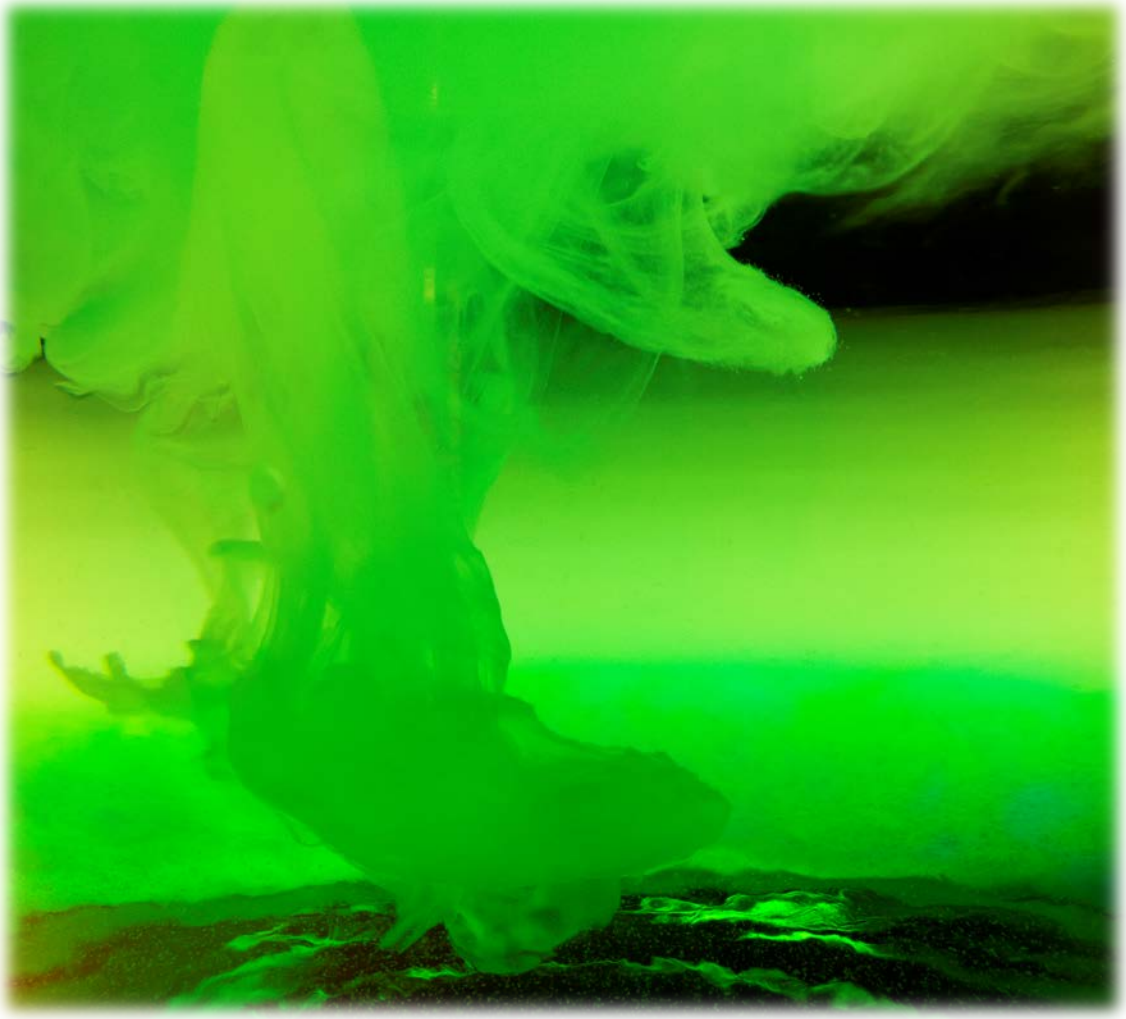
Third Team Assignment



Jacob Varhus
MCEN 4151: Flow Visualization
April 30, 2013

Third Team Assignment

Jacob Varhus
MCEN 4151: Flow Visualization
University of Colorado Boulder

This report outlines the process of creating a flow visualization image of the interaction of dish soap and WD40 with water. Essentially three experiments were performed. The first observed the umbrella instabilities of soap in water while the second observed the jet created by spraying WD40 into the soap and water solution. However, the third and final observation was of clouds formed by the interaction of WD40 and dish soap suspended in water.

