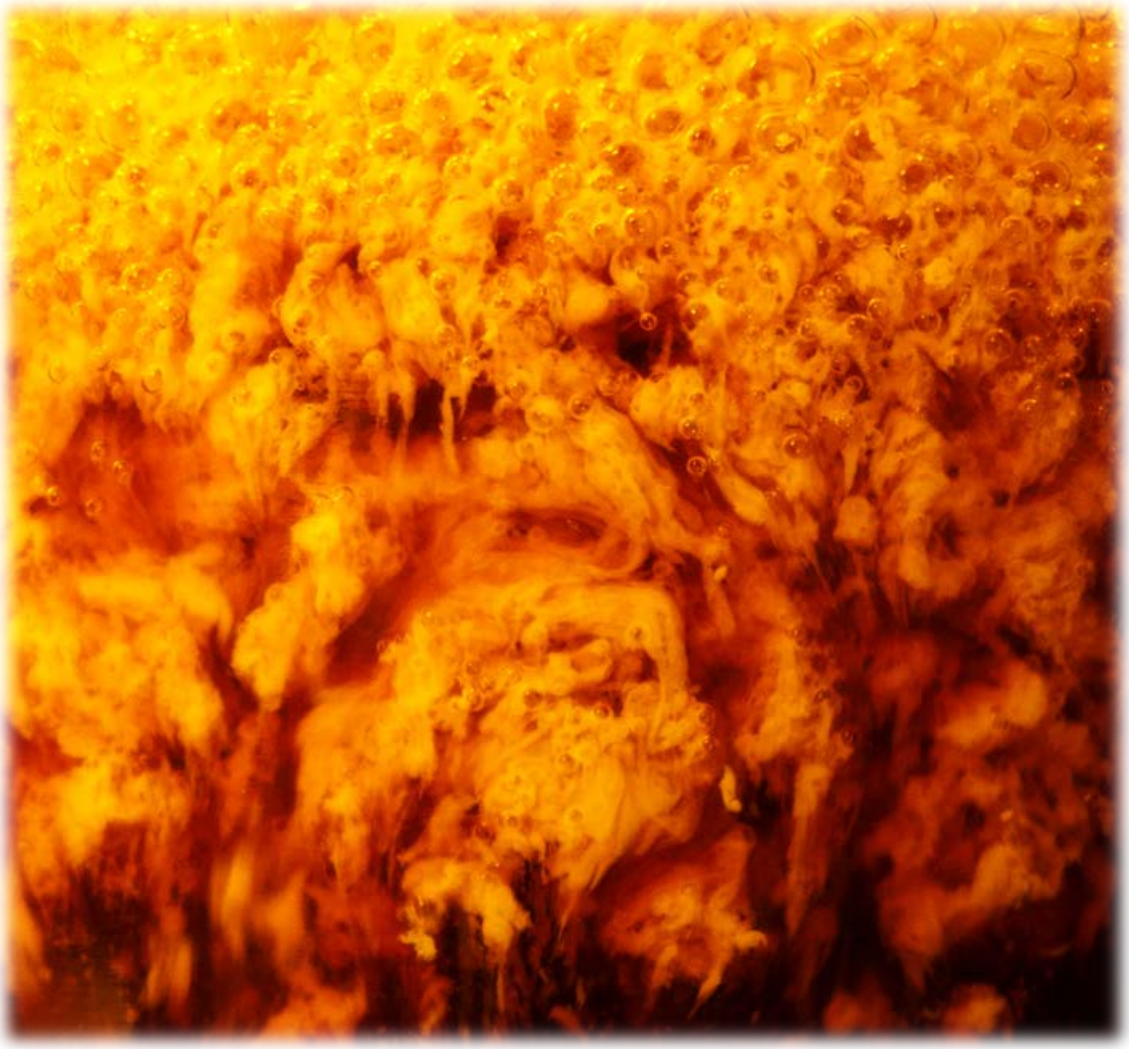
Second Team Assignment



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MCEN 4151: Flow Visualization
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This report outlines the process of creating a flow visualization image of the interaction of Irish style cream liquor with an Irish stout. Images were initially captured to visualize the physics of the flow; however some very interesting chemistry presented itself. Therefore the attention of the image was focused on the chemical reaction between the two fluids as well as the physics.

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I. Introduction

The purpose of this assignment was to satisfy the requirements for the second group project of Flow Visualization at the University of Colorado. After several failed attempts at visualizing a multitude of flows frustrations were high and students were becoming desperate. It was decided to attempt to photograph the interaction that occurs when a small glass of Irish cream whiskey is dropped into a larger glass of an Irish stout. The chemical reaction combined with the fluids' physics resulted in some very unique images.

II. Experimental Setup

The experiment was performed in a standard residential kitchen. A pint-sized glass was filled halfway with an Irish stout and placed on a white countertop in front of a white backdrop. A simple desk lamp was used for overhead lighting. A smaller, 1.5 oz, glass was filled with an Irish style cream liqueur. The camera was positioned to the side of the pint glass at a distance of about 2 inches. An assistant then dropped the smaller glass containing the cream liqueur into the larger glass containing the stout. As soon as the glass submerged the camera began taking a rapid series of images.

Note: No chemicals used in this experiment were poured down the drain. All chemicals were disposed of according to the manufacturer's specifications.

III. Description of Flow Physics

A. Observations

Once the smaller glass entered the larger glass some interesting phenomena were observed. First of all the different densities of the fluids resulted in some interesting physics as the two fluids mixed. Because of the stark difference in color between the dark stout and light cream the mixing effects were easily visible. However, due to the speed of the fluids' movement it was very difficult to photograph these effects. The most obvious phenomena observed were vortices above the falling glass which caused a circular mixing of the fluids. A slight trace of one of these vortices is visible in the image.

Chemistry most easily explains the phenomena which occurred when the fluids were mixed. Irish cream liquor, like milk, curdles in the presence of a weak acid. This happens because the cream contains a substance called casein which is a protein found in milk. Casein coagulates when mixed with weak acids. Since the Irish stout is slightly acidic, it causes the casein in the cream to coagulate and curdle.

IV. Photographic Technique

B. Image Capture

A Cannon PowerShot G9 digital camera with a macro lens adapter was used to capture the image. Various shutter speeds, exposures, and ISO settings were experimented with in order to capture the image. Some photographs were taken with a macro lens, however they did not turn out as well. 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/2.8, 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 captured with the intent of visualizing the fluid's motion. However after looking at the images the curdling phenomena appeared very interesting. Therefore the image was cropped to focus just on the chemical interaction between the head and the stout. The original image was 4000x3000 pixels in dimension. After editing the final image size was 1472x1368 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. Figure 1 and Figure 2 show the image before and after editing in Photoshop respectively.

Figure 1: Before Editing

Figure 2: After Editing

V. Conclusion

Although the results from this experiment were not as expected, the image effectively portrays the chemical reaction that occurs between the two fluids. If this experiment were to be performed again it would be nice to have a faster camera in order to capture the motion of the fluids as they are mixed.

VI. References

[1] M. J. Moran, H. N. Shapiro, B. R. Munson and D. P. DeWitt, Introduction to Thermal Systems Engineering, John Wiley & Sons, Inc., 2003.

[2] Keith, "Drink Workshop," 23 March 2011. [Online]. Available: http://www.drinkworkshop.com/2011/03/cocktail-chemistry-why-milk-curdles-in-alcohol/. [Accessed April 2013].

VII. Acknowledgements

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