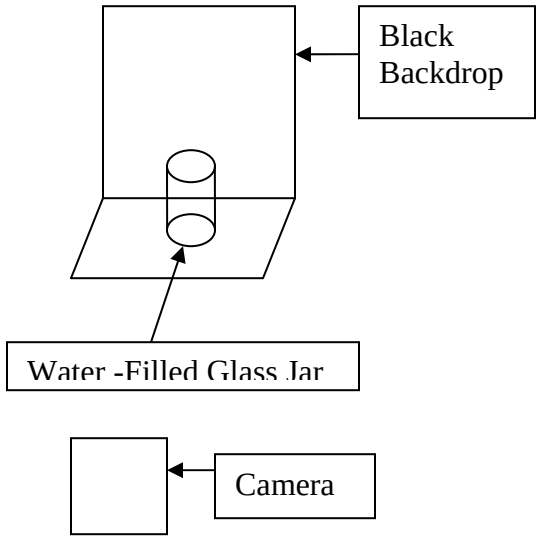

Figure 1: Set-Up

Fluid Phenomena

The fluid consisted of several varying colors of chemiluminescence. It was observed while pouring the fluid in to the water filled jar, the chemiluminescence fluid was of low viscous nature. The adhesion observed was low as evidenced by the edges of the fluid not adhering to the walls of the container. The surface tension of the fluid was high as shown by the droplets. The surface tension can be expressed as the free surface energy per unit area (Fig 2). The work required to create surface tension is the surface tension and the change in area. [Ref 1]

$$W_{min} = \gamma \Delta A$$

Fig 2

The cohesive forces of the chemiluminescence fluid are slightly greater than that of water as illustrated by the droplets in the image. The loss of the chemiluminescence fluids surface tension without externally applied forces shows that the surface tension is greater than water, and physically observed to be close to oil.

Chemiluminescence is a chemical reaction, which produces energy that emits light. The fluid consists of hydrogen peroxide (H_2O_2) which is mixed with a phenyl

oxalate ester ($(COOC_6H_5)_2$) (Fig 3) and fluorescent dye which produces the color [Ref 2]. Five colors were used during the project. The orange color would not pour, and the remaining colors included pink, blue, green, purple, and yellow.

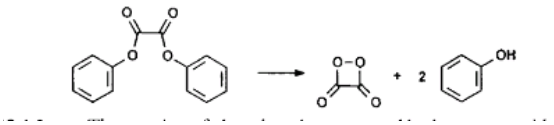

Fig. 3

The properties observed between the different chemiluminescence fluids were identical with droplets forming upon initial pour, and loss of surface tension and dispersement taking place upon the addition of fluids. The colors did not exhibit mixing, and are well delineated in the image.

Visualization Technique

The materials for visualization included a black poster board used as a back drop to highlight the luminescent properties of the fluid. The poster board was purchased at a store. The images were taken in low light conditions to further enhance the luminescent properties of the fluid. No flash was used.

Photographic Technique

The field of view was shallow in order to focus on the main fluid of the blue droplets within the composition. The image was taken at approximately 12 inches in distance from the lens to the droplets. The photography equipment used included a Canon Digital EOS Rebel T6 with a standard 18 - 55mm focal length lens. The ISO setting was set at 6400; aperture was 5.6; and the shutter speed was 1/50 sec. due to the low light conditions. The focal length was 55mm. The original image is 3456 x 2304 pixels (Fig 4), and the final image is 2852 x 1634 pixels (Fig 5). Post processing included adding a blue filter and cropping the image to gain the maximum artistic effect.

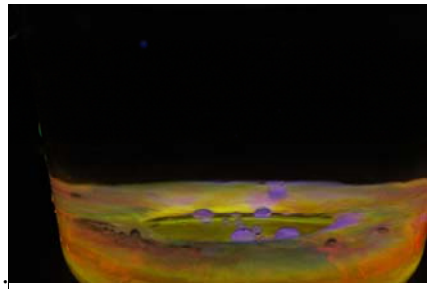

Fig 4

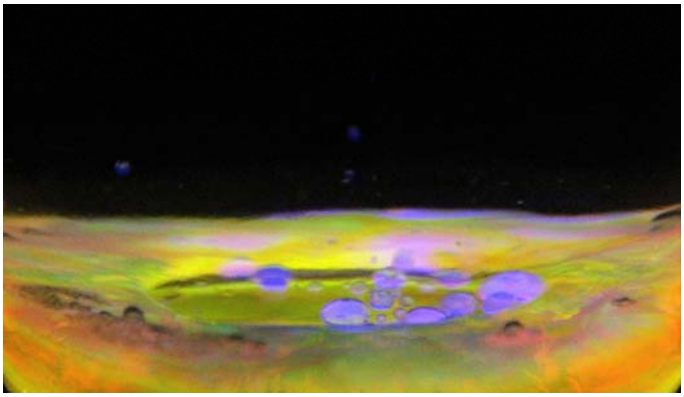

Fig 5

Image Composition

The image was composed to highlight the luminescent nature of chemiluminescence fluids. The image is subtle yet provides a “glow” effect, which was the vision. The quality of the image is much higher in .png and the .jpg image uploaded to flowvis.org is low quality and grainy and not as aesthetically pleasing as the high quality image.

REFERENCES

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