Table of Contents

I. Introduction

The purpose of this assignment was to satisfy the requirements for the third group project of Flow Visualization at the University of Colorado. Initial experimentation involved the visualization of dish soap dropped through water and photographed from underneath. Some good images were captured which demonstrated the umbrella instability quite well. After experimenting with soap the water turned a green color as the soap saturated the water mixture. The experimenters then decided to use a can of WD40 and spray it into the water and soap mixture to attempt to visualize the jet produced from the spray. This resulted in some very clear images of the jet. After experimentation with WD40 was complete the solution was allowed to sit. A mysterious cloud began to form as the WD40 interacted with the soap solution. Just for fun the photographer imaged the multiple layers of fog near the bottom of the glass. These images turned out and resulted in the final image presented for this project.

II. Experimental Setup

The experiment was performed in a standard residential kitchen with a white poster board backdrop. A cylindrical vase was used as a glass to contain the fluids. The setup was illuminated with a standard desk lap from above and slightly to the side of the glass. Small adjustments were made to the position of the light to reduce glare off the side of the glass. The entire setup is shown in Figure 1.

Figure 1: Experimental Setup

In order to create the final image first the vase was filled about 2/3 of the way with tap water. Then green dish soap was dropped into the water and allowed to dissipate, coloring the water green. After the soap had dissipated and the water was an even green color a short burst of WD40 was sprayed into the top of the water as the jet was observed. This too was allowed to dissipate and form a cloud. Then as the WD40 was settling images were taken from below of the boundary between clear soap and water mixture and the cloudy WD40 mixture.

III. Description of Flow Physics

A. Observations

First, as the soap was added to the water the umbrella instability was observed. This created some very interesting fluid behavior. An image of the soap being added to the water is shown in Figure 2

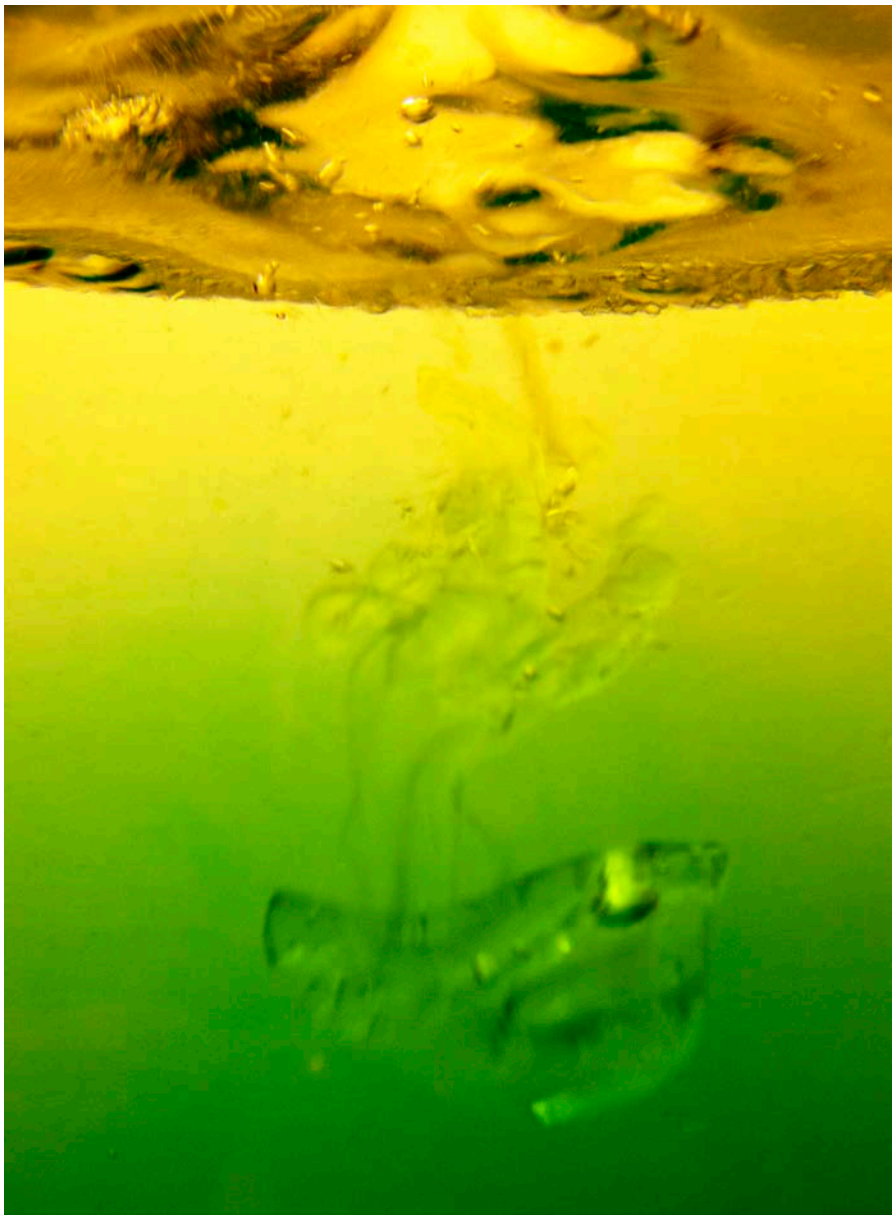


Figure 2: Soap Addition

Then as the soap from the umbrella instability dispersed a jet of WD40 was introduced into the system. Images were also captured of the WD40 jet as shown in Figure 3.

Figure 3: WD40 Injection

After the WD40 was injected into the solution some interesting chemistry was observed. WD40 is an oil-based lubricant. Therefore the soap in the water immediately began to break down and dissolve the oil creating a cloud. This cloud slowly settled from the top of the glass into the bottom. Due to natural convection the settling did not occur evenly and various fluid interactions were observed at the base of the cloud where it interacted with the clear solution beneath. The image was taken of this interaction.

IV. Photographic Technique

B. Image Capture

A Cannon PowerShot G9 digital camera was used to capture the image. Various shutter speeds, exposures, and ISO settings were experimented with in order to capture the image. It was difficult to capture macro images as rapidly as required to capture the fluid's motion. The final image was captured using a shutter speed of 1/30 sec, F-stop of f/4.0, ISO of 100, and focal length of 7.4 mm. At these slow shutter speeds a clear image was difficult to capture the moving fluid without a tripod.

C. Post Processing

After capturing the image it was adjusted using Adobe Photoshop. The image was cropped slightly to focus attention on the fluid interactions and to cut out distracting elements such as the glass's edge. The original image was 4000x3000 pixels in dimension. After editing the final image size was 2716x2464 pixels. Then a slight adjustment of contrast was made. Overall contrast was adjusted using a manual S-curve to better highlight the lights and darks in the image. Extreme care was used to avoid adjusting the appearance of the fluid. A few blemishes were removed from the image which were caused by imperfections in the glass. Care was taken to avoid altering the appearance of the fluid properties. Figure 4 and Figure 5 show the image before and after editing in Photoshop respectively.

Figure 4: Before Editing

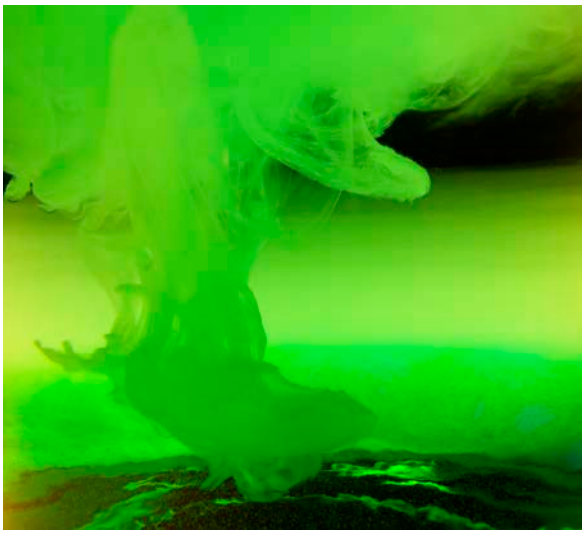


Figure 5: After Editing

V. Conclusion

Although the results from the expected experiment were not used as the final image, the work led to the observation of some very interesting phenomena. It was a difficult

decision deciding which images to use as essentially three experiments were performed. Each experiment resulted in some good images all representing different physical phenomena.

VI. References

Moran, M. J., Shapiro, H. N., Munson, B. R., & DeWitt, D. P. (2003). *Introduction to Thermal Systems Engineering*. John Wiley & Sons, Inc.

VII. Acknowledgements

The author would like to thank teammates Mark Carter, Gage Henrich and Hannah Schumaker, roommate Cameron Trussell, as well as Prof. Jean Hertzberg for their help with this project.